PN-AAU-410

ECONOMIC STUDY OF POSSIBLE USES OF ADDITIONAL WATER ON THE KOMATI RIVER, SWAZILAND

VOLUME I : THE MAIN REPORT

VOLUME II : PRE-FEASIBILITY ANALYSIS OF THE KOMATI RIVER IRRIGATION PROJECT

VOLUME III : MARKETS AND MARKETING

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645 00 68
August 31, 1985

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ACKNOWLEDGEMENTS

Many people contributed to the successful completion of this report. Particularly concerned and helpful were:

Ministry of Natural Resources, Land Use and Energy

1. Mr. A. Maseko, Under Secretary
2. Mr. J. Vilakati, Land Use Planning Officer and Leader, Government of Swaziland (GOS) Counterpart Team
3. Mr. W. Gibson, Land Use Planning Advisor and Deputy Leader, GOS Counterpart Team
4. Mr. Robert Thabede, Senior Water Engineer
5. Mr. Noah Nkambule, Senior Land Planning Officer
6. Mr. Musa Shongwe, Soil Scientist
7. Mr. Caleb Bhembe, Irrigation Engineer
8. Mr. Stephen Dlamini, Water Control Officer
9. Mr. David Jenkins, Hydrologist, Water Resources Branch

Ministry of Agriculture and Cooperatives

10. Mr. Robert Thwala, Under Secretary
11. Miss Funekile Simelane, Rural Sociologist
12. Miss Nonhlanhla Thwala, Agricultural Economist
13. Mr. Gail Dunn, Irrigation Agronomist (Research)

Economic Planning Office of the Prime Minister

14. Miss Ruth Griswold

USAID

15. Mr. Paul Daly, Agricultural Development Officer
16. Mr. Neil Cohen, Regional Economist
17. Dr.E.V. Richardson, Irrigation Engineer (Consultant)

Other

18. Mr. J.R. Bond, Impompi (Swaziland) Ltd, Irrigation Engineers and Suppliers
19. Mr. Geoff Morling, Chief Civil Eningeer, SIS
20. Mr. Charles Sellick, Engineer, Chunnett, Fourie and Partners.

We are also appreciative of the assistance provided by the numerous officials and representatives in other governmental and private agencies, firms and enterprises, especially those connected with the agricultural sector, e.g. irrigation projects and processing establishments.

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LIST OF ACRONYMS AND ABBREVIATIONS

ACP	Africa, Caribbean and Pacific
BLS	Botswana, Lesotho and Swaziland
CAP	Common Agricultural Policy
CDC	Commonwealth Development Corporation
CET	Common External Tariff
CI	Crop Intensity
CIDA	Canadian International Development Agency
CSO	Central Statistical Office
EDB	European Development Bank
EDF	European Development Fund
EEC	European Economic Community
EIRR	Economic Internal Rate of Return
FAO	Food and Agricultural Organisation (of the UNO)
FIRR	Financial Rate of Return
GOS	Government of Swaziland
GM	Gross Margin
GSP	Generalized System of Preferences
GDP	Gross Domestic Product
IBRD	World Bank
IDU	Irrigation Development Unit
IFAD	International Fund for Agricultural Development
IRR	Internal Rate of Return
ITC	International Trade Centre, UNCTAD/GATT
ITF	Individual Tenure Farms
JPTC	Joint Permanent Technical Committee
KOMAPRO	Komati Agricultural Products Marketing Authority
MAR	Mean Annual Runoff
MOAC	Ministry of Agriculture and Co-operatives
MSL	Mean Sea Level
NAMB	National Agricultural Marketing Board
NIDCS	National Industrial Development Corporation of Swaziland
NRLUE	Ministry of Natural Resources, Land Use and Energy
PY	Project Year
RDA	Rural Development Area
RDAP	Rural Development Area Programme
RSA	The Republic of South Africa
SAAGA	South African Avocado Growers Association
SACE	South African Citrus Exchange
SACU	South African Customs Union
SAMB	South African Maize Board
SAMGA	South African Mango Growers Association
SATS	South African Transport Services
SCB	Swaziland Citrus Board (Swaziland Cotton Board)
SI	Shortage Index
SIS	Inyoni Yami Swaziland Irrigation Scheme
SNL	Swazi Nation Land
STABEX	Export Stabilization Fund, EEC
TDF	Title Deed Farm

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TDL	Title Deed Land
TLTS (T AND L)	Tate and Lyle Technical Services
TOR	Terms of Reference
UK	United Kingdom
UNDP	United Nations Development Programme
USAID	United States Agency for International Development
USCOE	United States (Army) Corps of Engineers
VA	Value Added

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CURRENCIES, WEIGHTS AND MEASURES, CONVERSIONS

CURRENCY EQUIVALENTS (END JUNE, 1985)

USA Dollar $1.00 = Emalangeni E1.85
Lilangeni 1 = RSA Rand 1

(Rand is also legal tender in Swaziland)

WEIGHTS AND MEASURES

The international system of units (SI) are used throughout this report. Base units for this system are:

Metre (M)	-	unit of length
Second (s)	-	unit of time
Kilogram (kg)	-	unit of mass/weight
Ampere (a)	-	unit of electric current
Celsius (c)	-	unit of temperature
Litre (ℓ)	-	unit of liquid volume
Hectare (ha)	-	unit of space

SI UNIT PREFIXES USED ARE AS FOLLOWS

Multiples & Submultiples	Prefix	SI Symbol
10^9	Giga	G
10^6	Mega	M
10^3	Kilo	K
10^{-3}	Milli	M

CONVERSIONS

The following conversions are offered:

From old Units	Multiply by (approx.)	To SI Units
Ft^2	0.0929	M^2
Acre	0.4047	ha
$Mile^2$	2.590	Km^2
lb/ft^3	16.018	kg/M^3
Ft^3/s	0.0283	M^3/s
gpm	0.0631	L/s
Mile	1.609	km

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Ft	0.3048	M
in	25.4	mm
Ton(long)	1.016	t,Mg
Ton(short)	0.907	t,Mg
lb	0.4536	kg
hp	0.746	kw
psi	6.895	kPa
Mile/h	1.609	km/h
Yd^3	0.765	M^3
Bushel	35.24	L
Gallon	3.785	L

MOST COMMONLY USED

1 hectare (ha)	=	2.47 acres
100 ha.	=	1 sq. kilometre
1 tonne (t)(MT)	=	1000 kg
1 kg	=	2.2 pounds (lb)
1 km	=	0.62 miles
1 metre (m)	=	3.28 feet (ft)

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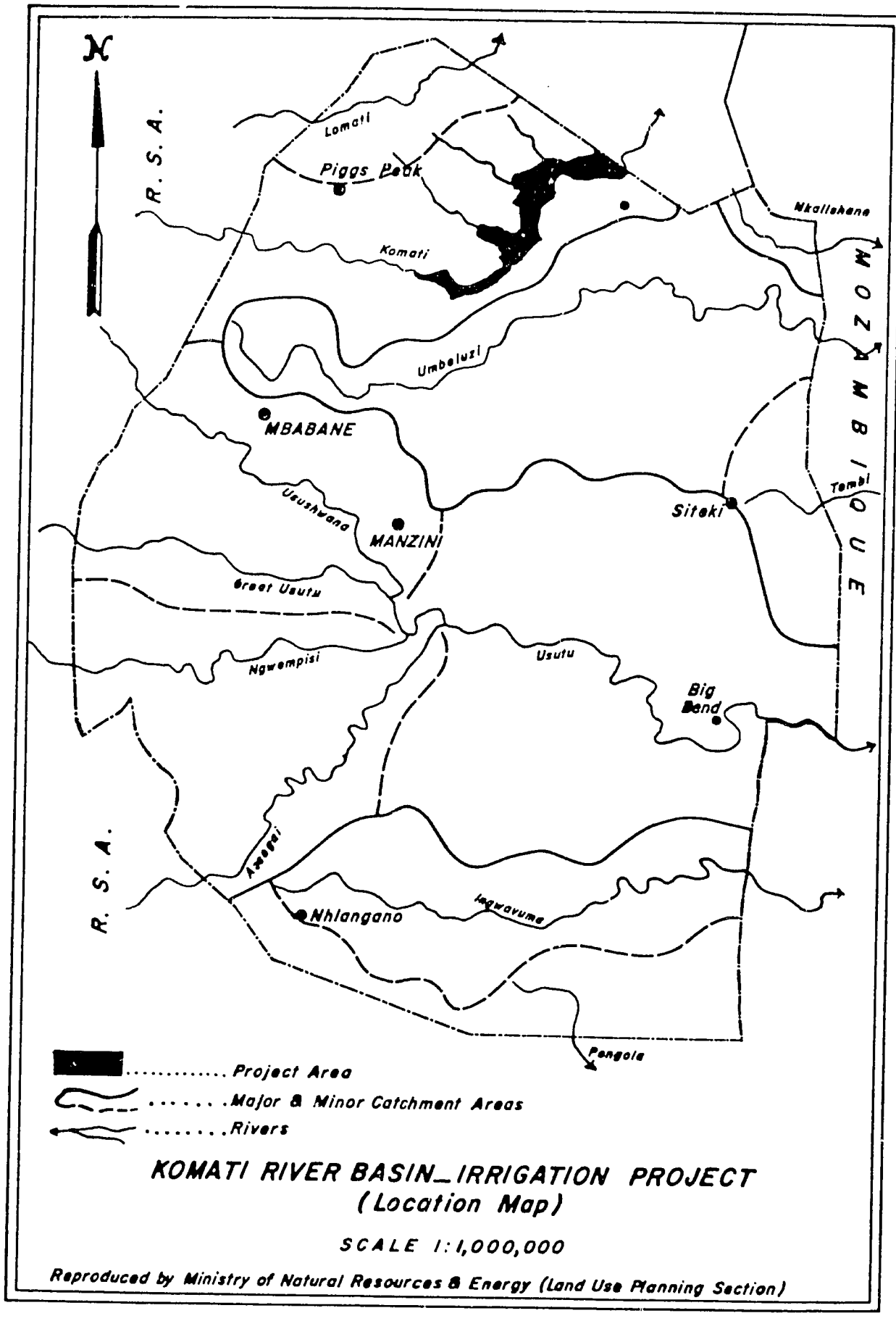

SWAZILAND: ECONOMIC STUDY OF POSSIBLE USES OF ADDITIONAL WATER ON THE KOMATI RIVER

Figure I-1: Location Map of the Komati River Basin Irrigation Project

EXECUTIVE SUMMARY

A. Introduction

This study has been completed in three Volumes. Volume I is the Main Report which embraces all aspects of the consultant's Terms of Reference and addresses all issues relevant to decisions on the alternative economic uses of water from the Komati River Basin in Swaziland. Volume II restricts itself to the pre-feasibility analysis of a 3,000-5,000 ha smallholder-nucleus estate irrigation project on the Komati River, one of the possible uses of that water. Volume III contains the detailed marketing analysis in support of that pre-feasibility study. Each volume contains a series of amplifying and detailing annexes.

Volume II and Volume III contain summaries pertinent to themselves; in Volume II the findings and recommendations are organized as the concluding Chapter V. In Volume III they are presented as an Executive Summary of that volume. This Executive Summary, contains findings and recommendations pertinent to this Volume I and the highlights of the two companion volumes.

The primary objective of this study was to provide hard financial/economic information to the Government of Swaziland regarding alternative uses for any increments in the availability of water from the Komati River. The two prime alternatives given such consideration were the firming up of water supplies to existing run-of-river uses and the development of new irrigated agricultural activities. Other possible water uses have been examined, as have a range of considerations supporting Swaziland's rights to more Komati water and the various costs of those differing levels of water use.

B. Main Findings

1. A 3,000 - 5,000 ha smallholder-nucleus estate irrigation project on the Komati in the lowveld is economic providing appropriate management systems are applied and the necessary agronomic and financial discipline forthcoming. The main characteristics of the project for each of the 3,000 ha and 5,000 ha sizes are shown in Table I-1 and Table I-2. The analysis showed good economic and financial rates of return for both project size alternatives but the larger (5,000 ha) project yielded better rates of return when the cost of the Maguga Dam was included.

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Table I-1 : Summary Statistics: Base Project (Three IDUs) (Consuming 40 MCM)

Net Irrigated Area	
Nucleus Estate	1,800 ha
Smallholders	1,200 ha
Total	3,000 ha
Investment Costs	
Total (including dam)	E71.50 million
Of which	
(Irrigation Development)	(E31.50 million
(Housing and Utilities)	(E 8.36 million
Operating Costs	
Fixed Costs	E 0.92 million/annum
Direct Operating Costs	E 0.82 million/annum
Total	E 1.74 million/annum
Gross Value Added	
Total Crop Revenues	E 8.27 million/annum
Of which	
(Smallholder Revenues)	(E 3.02 million/annum)
(Foreign Exchange)	(E 4.00-5-60 million/annum)
Annual Agricultural Production	
Field Crops	Tonnes
Maize	2,870
Cotton	1,250
Tomatoes	8,400
Potatoes	14,700
Cabbage	14,800
Fruit Crops	
Mangoes	4,410
Papayas	9,500
Avocadoes	15,200
Citrus	15,000

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Table I-1 : Summary Statistics: Base Project (continued)
(Consumming 40 MCM)

Employment Generation	
Smallholders	600 families
Full-time paid farm workers	927
Seasonal workers	627
Personal Incomes Generated	
Smallholder families	E5,035/annum
Paid farm workers	E1,050/annum
Return on Investment	
Exclusive of Maguga Dam	
Economic Return	10.02 percent
Financial Return	8.62 percent
Inclusive of Maguga Dam	
Economic Return	3.87 percent
Financial Return	2.68 percent

Source: Devres Staff Estimates, August 1985

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Table I-2 : Summary Statistics: 5000 Ha Project (Five IDUs) (Consuming 63 MCM)

Net Irrigated Area	
Nucleus Estate	3,000 ha
Smallholders	2,000 ha
Total	5,000 ha
Investment Costs	
Irrigation Development	E92.50 million
Of which	
(Irrigation Facilities)	(E52.50 million)
(Housing and Utilities)	(E13.93 million)
Operating Costs	
Fixed Costs	E 1.53 million/annum
Direct Operating Costs	E 1.38 million/annum
Total	E 2.91 million/annum
Gross Value Added	
Total Crop Revenues	E13.71 million/annum
Of which	
(Smallholder Revenues)	(E 5.03 million/annum)
Annual Agricultural Production	
Field Crops	Tonnes
Maize	4,970
Cotton	2,250
Tomatoes	14,600
Potatoes	25,200
Cabbage	25,400
Fruit Crops	
Mangoes	7,470
Papayas	15,250
Avocadoes	24,400
Citrus	25,000

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SWAZILAND: ECONOMIC STUDY OF POSSIBLE USES OF ADDITIONAL WATER ON THE KOMATI RIVER

Table I-2 : Summary Statistics: 5000 Ha Project (Five IDUs)(continued)
(Consumming 63 MCM)

Employment Generation	
Smallholders	1,000 families
Full-time paid farm workers	1,545
Seasonal workers	1,045
Personal Incomes Generated	
Smallholder families	E5,035/annum
Paid farm workers	E1,050/annum
Return on Investment	
Exclusive of Maguga Dam	
Economic Return	10.34 percent
Financial Return	8.75 percent
Inclusive of Maguga Dam	
Economic Return	5.74 percent
Financial Return	4.32 percent

Source: Devres Staff Estimates, August 1985

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2. Financial analysis of a 3,000 ha project (40 MCM) also indicates that anticipated Stage I dam costs can be covered if appropriate cost recovery processes are implemented. Such cost recoveries can be encompassed within overall financial and economic viability. A 5,000 ha project (63 MCM) would enhance and accelerate such cost recovery systems as would charging other users of Komati water. Such recovery processes would also improve financial/economic rates of return.

3. In the light of recent expansions of reservoir capacities at SIS there is no need to reserve large amounts of post-Maguga water for their "firming up."

4. The use of water for expanded forestry operations appears to be at least as financially/economically viable as other uses. Swaziland is a world leader is such afforestation activities which would use associated resources (SNL land otherwise not productive) to national advantage. Whether this should be a pre- or post-Maguga Dam consideration will have to be determined by further study.

5. A similar finding applies to the use of enhanced Komati water supplies for coal-thermal plants. Data available to the study team on this use of water are rather weak; thus estimates of possible water needs for this purpose are similarly weak. Nonetheless, such a use has been and is immenseley economic elsewhere in the light of energy alternatives. Thermal power development using domestic supplies of coal has possible import substitution/ independence/export earning impacts.

6. Swaziland must obtain as much water as possible on the Komati River Basin. The analysis has shown Swaziland's right to such water as a matter of equity (shares of land available, of future population, of MAR, etc); and the ability to use those amounts economically especially for irrigation, forestry and thermal power. Strong economic arguments can be made for amounts of new water ranging from an absolute minimum of 112 MCM up to 158 MCM at a dam or dam system cost ranging from E39 million to E62 million. Regardless of dam cost, the economic activities for which the new water is used can pay for those costs and still remain financially viable. The economic demand for new water far exceeds the possible future supply.

7. These viable water using activities--irrigation, forestry, thermal plants--do not really need massive doses of new feasibility work to sell themselves. They would be perfectly acceptable in principle to international public and private sector investment agencies; such candidate investor organizations would then no doubt pursue the requisite studies.

8. Such investments require guarantees. It is considered most unlikely that Swaziland would receive external funds for their investments without (a) finalizing an international agreement

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regarding apportionment of Komati River water; (b) firming up the legal structure concerning water rights; (c) the organization and development of a proper Basin management system; (d) creation of an active and broadly-based programme of professional/technical training in the fields appropriate to irrigation management; and (e) establishment of a properly managed and centralized national water planning/development system.

9. It is well recognized that Swaziland is about to face an overall water shortage unless reservoir capacity is expanded. That is very expensive. The current proposed Komati Basin Irrigation Project is possibly one of the few remaining areas in the nation below 50-60m of lift with this area of good irrigable soils. Subsequent projects probably will not be so economic, putting still further onus on other economic water uses.

10. There is a dearth of professionally qualified Swaziland nationals to organize and manage new irrigation projects. New efforts, perforce, in the medium term and including this project, will require expatriates. The lead time to educate and train the professionals required by such projects is rather long and expensive.

11. The absence of a Komati Basin water management planning and control agency could prejudice the proper management of water resources and the acquisition of external funding. It is hoped that steps will be taken to remedy this situation by the JPTC.

12. An overall national water management plan is needed and that need has been recognized for some time. To be avoided, at all costs, is the all-too-common and debilitating problem of several disparate agencies attempting to manage plan and use water resources. In far too many nations one Ministry/Department/Agency is responsible for delivering water to its users, and an entirely separate organization is charged with end-use applications, certainly for irrigation. Hopefully, an independent water management agency with vested legal authority will obviate these problems in Swaziland.

13. It has become clear that a 3,000-5,000 ha Komati Irrigation Project could become a model for similar and subsequent projects elsewhere in the country. In addition, with proper planning and organization, the project could serve a wide variety of national purposes, for example, training of extension workers in smallholder irrigation farming. These beneficial linkages are discussed in the report.

C. Main Recommendations

1. Economics and economic feasibility analysis

- The detailed economic feasibility of establishing the Komati Irrigation Project should proceed with all possible speed. Most needed are studies of reservoir management, sedimentation and associated hydrology; socioeconomic aspects; soil surveys and land capability and administrative and organisational studies;

- Technical, financial, political/administrative and hydrological aspects of exotic afforestation on Swazi Nation Land (SNL) in the Komati Basin should be examined. Basin issues include the impact of any new forestry development on reservoir management and whether or not forestry development in any case is a "pre-dam" consideration. For the post-dam/reservoir phase downstream management should be studied;

- The technical, financial and economic feasibility of the use of Komati water for thermal power production for both domestic use and exports should be evaluated;

- The technical, financial, hydrological and engineering feasibility of using Maguga Dam and Reservoir for both base load and peaking power should be studied; and

- The biological, ecological, hydrological and economic feasibility of a commercial and/or recreational fishery, and aquaculture, in the post-Maguga Reservoir environment should be evaluated.

2. Institutional analysis

- Swaziland must have an operationally effective Water Master Plan as soon as possible. It is understood that the development of such a plan is being accelerated;

- Integrated resource development planning must be organized and structured at the Basin level. Whatever its form, such an Authority, or Board, must be operationally independent of the normal financial and administrative fabric of Governmental operations (as must any irrigation project in the Komati Basin). Such projects must be integrated into the wider web of water and related resource management planning and development practices at the Basin level;

- The legal structure must be developed to accomodate the dynamics of the increasingly complicated Swaziland water development world. The legal environment surrounding water rights, water allocations and water obligations appears to

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be in serious disarray and will likely not stand up to the new requirements being demanded of it by recurring water shortages and new projects. Hydrological data bases must be improved and criteria developed for sharing relative water shortages. International agreements regarding water apportionment must be finalized as soon as possible;

- Given the natural economic handicaps under which future irrigation development must operate (e.g. long canals and/or large pumping lifts), it is essential that new projects establish the requisite institutional structures for ensuring cost recovery. This can take numerous forms but political/administrative discipline is implicit to any effective process. The current pre-feasibility analysis of the Komati Irrigation Project has attempted to provide some guidelines in that direction. Fiscal and monetary policies at the macro level must express themselves in budgetary procedures at the project level. A senior working Committee could be struck to examine this issue with respect to this specific project; and

- A directed, organised and integrated programme of professional development must be started with all deliberate speed. This is necessary because Swaziland does not have at this time the technical, professional and management expertise to implement water management and irrigation programmes of the magnitude and speed contemplated. Once again a central group must give these professional needs hard study and prepare a proposal for external funding.

3. Research needs

- It is recommended that appropriate hydrological studies be undertaken to facilitate improved water use planning in the future;

- It is clear that that there is a significant volume of smallholder irrigation experience in Swaziland (in the RDA programme, in Cooperatives, in Farmers Associations, etc.) that should be studied to assist the development of future projects. Further, continued monitoring and measurement systems are needed as an integral part of the management of any new projects featuring smallholders, such as the Komati Irrigation Project;

- Theoretically, new water should be applied at the margin where net economic returns per M^3 are greatest. While sophisticated data to pursue this dictum are understandably absent, the principle is operationally sound. Water "saving" is the heart of that process. Given current and definitely future water shortages--needs far greater than supplies--it is incumbent to accelerate efforts to permit water "saving",

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namely, accomplishing the same result with less water. As with smallholder farming research, there is a wealth of international experience which should be collected and drawn upon; and

- Given the growing shortages of easily accessible high capability land, it is necessary for Swaziland to intensify its use of previously irrigated land--yields per irrigated hectare must rise. Research efforts should be directed to determining the optimal level of incremental returns to additional crop water usage. Alternative economic uses for water should be found when returns start declining in a given use. This is the core issue in water allegedly needed for "firming-up" existing irrigated area--that same amount of water used elsewhere would probably achieve much higher net economic returns.

4. Package for external funding

Virtually all the above recommendations require external donor funding and staffing. Presumably some consortium or consultative group could tackle these and the same group may fund the subsequent water development projects. There is the real danger that approaches to these various necessary efforts will be handled piecemeal; such ad hoc fragmentation is of course the death knell of organised and effective water development planning. Our final suggestion, therefore, is that these recommendations be prepared as an integrated package for submission to candidate donors.

I. INTRODUCTION

A. Study Project History and Background

1. Overall historical perspective

The recent history of water management effort by the Swaziland government has focussed on three areas. One has been a series of activities towards the evolution of an overall water management plan for Swaziland. This umbrella set of objectives and policy deliberations would guide the other two areas. Recent work by the U.S. Corps of Engineers was towards this end.

The second area of focus has been the quest for financially and economically viable projects in agriculture., both estate and smallholder, or a combination. The effort has been made in these studies to find projects which would attract the private sector and international agencies (bilateral/multilateral). The most recent such study was that conducted by Tate and Lyle on the Usutu and Ngwavuma Basins; they identified several projects at Big Bend South (4500 ha) as first development stages.[1] Studies have also been conducted at several sites for hydro-electric power generation.

The third thrust, overlying and permeating the other two as well, has been the need to bargain with neighbouring countries (the Republic of South Africa (RSA) and Mozambique) over rights to and use of water. Swaziland has no important rivers which rise in Swaziland and delta/estuary in Swaziland. They either rise in Swaziland and move on to one or two neighbours; or they rise in the RSA, pass through Swaziland, and move on to the RSA and/or to Mozambique. The Komati is an example of this latter.

The RSA, rather quickly, has been expanding its management control over its water resources. Pressures have been exerted on Swaziland, therefore, to accelerate the bargaining/agreement process for Swaziland's major river systems. A Joint Permanent Technical Committee (JPTC) has been formed for the Komati and it meets regularly. The JPTC can and does commission studies to assist it with the information base needed by which it can make decisions regarding the equity of any proposed water sharing arrangements and the sharing of costs to firm-up and/or increase water supplies. Mozambique recently became a member of the JPTC. This present study is designed to assist the Swaziland members of the JPTC in that bargaining process with respect to the Komati river.

2. Some underlying economic elements of irrigation development

Several major economic constraints and issues inhibit the design of economically viable irrigation projects in Swaziland. As an example, and as indicated above, the most recent and probably the most thorough study of irrigation potential was that done by Tate and Lyle Consultants on the

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1 Tate and Lyle Technical Services Ltd, Reconnaisance Study Usutu and Ngwavuma Basins (Bromley, U.K., December, 1982). Main Report and 12 Supplementary Volumes. Henceforth referred to simply as Tate and Lyle.

Usutu/Ngwavuma systems. Irrigable areas were identified, and the feasibility of two "smaller" initial projects was studied in some detail. The initial schemes at Big Bend South would have cost about E72 million and E28 million, the former including a storage dam. These costs excluded major indirect cost elements such as much of the infrastructure needed, and even various direct cost such as those of resettlement. Rather "optimistic" assumptions were also made respecting other costs, and regarding project benefits.

Nevertheless, the projects were not economically viable; properly and fully "loaded" on the cost side, their rates of return undoubtedly would have approached zero. Balancing elements to improve the rate of return calculations might have been the inclusion of improved market and farm-gate price data; the introduction of tree crops for sale in export markets (papaya, mango, etc) might also have helped.

The basic fact remains, however, that Swaziland's togography inhibits low-lift pump irrigation for the most part. Pumping lifts of 70-200 metres were involved in the Usutu Big Bend projects. Energy costs literally kill such projects. As a rule of thumb in other nations, a lift of over 50 metres automatically rules out a project unless there are compelling and balancing elements. The Komati River Project now under examination has a 50 metre lift. Only a significant drop in world petroleum prices--perhaps down to 40-50 percent of their recent levels--would improve the economics of those projects with more than 50m heads.

Bearing this cost reduction improbability in mind, this basic fact of Swaziland topography would appear to force the analysis of irrigation possibilities in several directions. First, much more detailed and particularized soil and land capability analyses are needed in areas where lifts need not exceed 50m in the first instance. Second, initial screening of candidate areas should emphasise those where canals can be used for gravity - flow irrigation. In the Komati River Project such a canal, suggested initially by the U.S. Army Corps of Engineers, has been ruled out as the distance from its diversion to the project site was too great. At a guess, given no more than a 50m lift and moving 40-60 MCM/year, a canal over about 20 km in length (or less) would not be as viable as on-site pumping from the river. The capital costs of such canals per hectare cultivated are so immense that, regardless of how productive that land can be made to be, they cannot bear that heavy burden.

But searching for such projects (using fairly short canal systems) should nevertheless continue as real energy costs will no doubt continue to rise over time. As well, moving in favour of canals, the technologies of materials and construction are constantly improving--the difference between the economics of pumping and of using canals constantly lessens.

The irrigation project area under consideration in this report thus becomes a rather unique one in Swaziland.

B. Purpose and Objectives of the Komati Basis Study

The basic objective of this study project is to provide the GOS with economic and planning materials to support their discussions with the RSA with respect to possible future Komati Basin water supplies. The historical background of this Komati Project is at Annex 1. The Terms of Reference (TOR) for this Devres study are at Annex 2. They include the following eight objectives:

- The pros and cons of cost-sharing with the RSA regarding any additional water received;
- The relationship of water and cost sharing issues to Swaziland national development policy and needs;
- The alternate uses of increased water;
- The study of one of the alternative uses in economic detail, at the pre-feasibility level, of an irrigation project using 40-63 MCM annually;
- The study in economic detail the possibility of water to be used to firm up existing irrigated estates;
- The synthesis of these two prime uses in one analysis;
- The provision of recommendations as a result of these other appropriate analyses to the Government of Swaziland regarding their bargaining position with the RSA;
- The preparation of the TOR for the more detailed design study for the proposed irrigation project, recognising that this analysis is at the pre-feasibility level.

C. Structure of the Main Report (Volume I)

In the light of these basic objectives, analyses are presented to address them. They are sequenced approximately as listed at B. above. After presenting a sketch of the possible alternative uses for enhanced Komati water supplies (Ch.II), Chapter III relates those possible uses, especially irrigation, to the structure and dynamics of the Swaziland economy, and its needs. Chapter IV presents summary financial and economic analyses at the pre-feasibility level of the Komati Irrigation Project; the full and detailed analysis is at Volume II. Chapter V explores the matter of firming up water supplies to the existing irrigated production areas of the Inyoni Yami Swaziland Irrigation Scheme (henceforth called SIS). TOR for the subsequent design-stage study are summarized in Chapter VI; and recommendations to government are presented at Chapter VII. Annexes supplement the main discussions.

II. ALTERNATIVE USES FOR INCREASED KOMATI WATER

A. Introduction

This chapter's purpose is to outline the alternative uses to which Swaziland could put any increments in Komati Basin water supplies. For that matter, some water now going to any specific use could also be transferred, although there may be costs involved with such transfers. The discussion is divided into 1 consumptive and 3 non-consumptive uses. Some of the former are of more immediate relevance to this analysis; the latter are highly germane if the project moves ahead.

B. Consumptive Uses

1. Smallholder-nucleus estate irrigation projects

A priority use considered for more water would be for an agricultural production project on the lowveld in an area of suitable soils and low pumping lifts (less than 50 metres). Ideally, the area would not be too heavily settled, thus minimizing the serious social and economic problems of resettlement. As well, the area should not be so remote as to occasion extra heavy new investment in roads, communications and other social and economic infrastructure. A preliminary "model" of such a project was developed by a major consulting firm in 1983 for a roughly equivalent area at Big Bend on the Usutu River.[1] The Komati Irrigation Project relies upon that model for many of its basic dimensions. It would need to be designed, however, so as to consume different levels of water, namely 40 MCM and 63 MCM, depending on how much water could be available after negotiations, and how much such water was to cost. The full pre-feasibility analysis of that Komati Irrigation Project is at Volume II with a summary of its financial/economic analysis at Chapter IV below.

2. Firming up existing schemes

A second important candidate use for new Komati water would be its availability in those years in which rainfall and runoff in the watershed are reduced; a series of dams with storage reservoirs could almost guarantee water availability, at least for a larger share of years than in more recent, and drier, times. The cost of using water in this way would be its non-use in some other way; the benefits would include the "saving" of a certain level of yield, at the margin, which would not be lost if the crop continued to have its usual water supply, or very close to it. In the event, this particular possible claim on new water supplies proved to be less straightforward of resolution than anticipated. Its full analysis is at Chapter VI below.

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1 Tate and Lyle, ibid

3. Expansion of existing private estates

Yet another alternative for the use of new water supplies would be the expansion of already existing agricultural estates. Essentially the Swaziland Irrigation Scheme (SIS), this large producer of sugar (and some citrus) is the major Swaziland user of Komati water; it would be this enterprises' water supplies which would be considered for "firming up" at 2 above. As a private estate on private land, there would naturally be many factors involved in such an expansion. It would be most unlikely, for example, that the area put down to sugar would be expanded given the nature of world sugar markets and quotas, etcetera. Further citrus plantations would no doubt be viable, with much the same net returns as the citrus plantations contemplated for the smallholder-nucleus estate irrigation project. The study team was advised, however, that as a matter of policy estate expansion was not a priority at this time. Therefore, no further economic enquiry was conducted.[1]

4. Coal thermal plants

It has not been possible to acquire reasonably useful data on plant water consumption. A study is recommended to fill this gap (see section VII.C.7 below). Data used elsewhere in this report are first approximations only. Subsequent analyses use different water consumption rates merely to provide a range of options (from 20,000 M^3/MW to 80,000 M^3/MW).

5. Forestry

a. Background

An alternative use of Komati water would be putting SNL lands in the watershed down to exotic trees for commercial purposes. This is discussed at some length here as there is no other discussion of this sector's use of water elsewhere in this report.

Tree planting on private land has been regulated in Swaziland by the Controlled Tree Planting Act No. 7, 1912. A maximum of 15,700 hectares has been permitted under the Act in the Basin, and all permits have been taken up; unless further permits were granted, there is no more area available on private land, even though it is understood that some private firms are actively looking for such land. The engineering Consultants who prepared the JPTC Komati Basin background documents thus show no further planting (hence no further water consumption) by afforestation in Swaziland. No allowance was made in the preliminary water use calculations (post-Maguga Dam) for this use of water for Swaziland.[2]

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1 It nonetheless could be good water husbandry (and economic) policy to encourage a transfer of land from cane to tree-crop production; market conditions would seem to permit.

2 Olivier, H. et al, Komati River Basin Development, Vol.1, (Johannesburg: February, 1984). pp.2.22-2.26 and their Interim Report on forestry of November 1981.

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Yet, there are 74,640 ha in the Komati Basin in Swaziland suitable for forestry, of which some 62,200 are considered to be of very high potential. Only 25 percent of this 62,200 ha has actually been planted, or 15,700 ha. The balance of high potential forestry land is thus 46,500 ha, all of it SNL. Given well established alternative land uses in some areas,--cropping and grazing--clearly not all of these 46,500 ha would be available for forestry. Selecting suitable areas, however, should not be too difficult since many areas probably are not used heavily for other reasons, e.g. beginning to erode, overgrazed, remoteness, steepness. Nor would much be needed; depending on pulpmill or sawmill size, some 5,000 ha, 10,000 ha or 20,000 ha would suffice. Smaller areas could support smaller forestry milling facilities. Most of the Usutu pulp plantations appear to be on SNL land acquired for the purpose. The exact nature of the tenure is not known.

Using the Olivier et.al. data and ratios, a 10,000 ha project would consume some 13 MCM; a 20,000 ha would consume some 26 MCM; and a 5,000 ha plot would require only 6,000+ MCM. This would reduce the MAR accordingly, and dam storage capacity would be dropped by 8.333 MCM and 16.000 MCM and 4.167 MCM, respectively (what may be stored is 64.1 percent of MAR).[1]

The use of water for exotic plantations should be examined very carefully on economic grounds but it has other obvious attractions. After relevant market studies, the investment and management resources needed could be carried entirely (or nearly) by the private sector. In addition, a very great deal of land, carefully selected, can be used which otherwise makes very little contribution to Swaziland's development and improved welfare. An important side benefit is the retardation of erosion and thus the siltation of rivers and reservoirs. There may even be a slight improvement in rainfall. Net foreign exchange earnings would also be high. Economic elements are discussed below.

All of these economic/social impacts and benefits must then be compared to the economic/social benefits lost by the use of water in this way. That is, 4-17 MCM will be lost to Maguga Reservoir, depending on the afforestation area. That approximates water use for agriculture of some 200-1150 ha. Without being in a position to compare these irrigated water uses with more sophisticated data, there is a strong presumption that the overall economic returns and benefits to the use of an M^3 of water for afforestation are at least as high as those for irrigated agriculture. It would certainly become one of several most effective ways for Swaziland to use any increments in water supplies.

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1 It is appreciated that extending forestry plantation water use could be considered a "pre-dam", not a "post dam" activity. As well, there are serious questions regarding the impact of afforestation on the MAR and on reservoir capabilities and regulations. These are addressed in report sections VII.C.8 and VII.C.10

b. Some quick forestry economics

In the light of these preliminary observations, an cursory effort has been made to identify the impact on the economy of the using of additional Komati water resources for the expansion of exotic forestry plantations. As suggested above, there could perhaps be 5,000 ha, 10,000 ha or 20,000 ha plantations on SNL land least suitable for other activities.[1] Data for the following analyses are derived exclusively from the 1983 Annual Statistical Bulletin.[2]

The total exotic plantation area in 1983 was 101,000 ha. That area, or an area very close to it every year (the figure excludes areas cut off and not yet replanted), supports a logging, sawmilling, pulpmilling, paper-making and other facilities sector with a direct employment of 5,004 persons.

That number too changes slightly annually. There are no doubt many more jobs occasioned by the industry in transport, etc. Using those data, nonetheless, that is one employee for every 20.18 ha of active plantation.

Secondly, the annual wage bill calculates out to be, for the 5,004 employees, a total of E6,983,000, an average of E1,395/person employed (most of whom were unskilled workers earning E800 - E900 annually in 1983; the figure would be higher in 1985). This provides a figure of E69.14 wage bill per hectare under forest.

Thirdly, these data may be related to the export values of the various wood products, including especially unbleached pulp which dominates other products. Table G.3 in the Statistical Bulletin provides an export total for the sector of E56 million plus; Table G.4 provides details by product category and they summate to some E67 million. These calculations then give:

Export values per ha:	low value	=	E564/ha
:	high value	=	E663/ha
Export values per employee:	low value	=	E11,391
:	high value	=	E13,389
Export values per unit of wages:	low value	=	8.16:1.00
:	high value	=	9.59:1.00

Translating these data into a 5,000 ha forestry project, one achieves the following:

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1 It is recognized that patches of afforestation cannot be too small and too separated; road and other operational costs may then become excessive per hectare or per cunit harvested.

2 Central Statistical Office, Mbabane. Timber Plantation data, Tables F.14 - F.17; value of domestic exports, Table G.3 and G.4; employment and earnings, K4-K8.

Employment (5,000 divided by 20.18 ha)		=	248 persons
Wages/Salaries (5,000 x E69.14)		=	E347,700 annually.
Export values:	low (5000 x E564)	=	E2,821,800 annually
	high (5000 x E663)	=	E3,136,850 annually

Since this project would consume only some 10 percent of the amount of water as an irrigation project of the same size, ratios could be worked out per M^3 or MCM; they could very well favour forestry.

In conclusion, forestry could no doubt provide very solid economic returns to land, water and people. The industry is established and working, markets are increasing gradually and an increment of 5,000 ha is only some 5 percent; a 10,000 ha project would add only 10 percent, and a 20,000 ha afforestation project only 20 percent; it could be phased over 10 years or more. Swaziland is clearly one of the world's most skilled in afforestation; this would no doubt expand that role.[1]

We will be recommending that a more detailed technical and economic analysis be made of the forestry possibility, and its impacts on the hydrology of Maguga reservoir.

6. Peak power at Maguga Dam

As at B.4 above; studies are needed.

7. Other consumptive uses

Possible other consumptive uses of additional Komati water would be for the further processing of agricultural products. It is most unlikely, however, that the region's sugar industry will be expanded. The only other processing use could be for sisal/jute/kenaf processing--given the nature of markets for these crops, this is not a very likely development even in the longer run.

C. Non-consumptive uses

1. Base power at Maguga Dam

As at B.6 above; studies needed.

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1 Community forest lots have also proven their worth in other parts of the world. They are also highly economic. See J.A. Bleijs, "Forest as a Source for Development and Renewable Energy," Journal of the Royal Swaziland Society of Science and Technology, Vol.4, No. 1, September, 1981, p. 29-30.

2. Fishery/aquaculture

The Komati system apparently supported a reasonable fishery prior to the installation of the existing dams. Work by Olivier et.al. suggests that further studies could not only identify any impact of new dams, but also the possibility of enhancing the fishery--commercial and recreational--with the changed nature of the water resource. That is, there could be opportunity for a fishery in the new reservoirs, including Maguga, for both commercial harvesting and for recreation. As well, any new irrigation project, such as the one studied in this report, could quite easily incorporate an aquacultural research activity. Numerous bilateral funding agencies would no doubt show keen interest (e.g. Sweden's SIDA and Canada's IDRC).

3. Recreation/Tourism

Finally, dams and reservoirs can be turned to advantage as playgrounds and sports theatres. Depending on many factors, obviously, there are fisheries and all manner of boating and water sports. Construction activity generally carries with it the opening up of new areas by roads and other facilities. Interfering with some of these possibilities of course could be the need for fencing protection for health reasons, and a drawdown which makes it awkward for facilities or bruises aesthetics. Maguga Reservoir would also be close to new tourist hotel development in the Pigg's Peak area.

III. SWAZILAND DEVELOPMENT OBJECTIVES AND NEEDS, AND ALTERNATE WATER USES

A. National Objectives, Needs and Policies

1. Introduction

The purpose of this section is to review very briefly Swaziland's macro-development objectives. This is not an "academic" exercise. The assumption is being made that a national committment of many millions to development projects in the Komati Basin must be consistent with overall development objectives of Government; more strongly, it must help to reach those objectives in a highly positive way. Further and more detailed discussions of Swaziland's macro-economic environment are at Chapter I.A.5 of Volume II.

2. Balance of payments and foreign exchange

Swaziland generally runs a deficit on its balance of payments. Merchandise imports have exceeded exports annually as of 1978 and negative balances on current account are high. Direct capital investment inflows mitigate this somewhat, especially long-term capital flows to Government. Some short-term capital inflows further reduce the imbalances. Changes in foreign reserves and assets are sometimes positive, sometimes negative. The overall effect is negative, however.

The imbalance is not worsening particularly or dangerously, however, in spite of a growing merchandise trade imbalance. Domestic exports have not risen in market prices (E315-322 million over 1981, 1982 and 1983);[1] thus, they have fallen in real terms. The value of sugar exports has risen, and of canned fruit; virtually all other export categories have declined in value. Imports, on the other hand, have risen steadily, if not remarkably, roughly maintaining their real levels. The major relative increases have come in the commodity classifications of animals/vegetable oils/fats; machinery and transport equipment; and food and live animals. Within the last category, the major surges in imports have been of unmilled maize, and wheat meals and flours, almost entirely from RSA. Cereal preparations have also risen, as have fresh/frozen vegetables and fruit preparations.[2]

It seems clear, therefore, that development policy must encourage exports, discourage imports, foster import substitution activities, and attract external investment and other development funds. New water-using and land-using activities, therefore, also must seek to achieve these objectives as a matter of some priority.

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1 Data in this section from Central Bank of Swaziland, Quarterly Review, December 1984.

2 More detailed information from Central Statistical Office, Annual Statistical Bulletin, 1983, Tables G.7 and G.8

3. Population growth and unemployment

The recent publication of the 1976 Census results apparently rather shocked many policy-makers. They not only indicated a de jure population far greater than anticipated, but, perhaps more importantly, a rather surprising net rate of de facto growth of some 3.4 percent. This provided an 1983 African population of nearly 600,000 persons. Public and private sector total employment in 1983 was nearly 78,000, with another 14,000 on South African mines. That gives a paid labour force share of total population of 12.2 percent. Employment losses in the private sector in the early 1980's (about 3,000) were not compensated for by slight gains in the public sector (1,700). The major drops within Swaziland have been in manufacturing, mining and agriculture. As well, the number of Swaziland workers on RSA mines was 17-20,000 in the mid-1970's; it was down to 10-13,000 in the early 1980's, putting even more pressure on domestic labour markets.

Combining the rapid demographic growth data on the one hand, with a slumping and depressed labour market on the other provides discouraging results. Instead of jobs available rising by 3-4 percent annually, some 2,500-3,000 new jobs, just to meet population requirements (let alone put the currently unemployed back to work), the total number of employment posts available has been falling. Looking ahead, and assuming a 1983 population of 603,340 persons and a 3.4 percent rate of growth, Swaziland will have 1,065,152 people in the year 2000. A paid labour force share of 13.2 percent would mean that about 140,600 job places will be needed even if labour force participation rates do not rise over early 1983 levels. That means some 47,600 employment places needed over 1983, or 2,600 annually (a figure consistent with the range posited above of 2,500-3,000 annually). That equates to about 1,500-2,000 ha of new irrigation annually, a rather staggering amount if all of these were to be employed in irrigated agriculture.

4. Food self-sufficiency

Agriculture in Swaziland, both relatively and in many ways absolutely, is on the decline or, at best, barely holding its own. While some crops have expanded in area and production over the last decade (e.g. sugar cane) all major crops have experienced declines in per/hectare yields except oranges. The basic food crop, maize, using 1971/72 as a base of 100, has dropped to 88 in area, to 26 in total production; and to 30 in yield. Most is grown under rainfed conditions on Swazi Nation Land (SNL); volume produced in 1980/81 was 94,000 MT; in 1981/82 was 52,000 MT; and in 1982/83 was down to 30,000 MT.

Maize supplies, including those grown on private land, may roughly be summarized in Table I-3.

Table I-3: Maize Production and Imports in Swaziland, 1980-83

Source	1980/81	1981/82	1982/83
Domestic Production (MT)	104,000	60,000	40,000
Imports (MT)	52,000	57,000	51,000
Total (MT)	154,000	117,000	91,000
Total Per Capita (African) kg	277	203	153

Data in whole maize equivalents.

Source: FAO, The Maize Industry in Swaziland (Rome, August, 1984) Vol. 2, p.56

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As imports are now assuming an increasing share of what must be a declining total maize consumption, it behoves new projects using scarce land and water supplies to attempt to contribute to reducing this maize deficit if economically possible. At a per capita annual requirement of 150 kg, in the year 2000 Swaziland will need some 160,000 tonnes annually; it must produce another 70,000 tonnes before it can reduce imports below some 50,000 tonnes--that is almost a tripling of current 1983 production levels. New projects, therefore, caeteris paribus, should address this food supply issue.[1]

B. Land and Water Sectoral Objectives

1. Optimize Land Resources

Like elsewhere, Swaziland's soils range from the unusable to the excellent. Sufficient soil analysis and classification has been conducted to indicate where the highest potential lands are, especially in combination with altitude, rainfall, and other factors basic to agricultural productivity. All other things being equal, these "best" lands not only should be developed first, in declining order of capability; they can also stand more intensive use. For irrigation purposes, one is generally talking of lowveld soils where class 1 and class 2 soils suitable for irrigation are reasonably large shares of the total.

For a range of historical reasons, however, large segments of these better soil areas in the lowveld have been acquired by private owners who are legally less bound by Government development requirements, at least until the present. With continuous build-ups of population and food requirement pressures, however, it could very well be that even private owners may be required to enhance or maintain production at certain prescribed levels. Most of the high quality lowveld land still available for irrigated agriculture is SNL land. Its release for development is thus subject to the regime of that structure. Highveld and middleveld SNL land in the upper reaches of the watersheds could be used for exotic afforestation as well.

The development objectives, nonetheless, must be to optimize land use, regardless of its quality or location. Every 25-30 years the amount of cultivable land available per capita drops by half as population doubles. Given also the loss of better land to overgrazing and erosion; to overcultivation; and the like, the proportional drop in per capita good land available is undoubtedly greater than a halving every generation. Thus new projects must stress land productivity.

2. Optimize Water Resources

An identical philosophy surely must apply to the development of Swaziland's water resources. A critical difference of course is that water resources generally are renewable, at least surface water resources resulting from natural rainfall and runoff--streams and rivers. Since a very large share

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1 It is recognized that numerous other problems beset the "maize" syndrome, including pricing issues.

of Swaziland's rivers also arise in and/or flow through to other countries, the optimization is of total water use, not just Swaziland's use of a share of those waters.

As of 1979 some 42,005 ha were irrigated in Swaziland, consuming 629 MCM. Water so used was almost equally one-quarter Komati, one-quarter Mbuluzi, one-quarter Lower Greater Usutu, and the balance from six other rivers, mainly the Upper Great Usutu.[1] The further irrigable potential on these same river systems as of 1980 was thought to be an additional 51,000 ha, using the final 492 MCM, with 75 percent of that potential in the lowveld. While these figures need firming up in every case, since there are some obvious anomalies, they would suggest nonetheless, that, of the 1,121 MCM thought to be available annually for irrigation, only 492 MCM are left unused, or some 44 percent. On average as well, the areas remaining, some 51,000 ha, are 55 percent of the total but without doubt of lower quality, less ideally located, and probably require, again on average, either greater pumping lifts or greater canal costs.

Thus, optimizing water use henceforth is not akin to starting afresh with all of the most suitable land/location/altitude options laid out to choose from. One is now working at the margin with 44 percent of the water for 55 percent of the land, or proportionately less water per hectare. The onus is therefore strong for new irrigation projects to be designed for maximum economic effectiveness, "picking the eyes" out of the needed companion resources still available.

Those prime irrigation uses, in turn, must be balanced against other consumptive uses of that same water, particularly for further afforestation, and for coal thermal plants. An overall water management plan would establish working criteria by which to judge and rank those alternatives on both national, inter-basin and basin levels.

C. People Productivity Objectives

Implicit in the objectives and targets expressed in the Third and Fourth Development Plans is that of raising the productivity of the average Swaziland producer, certainly those producers in the rural environment. This includes the optimization of the land and water resources used in that process, and aspects of those objectives are discussed at Section B immediately above. But the objective spans as well all of those institutional, servicing, structural, organisational and decision-making systems through which the basic land, water and people resources may be combined for better results. The best land and water resources in the world won't produce one tonne of anything without a continuously effective structure for people to make it happen.

Thus, once again, the onus is on the developer who is combining the land and water resources in a "project" to produce something (agricultural products, power, trees, fish) to provide this organisational and

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1 Information in this section from U.S. Army Corps of Engineers, Swaziland: Water and Related Land Resources - Framework Plan (Omaha: Department of the Army, 1981), p.I-33 to I-35.

implementation infrastructure. Merely to maintain per capita (per farmer, per worker) productivity, never mind increasing it, demands an ever more effective infrastructure because the land and water resources being used, on average, are of lower economic quality over time. New projects therefore must direct themselves to meeting these "people productivity" objectives.

D. Summary and Dynamics

1. General

No country's prospects, possibilities or problems ever stand still. Swaziland is no exception. Doors close in one place; a door or a window opens up somewhere else. Each basic dynamic issue itself changes over time; combinations and inter-relationships create, by definition, a continuously evolving matrix of both opportunities to grasp and problems to avoid or mitigate--those are the tasks of the planner and policy-maker.

2. Core elements/dynamics for the future

There seem several core elements in Swaziland's economic future. They are not going to go away. They must be allowed for and catered to. They can, in some cases, be taken advantage of. They condition, individually and especially collectively, in an iterative process over time, the priorities and phasings of Swaziland's development policy and activity:

a. Rapid population growth generally, and in more heavily settled areas in particular through internal migration.

b. A concommitant growth in the available labour force. Under similar labour market and demographic growth conditions elsewhere, wage labour force participation rates actually rise, especially for women and for people leaving the countryside. Labour force growth, thus, will no doubt not fall below 3.8-4.1 percent rates for some time.

c. The pressure for paid employment in domestic markets is increased through the faltering of the neighbouring RSA economy. That economy will continue to have its shorter cycles of reduced prosperity and not-so-reduced prosperity. It is most unlikely, however, to experience growth rates in its mining and associated industries which will absorb Swaziland workers at the current levels. This is particularly so since the RSA African labour force growth approximates that of Swaziland--employment in RSA is no longer a dynamic for Swaziland's growth; quite the opposite, since the jobless total in the RSA now approaches 750,000 (Star, August 16, 1985, p.3).

d. Combining a., b., and c. above, and unless new economic conditions obtain, a cumulative rise in unemployment in Swaziland.

e. The depressed conditions in RSA have also meant a decline in the manufacturing sectors in that country with which Swaziland's enterprises have been linked. Factory after factory has closed down in Swaziland or

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reduced operations because of those slumped RSA economic conditions. Improvement in Swaziland is of course possible in the manufacturing environment over the medium term. But it will be slow.

f. Swaziland's land base very gradually has been declining in productivity potential. Hard to identify and measure, this attrition has taken the form of overgrazing and overharvesting of natural vegetative cover, consequent erosion and siltation of water courses, the gradual demise of conservation contours and bunding, and the like. On irrigated land, some salinization and water table build up have occurred. Gradual as this has been, in the light of pressing needs for land into the future, the downward pressures on quality seem inexorable in the medium term.

g. With several exceptions only, and perhaps for not very long, Swaziland's run-of-river water availability has been over-used, providing even greater vulnerabilities in lower rainfall periods. This is partly due to excessive RSA abstractions. Indeed, one of the positive dynamics is the need to come to terms with Swaziland's neighbours regarding water sharing into the future. Each new increment of water available henceforth is going to cost increasingly more.

h. The bulk of the land available for more intensive farming (dryland or irrigation), for new forestry activities, and the like is in SNL. Historically there have been social, political and administrative/legal/jurisdictional difficulties in many instances where new projects/activities alter the more traditional system. Without prejudging in any way, and relying only on recent experiences, there is the presumption that similar institutional issues could arise with new development efforts on SNL land (such as irrigation projects). These issues must be faced but certainly their resolution, in the nature of things, is not imminent.

i. Finally, looked at another way, the increased population must be fed. For a range of reasons already discussed, a rapidly rising share of the nation's basic food supplies is imported. That puts increasing pressure on external currency reserves, and strains within the Southern Africa Monetary Union.

3. Conclusions for irrigated agriculture generally and the Komati project in particular.

An integrated synthesis of the foregoing must conclude that:

- The GOS should begin its new water/land project development processes as quickly as possible and maintain a very high momentum;

- The onus must be on developing economically viable projects which attract external capital and which pay for themselves;

- Direct and indirect employment/income earning opportunities must receive simultaneous emphasis;

- Detailed economic planning exercises must commence to plan the optimum sequential development of gradually scarcer land and water resources. One critical part of this, but only one, is water management planning; and

- Given its satisfactory financial and economic elements, the Komati River Irrigation Project should be planned for and implemented with all deliberate speed.

IV. SUMMARY FINANCIAL AND ECONOMIC ANALYSIS OF THE KOMATI RIVER IRRIGATION PROJECT

A. The Pre-Feasibility Study: Background and Description

1. Background

This study develops a nucleus estate--smallholder irrigated farming project in the north-east corner of the Komati River basin in north-central Swaziland. It is of two sizes, depending upon assumptions made regarding water availability. The first size, the "base" project, uses some 40 MCM and is 3,000 ha. The second case consumes some 63 MCM and is for 5,000 ha. In both, 40 percent of the irrigated area is devoted to smallholders and 60 percent of nucleus estates. The analytical technique has concentrated on creating one irrigation Development Unit (IDU) of 1,000 ha and then adding these equivalent modules consecutively over time to reach the "base" project of three IDUs; then the larger project of five IDUs.

The analysis of the irrigation project is one of the several key elements in support of the Government of Swaziland's position when negotiating with neighbouring states with respect to the future development of common water resources. Studies have shown that virtually all of Swaziland's run-of-river water resources are fully utilized or nearly so. While additional upstream releases from the RSA could provide modest increases in Swaziland's water supplies on occasion, though perhaps rather temporary, any subsequential enhancement must come from the increased storage provided by dams and reservoirs. This pre-feasibility analysis concentrates on one use of a possible increase in Komati River supply, an irrigation scheme utilizing water provided by the proposed Maguga Dam.

It is important to note in this connection, however, that even if negotiations with the RSA--funding/costing decisions, design studies, tendering processes, dam construction, etc--were expedited fully as of mid-1985, it would still be nearly a decade, nonetheless, before agricultural and other benefits could materialise on any scale. To even think about costs, prices, crop/product suitabilities, market windows, etcetera for a point that far in the future does seem rather unreal.

The consulting, team, perforce, thus concentrated in this study on establishing a well documented process and its framework, indicating methodologies and analytical steps in detail. This will permit subsequent and more timely analyses to be effected in due course with some ease; it will be a matter of updating, not one of starting all over again.

2. Description

The base 3,000 ha project consists of the phased installation of three Irrigation Development Units (IDUs) each containing a total of 1,000 ha. Each IDU is divided into a nucleus farm and individual smallholder farms. A

water allocation is to be provided from the construction of the Maguga Dam on the Komati River. The project is located along the North Bank of the Komati River immediately to the west of Bordergate and across the river from the SIS estates.[1]

Each IDU is a self-contained farming enterprise consisting of the following features:

- Net cropped area is 600 ha to the nucleus farm and 400 ha to the smallholder;
- Establishment of 200 smallholder farms of 2 ha each;
- Construction of pumping stations on the Komati River to supply flows to the units;
- Installation of buried permanent mainlines with balancing reservoir to provide irrigation water on demand to the infield portable overhead irrigation systems;
- Establishment of a 130 unit village to house the permanent labour staff with required utilities and social amenities;
- Establishment of a management housing compound consisting of 20 units with required utilities;
- Establishment of the necessary shop, warehouse, office, and crop processing facilities;
- Provision for extension counselling, input supply, and other basic services to smallholder;
- Establishment of cropping systems, emphasising tree crops;
- Establishment of a nursery to supply both the smallholders and the nucleus estate with fruit tree planting material and to conduct research in due course;
- Establishment of an effective management and organisational structure.

The sequencing of IDUs is designed to optimise contractor and management resources. Some production and nursery establishments on the first IDU can occur prior to dam water becoming available by modest run-of-river pumping. Full output levels on the first IDU are reached at project year 7; for three IDUs at PY 15, and for five IDUs at PY 23. By the time 3 or 4 IDUs are established it is entirely likely that an umbrella project management structure will be required.

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1 Inyoni Yami Swaziland Irrigation Scheme; usually referred to as SIS.

B. Project Costs and Revenues (Benefits)

Detailed cost and revenue data are provided at Volume II, Chapter II.C. They were developed for both the 3000 ha base project and the larger 5000 ha project possibility, using the 1000 ha IDU module and streaming then over time. Dam capital costs and O and M were furnished by Olivier et. al; on-site capital costs, including building, machinery, etc as well as the irrigation delivery system, were based on Tate and Lyle assumptions, or current estimates derived from the private engineering sector. Without including the dam, capital costs are E9,950/ha, or E10,500/ha with field equipment costs. Adding the dam costs (E40m plus O + M) brings the total E23,800/ha. Housing costs weigh very heavily in these calculations. Without the dam, a 5000 ha project would cost E52.5 million; of which nearly E14 million are housing and utilities. We have been very conservative in these cost estimates.

Overhead and operating costs were calculated in detail. Over half of these are salaries and wages of permanent project personnel (E275,000/year/IDU). Materials and services account for the balance. Resettlement costs were also included--E6.44 million for a 3000 ha project; E8.16 million for the 5000 ha project (900 families, nearly 1200 families).

Revenues from crop sales were calculated "farm gate," with a loss element allowed for. For the 3-IDU project, such revenues reach E8.28 million at full development, over E3 million from smallholders. Gross value added on the 5000 ha project are E13.7 million. The values include, however, the shares of output thought to be consumed by the smallholders.

Government revenues are identified from three sources: "irrigator", charges, increased tax earnings and an enhanced share of SACU earnings. Detailed calculations were effected to assess what charges would be required per hectare to pay for the E40 million dam cost and its O and M in the event the GOS decided to pay for the dam in this way. For the base project, these would come of E330/ha, dropping estate net returns to E2590/ha and smallholder income to E4325. For the 5000 ha project, the charge drops to E300/ha. Annex 6 to Volume II provides other cost recovery options. Tax earnings would come to E126,000/annum since most married men on the project would be exempt; it is also assumed that the project authority would be exempt--it probably could afford to pay Company tax, however. Import duty enhancement, paid on capital goods over the establishment period, were calculated as nearly E4 million and were added back in to the benefit stream in the economic analysis.

C. Financial and Economic Analysis

Table I-1 and I-2 summarize the essential features of the basic project and of the 5000 ha project. Tables I-4 and I-5 provide the highlights of the financial analysis of both projects. Table I-6 and I-7 are the results of the economic analysis. By and large these rates of return are satisfactory. If the range of cost recovery options is added to the net benefit streams (shown in detail in Volume II) then the projects become very viable indeed. Generally speaking also, financial and economic rates of return are slightly better on the larger project; this is due almost entirely to the spreading out the fixed cost of the dam over a larger area.

Without an effective cost recovery programme, however, these irrigation projects, by themselves, cannot assume the full cost and remain viable. We have built into the financial/cost structure of the project, however, a number of costs which could also be added back onto the net revenue stream; these would bring the financial and economic rates of return, with dam cost included, up to satisfactory levels. Such fiscal/monetary policy options are discussed at Annex 6 to Volume II, as is the option of spreading the charges over all water users, current and probable future. Under that circumstance, assessing charges/M^3 of water used, the new irrigation schemes are punished less severely.

SWAZILAND: ECONOMIC STUDY OF POSSIBLE USES OF ADDITIONAL WATER ON THE KOMATI RIVER

Table I-4 : Economic Rate of Return Summary of Three IDUs

	Economic Internal Rate of Return (%)		
	Base Case	10% Increase in Costs	10% Increase in Revenues
Economic Analysis (Exclusive of Maguga Dam)			
Base Analysis	10.2	8.57	11.41
Sensitivities			
Exclusive of Housing and Resettlement Costs	14.83	13.0	16.54
Zero Shadow Wage	11.60	10.14	13.00
Reduced Cropping Intensity	5.03	3.62	6.33
Economic Analysis (Inclusive of Maguga Dam)			
Base Analysis	3.87	2.66	5.03
Sensitivities			
Exclusive of Housing and Settlement Costs	5.47	4.17	6.72
Zero Shadow Wage	5.18	3.99	6.34
Inclusive of Irrigator Charges	3.87	2.8	5.03
Reduced Cropping Intensity	-0.11	-0.41	1.08

Source: Devres Staff Estimates, August 1985

SWAZILAND: ECONOMIC STUDY OF POSSIBLE USES OF ADDITIONAL WATER ON THE KOMATI RIVER

Table I-5 : Economic Rates of Return Summary of Five IDUs

	Base Case	10% Increase in Costs	10% Increase in Revenues
Economic Analysis (Exclusive of Maguga Dam)			
Base Analysis	10.34	8.89	11.75
Sensitivities			
Exclusive of Housing and Resettlement Costs	14.83	13.08	16.54
Zero Shadow Wage	11.97	10.51	13.40
Reduced Cropping Intensity	5.09	4.67	6.42
Economic Analysis (Inclusive of Maguga Dam)			
Base Analysis	5.74	4.50	6.95
Sensitivities			
Exclusive of Housing and Resettlement Costs	7.73	6.38	9.04
Zero Shadow Wage	7.14	5.90	8.34
Inclusive of Irrigator Charges	5.14	4.63	6.95
Reduced Cropping Intensity	1.38	0.06	2.60

Source: Devres Staff Estimates, August 1985

SWAZILAND: ECONOMIC STUDY OF POSSIBLE USES OF ADDITIONAL WATER ON THE KOMATI RIVER

Table I-6 : Financial Rates of Return Summary of Three IDUs

	Financial Internal Rate of Return (%)		
	Base Case	10% Increase in Costs	10% Increase in Revenues
Financial Analysis (Exclusive of Maguga Dam)			
Base Analysis	8.62	7.3	9.9
Sensitivities			
Exclusive of Housing and Resettlement Costs	13.13	11.58	14.7
Reduced Cropping Intensity	4.2	2.9	5.4
Financial Analysis (Inclusive of Maguga Dam)			
Base Analysis	2.68	1.55	3.78
Sensitivities			
Exclusive of Housing and Settlement Costs	4.19	2.99	5.37
Inclusive of Irrigator Charges	3.98	3.00	4.96
Reduced Cropping Intensity	-1.0	-2.2	0.2

Source: Devres Staff Estimates, August 1985

SWAZILAND: ECONOMIC STUDY OF POSSIBLE USES OF ADDITIONAL WATER ON THE KOMATI RIVER

Table I-7 : Financial Rates of Return Summary of Five IDUs

	Base Case	10% Increase in Costs	10% Increa in Revenu
Financial Analysis (Exclusive of Maguga Dam)			
Base Analysis	8.75	7.41	10.08
Sensitivities			
Exclusive of Housing and Resettlement Costs	13.00	11.41	14.59
Reduced Cropping Intensity	3.96	2.60	5.26
Financial Analysis (Inclusive of Maguga Dam)			
Base Analysis	4.32	3.14	5.50
Sensitivities			
Exclusive of Housing and Settlement Costs	6.21	4.94	7.50
Inclusive of Irrigator Charges	5.95	4.61	6.70
Reduced Cropping Intensity	0.02	-0.11	1.45

Source: Devres Staff Estimates, August 1985

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V. THE ECONOMIC ANALYSIS OF SIS FIRMING UP

A. Background and Recent Issues

1. Historical

The historical Swaziland concern with the use of Komati River water has given high priority to the needs of the SIS's estates. Those sugar/citrus operations irrigate some 11,900 ha (1983) with Komati water. Most of this is sugar cane, although some 557 ha of citrus are grown, plus smaller areas of maize and winter vegetables. Of the total effective irrigated area, however, only 2,813 ha are in the Komati watershed; the balance are in the basin of the Black Mbuluzi River. Water is moved by a weir/canal/pump/reservoir system from one basin to another. Significant volumes of Komati water are thus lost to the Komati Basin as runoff, canal losses and drainage to the Mbuluzi.[1]

Areas planted at SIS gradually expanded as sugar export quota limits and reasonably ample water supplies permitted over the late 1960's and 1970's. So too was the use of Komati water by the RSA both upstream and downstream of Swaziland. When the lower flow (drought) period of 1981-83 hit, the over-commitments and over-extensions were very clear to all. One way to make water demand more consistent with run-of-river supplies is of course to reduce waste. But the areas irrigated could also be reduced! The cost of doing that would be considerably less than building dams to "firm-up" supplies to these overly extended areas! Such a course would not provide for greater future water needs, however.

Meanwhile, according to Legal Notice 51, Swaziland is required to release at least 1.27 cumecs at the eastern border (below SIS weir).[2] This then constrains diversions at the SIS weir which cannot go beyond that specific level. Meanwhile as well, greatly increased use has been made of Komati water both upstream and downstream of Swaziland in the RSA. The former has concentrated heavily on forestry and industrial use (coal thermal plants); downstream has witnessed rather non-regulated irrigation development spurred on by expanding domestic (RSA) sugar needs, the availability of virtually free

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1 All data from Olivier et al, Basin Development, Vol. 1, Tables 2.4 and 3.9. Runoff could be as high as 108 MCM annually with canal losses of some 18 MCM (Ibid, p.3.1.7; p.3.10 and Table 3.A.2).

2 There is no equivalent for RSA to guarantee a minimum amount entering Swaziland at the western border. Presumably such an agreement would be part of an understanding to build Maguga Dam and otherwise share the Komati system. The more workable solution perhaps is the incorporation in any agreement between Swaziland and the RSA of agreed-upon water use controls within each country which are compatible with one another.

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water, and a tax allowance system which permits large pump investments to be written off in one year.[1] Had all water entitlements been taken up, there would have been an even more severe shortage in 1983.

This entire inter-related process thus has led SIS management to request Government, and thence the JPTC, to keep their firming up needs in mind when negotiating the uses to which net additions to water supplies should be allocated.

2. Reported economic impacts of shortages

In writing up the Terms of Reference for this current study, therefore, this issue naturally was to be examined, and was given economic expression:

> "It is expected that if action is not taken Swaziland could experience a shortfall in mean need of at least 45 MCM by 1990, and at a frequency of one year in five. The shortage could be much greater in any given year, in fact it could exceed 70 MCM. With such declining flows and hazards, it is estimated that SIS would have to reduce its area under irrigation by at least 3,000 ha. Since SIS is a sugar producing scheme, this reduction would result in a serious loss of foreign exchange as well as jobs. In 1984 prices, a reduction of 3,000 ha would have meant a revenue loss of E12,7 million and 385 jobs, a considerate loss for a country the size of Swaziland."[2]

No research studies, apparently, were used as sources for these figures. A figure of 49 MCM was specified as the SIS "firming-up" water requirement (see discussion at 6. below).

3. Water shortage indexes

Partly in pursuit of a further and more precise delineation of these water shortages, several engineering/hydrological studies were conducted to that end. Several consultants over the last several years have worked on the calculation of such shortage indexes, but different assumptions have resulted in confusion regarding the shortage index at SIS.

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1 J.E. Harrison and W.E. Kaissier, Final Report Dealing with the Economic Benefits to be Anticipated as a Result of Constructing the First Two Proposed Dams for the Komati River Basin Development (Johannesburg: Olivier et al, December, 1983) Henceforth Harrison

2 USAID, Terms of Reference (TOR) for a Feasibility Study of an Irrigation Project in the Komati Basin, Mbabane, 1985, Section 2.2.D2, last para. Last sentence, word should no doubt read "considerable".

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Without burdening this discussion with undue technical detail, it is worth discussing these indexes and their differences, since they are supposed to show the degree to which SIS requires firming-up water. The shortage index formula is agreed upon.[1] One consulting firm (Fourie et.al.) states that the shortage index at SIS is about 0.35, and that, according to the US Army Corps of Engineers, a shortage index of about 0.25 on an unregulated river is acceptable elsewhere on an unregulated river.[2] Since these results are both essentially correct, though reflecting differences in approach, then it becomes truly difficult to assess actual shortages. Shortages elsewhere in the basin are greater than 4. Yates, on the other hand, calculated the shortage index as 0.68.[3] These differences are discussed at B.3 below.

4. Water "lost" from the Komati to the Mbuluzi

On the water applied to SIS lands, a certain percentage is lost as canal leakages, drainage and water applied in excess of crop water requirements. About 11 percent of the Komati water applied to the large areas of SIS in the Mbuluzi watersned is returned as runoff to the Mbuluzi river, some 126 MCM annually. While runoff is expected, there has been a questioning of whether or not SIS is, in fact, applying too much water to its cane and thus "wasting" Komati water, since that 126 MCM is returning to the Mbuluzi system, not to the Komati system for reuse downstream. That amount of water would irrigate a good deal of new land in the Komati Basin. The argument is fueled, of course, by the fact that SIS is not yet paying for the Komati water, so why not treat it as a "free" input? Quite aside from the losses of Komati water to the Mbuluzi system, of course, is the matter of "excessive" watering; to the extent SIS is "overwatering" (if at all), then firming-up water requirements (if any) · naturally less.

5. SIS system divorced from Komati Basin management

The Commonwealth Development Corporation (CDC) began the project as a private enterprise, and was duly granted water rights by the Swaziland Government. Historically, SIS management has operated their diversion weir, canals, pumps and reservoir independently. Recently, however, there are several new developments. One is the JPTC, interest in controlling and managing the entire Komati system, altering drastically the historic run-of-river situation with dams and reservoirs. As the primary single user of Komati water in Swaziland, now and probably in the future, there is the strong

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1 Shortage Index $= \sum_{1}^{n} \frac{(\text{water shortage during year})^2}{(\text{water demand during year})} \times \frac{100}{n}$

Where n = Number of years of record

2 USACOE Framework Plan, pp. N13-N14.

3 T. Yates, IYSIS: Water Resources for Mhlume Water (London: Binnie and Partners, January 1984). Yates posits different demands, however, and allows for both daily flow variations and a larger canal.

presumption that the SIS water management system must be integrated into the overall context/regulation process, especially if its firming-up needs (if any) are to be catered to by the working rules of the Maguga reservoir.

6. The 49 MCM

A detective cum sleuthing operation of finding the source of the firming-up figure of 49 MCM did have positive results. The water resource/hydrologist officials of the GOS, the Olivier et al and the Devres study team arrived at a mutually agreed listing of the current and proposed future allocation of Komati water as shown in Table I-8.

As can be seen, there is no allocation of 49 MCM for SIS firming-up, nor any room for a further 49 MCM unless it were assigned from a combination of Swaziland's 40 MCM for new requirements and the surplus 36 MCM, 16 MCM of which is already understood to belong to Swaziland. SIS is an existing water demand. Therefore, after the Maguga Dam construction SIS will be assured of receiving its demand, but the imporved assurance cannot be converted to a specific volume of water which will be for the sole use of SIS.

7. SIS weir measurements

As part of this overall package of efforts at clarifying the SIS "problem" and SIS's needs, more hydrological work and assessment were effected on river flows at the SIS diversion weir. Komati river water is in fact legally apportioned to individual licencees by their share of flows as measured at that weir. The proportion of Komati NSF (Normal September Flows) is specified in Legal Notice No. 51 of 1981, promulgated under the Water Act of 1967.

Some difficulties were also encountered here, in that the NSF shares specified in the Act appear to be based on a flow of 362 cusecs while in fact the flows are only some 161 cusecs. These new research efforts by the Water Resources Branch were also attempting, at this study team's request, to find sufficient run-of-river water to begin irrigation at the project site prior to the availability of Maguga Dam water, if only for some field crops and nursery establishment. The water is there.

B. Results of Studies and Investigations

1. General

Given these inter-related issues and problems, the studies and analyses have provided a series of results, not all of which are necessarily final or satisfactory. They will be addressed in this section in the order in which they appear above, and they represent, on balance, a qualitative step ahead in the Basin's usable information base.

SWAZILAND: ECONOMIC STUDY OF POSSIBLE USES OF ADDITIONAL WATER ON THE KOMATI RIVER

Table I-8: Current and Future Allocation of Komati Water

		MCM/Annum
Yield of Maguga Dam (System at 80% Assurance)		569.01
Existing Water Demands:		
Komati		
Swaziland	186.0	
RRSADS	147.7	
Nkomazi	20.6	
Mswati	0.8	
RRSAUS	6.5	
Lomati		
RRSAUS	5.9	
Nkomazi	4.5	
RRSADS	53.1	
Swaziland	6.1	431.2
		137.8
New Water Requirements:		
Reserve for primary demands	22	
RSA	40	
Swaziland	40	
Surplus (unallocated reserve)	36	138.0

Source: Olivier et al, Basin Development, Part 1, pp.17-18 and JPTC, Proposals, pp.13-14

2. Reported economic impacts of shortages

a. Introduction

Whatever data seemed relevant were examined to attempt to assess the actual impact on SIS of drought/drier period paying particular attention of course to 1981-83. As well as project-level materials available on per hectare yields and values, documentation was examined on national-level sugar and citrus yields and values during the same period (SIS being a major but not sole producer of sugar and a minor producer of citrus). In addition, a Consultant study is available which assessed the 1983 drought impact on smaller farmers in the RSA downstream of Swaziland on the Komati. (Harrison... op.cit) Though conditions there are slightly different, and the level of assurance against which drops in yield were assessed was 94 percent, the study nonetheless provided useful analogies.

b. National level crop yields, citrus and sugar

The two main crops grown at SIS, as already indicated, are sugar cane and citrus. The latter is a small share of national production; the former approximates 35-40 percent of national output. A dedicated effort was made to assess the overall impact of drought on Swaziland's sugar and citrus production generally. The purpose was to identify, at least in a very preliminary way, any overall national trends or movement over the 1970's and early 1980's especially of course in 1981-1983.

Citrus production and export data and price data at several levels were sought. Sugar data are complicated further by cane production/sucrose/farm gate (mill) yields and prices; the problem of some holdover stocks; and the complicating factors of quotas and STABEX, the EEC's Export Stabilization Fund. Without belabouring the point, virtually all date/information series, when examined, turned out to be "dust" and non-usable in any rigorous way; interelated factors such as product quality and monsoons made it quite impossible to establish any sorts of identities or correlations.

c. SIS crop yields: citrus and sugar

More to the point, however, a serious effort was made to obtain water consumption/yield/farm gate prices from the three main SIS estate components. Responses were received from two estates in time to be included in this analysis. In spite of the considerable work and record-searching, more ambitious plans to relate field-edge Komati water use to tons of cane/citrus exported to monetary values of those items was not really possible. There are just too many other variables affecting the relationships e.g. small sized citrus fruit not favoured on export markets; exhange rate fluctuations; rainfall fluctuations, and cyclone damage in 1984. Shortage indexes only become meaningful when a drop of, say, 300mm or 500mm not applied to a crop can be related to some definite and measured decrease in cane or sucrose yields (and vice-versa).

Four observations do emerge from analysis of data provided by the two estates which are of relevance to future inquiry:

a. A rather large percentage of land which has been invested with irrigation facilities is taken out of cultivation because (primarily) of salinization--these (apparently) contain the least well drained soils. The percentage of soils so abandoned reached its height on one estate over 1978-1981--9.9 percent to 10 percent. Reclamation costs at that rate surely add measurably to overall investment costs per tonne of cane.

b. There appear to be some rather perverse relationships between cane yields and rainfall. Both estates produce cane. Averaging annual yield per hectare of cane cut in five-year intervals provides the results shown in Table I-9.

It is recognized that within any one estate there will be a range of factors influencing yields, rainfall being only one of them. Changing management skills and production policies; changing percentage of better and not-so-good irrigable land; changing water volumes available in the Komati and the reservoir; etcetera. Many of these dynamics in fact would tend to run in opposite directions e.g. improved management skills enhancing yields, and a rising percentage of poorer soils depressing average estate yields.

Nonetheless, instead of a possible and gradual increase in yields just the opposite appears to have happened on both estates. Overall yields appear to have risen, and peaked in the late 1960's. They have dropped markedly since that time. Averages over the last 15 years on Estate A are only three-quarters of those of the 1966-1970 period; for Estate B they are only 85 percent. Not only is the relative drop in yield very much less on Estate B, their average yields over the period consistently exceed those of Estate A by a very wide margin. The 5-year averages also mask striking year-to-year yield changes. Estate A's lowest and highest annual yields were 82.77 MT and 126.62 MT; B's were 96.65 MT and 157.49 MT.

Yield records were then related to rainfall records--the actual total water applied to the crop was not provided by either estate. Using rainfall data provided in Yates,[1] particular periods of both low rainfall and high rainfall were identified, as were trends relative to that period (ascendent rainfall curve, descendent curve). Cane yields were also separated out for those same periods. The results of this correlation are shown in Table I-10.

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1 T. Yates, Water Resources, Figure 4.5

Table I-9: Comparative Five-Year Average Sugarcane Yields on Two Estates

Average for	Average Yield (t/ha) Estate A	Estate B
1961-1965	119.29	n.a.
1966-1970	127.58	134.07[a]
1971-1975	89.01	118.85
1975-1980	99.14	111.88
1981-1985	95.82	111.02[a]

[a] Four years only

Source: Devres Staff Estimates, August 1985

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Tabe I-10: Correlation Between Rainfall and Sugarcane Yields in Two Estates

Period	Estate A	Estate B	Rainfall Status: Rainfall	Rainfall Status: Position on Curve
1964-1966	109.64	n.a.	very low[a]	barely ascendent
1968-1971	96.72	126.94	very low[a]	sharply descendent[d]
1974-1979	96.68	114.60	very high[b]	sharply ascendent[e]
1980-1982	97.60	113.84	still high[c]	sharply descendent

[a] 50-60% below mean annual average
[b] 50-60% above mean annual average
[c] still above (20-30%) mean annual average
[d] 1971 began to rise again
[e] sharply ascendent 1974-1978; 1979 falling again.

Source: Devres Staff Estimates, August 1985

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It is recognized that MAR correlates to rainfall with a brief time lag, and therefore run-of-river water supplies, and that irrigation water can substitute for natural rainfall. The reader is also reminded that this inquiry began with a search for reasons for "firming up" water. What emerges from the above calculations is that cane yields are highest in periods of lowest rainfall (and thus run-of-river supplies), and lowest in periods of highest rainfall. The direction of the rainfall curve does not appear relevant in this analysis. What clearly could be relevant, however, is the role of the SIS storage reservoir.

c. A similar correlation exercise was conducted for sucrose content/rainfall relationships. These percentages vary as follows:-

		Average Percentage Sucrose content
Low rainfall periods		
(1)	1964-1966	13.85
(2)	1968-1971	13.57
High rainfall periods		
(1)	1974-1979	13.17
(2)	1980-1982	13.47

These calculations thus tend to support the well recognized proposition that "dryness sweetens the cane." What we wanted to find out was the relationship between these changing contents, on the one hand; and, on the other, the number of mms. applied to the crop. There is the presumption, utterly unproven, that one achieves a greater sucrose tonnage per M^3, or per Lilangeni spent to get that M^3, at reduced levels of water application; it appears to be good economics to underwater.

d. Finally, an equivalent exercise was conducted on citrus. Using the same periods and other definitions as with sugar cane, above, the following results:

Period		Cartons Exported (Per Hectare) (Long run average = 100.0)	Position on Curve
Low Rainfall Periods			
(1)	1964-1966	133	descendent
(2)	1968-1971	105	descendent
(3)	1983-1984	105[a]	descendent

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High Rainfall Periods

(1)	1974-1979[b]	97	ascendent
(2)	1980-1982	94	ascendent

[a] drought year of 1983-1984 was highest yield ever achieved (index of 118) except for 1970 when the index was 121.

[b] Yates (op. cit., Table 5.4) shows 1977 and 1979 as very high observed water demand years; yet they have the highest rainfall also.

Once again the results indicate, very clearly, that reduced rainfall (and thus run-of-river supplies) periods produce higher yields and higher rainfall periods result in lower yields. What is not known is the role of irrigation water and storage. Any conclusions clearly must depend on that.

In conclusion it seems clear that nothing is clear at least without further studies; those are suggested at Chapter VI.B.2.c. There is a reasonable body of evidence here, however, that suggests that "drought is good for you."

d. Consultant analysis in RSA downstream of Swaziland

The introduction to this section mentioned a recent study (Harrison ...) which assessed the impact of the 1983 drought in the RSA downstream of Swaziland. The report was examined carefully to see if any economic results could be useful for this analysis. The following are the salient findings pertinent to this SIS "firming-up" analysis:

a. Overextension of area irrigated occurred during the 1970's as there were no regulations on pumping, because tax laws permit one year write off of pump costs and there is no charge for water.

b. No regulation on pumping allows heavy wastage and thus heavy losses, especially along the Komati.

c. High cane prices have not stimulated water economies.

d. Thus ... "The preponderance of heavy rainfall years during much of the 1970's and early into the 1980's had unfortunately obscured from most peoples' minds the dangers inherent in the virtually unplanned and uncontrolled development of irrigation farming. The occurance of a poor rainfall year in 1981/82 followed by an even worse one in 1982/83 has illustrated the potential dangers of the present situation, but unfortunately has not, generally speaking, resulted in a sounder and more acceptable use of a relatively scarce asset." (pp.2-3).

e. There has been an inflation in land prices in spite of the drought due to continuing expansion of sugar quotas.

f. Sugar yields are well below average due to poor management far more than the water shortage ... "Incorrect application of water is probably the main reason for lower than optimum yields being obtained..." (p.8).

g. Nonetheless, sugar coped with the drought much better than other crops.

h. It was estimated that, overall, the net loss in gross income on the Komati was about one-half, input values were reduced by one quarter, (though still a higher value than the reduced gross impact), so there was a "loss" on current account of some 26 percent or so. Looked at another way, the difference between the "no water shortage" condition and 1982/83 was about R1340/ha, and less per hectare cropped since the cropping intensity is about 120.

i. The multiplier of this loss on the community is quite severe in terms of lost jobs and incomes, and in lost tax revenues to Government.

j. Based on their loss calculations, it was estimated that Phase I dams would "save" 13.8 percent of that area's gross farm income and about 9 percent of the net (with dams there will be notice of shortages and less "up front" spending).

It had been this Devres Consultant's intention to utilize these findings to guide suitably adjusted analyses of SIS possible losses under the one-year-in-five rule post-Maguga reservoir. It seems clear, however, that such an analysis is irrelevant since SIS is now in a position to adjust to that situation. In any case, perhaps as importantly, we were not provided with clear evidence overall of such crop losses.

3. Shortage indexes and their relevance

Section A.3 above posited the dilemma of two sets of results from essentially identical data sources and methods. How to interpret this? Most of all, how good are the basic hydrological data used? Numerous factors must be considered when evaluating the significance of shortage index estimates from these data sources:

1. All of the shortage index figures are calculated from the same or very similar base data;

2. All results are calculated using the same equations;

3. When similar data are put into the equations, similar answers should emerge; and

4. The shortage index and other methods used to measure water shortages in the Olivier et.al. report cannot "... be expected to give more than the crudest indication of the economic effects of water shortage." (Yates, para.1.1)

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In summary, all the quoted shortage index estimates are essentially correct, and they should not be relied upon heavily. Yates calculated the index at SIS as 0.39 when using the Olivier et al assumptions, functionally identical to their estimate of 0.35. Therefore, there is error neither in the method nor the input data used by each Consultant.

The differences seem to be based upon the following considerations. Olivier et.al. used water demands as provided by SIS from their abstraction records (see Olivier et al Vol. 2 of 5, pp.4.48-4-49). Their water demands and analysis are for the period 1921-1973 only and used monthly runoffs not adjusted for daily flow variations. Yates, on the other hand, appears to have incorporated a revised water demand assessment; has used a larger area of irrigation; has made corrections to modify runoff data to account for daily flow variations; has worked with a larger main canal; and has used a date series up through the 1983 drought.

Yates concluded that the cause of the difference between the Olivier et.al. shortage index of 0.35 and his shortage index of 0.68 is the use by Olivier et.al. of constant monthly evaporation rates. The evaporation rates used by Olivier et al for each month were the same from year to year, which is not necessarily realistic. Yates and SIS management maintain, however, that high evapotranspiration, crop demands, and low flows are all likely to coincide during a year of low rainfall. Because the Yates approach attempts to model the "real" world more closely, presumably his shortage index of 0.68 could be more accurate.

Unfortunately, however, the fragile nature of the available climate and river discharge data probably do not justify such sophisticated approaches. Al o, a conflict exists in the use and interpretation of this application/evaporation issue. Ideal growing conditions require maximization of evapotranspiration to move water and nutrients through the plant. Farmers typically will apply as much water as the plant and soil can accept, especially when the water is "free". Evapotranspiration is greatest during dry years.

This leads to the apparent contradiction that droughts are good for farmer. This is at least true as long as dams are able to supply water, because evapotranspiration, and therefore demands and yields, is highest during the low flow years. Cane yields may fall, but sucrose percentages rise. The financial loss is not proportional to dry cane volume loss--see the sucrose analysis at B.2.c. above. The word "may" is emphasised since it was shown above that cane and sucrose yields appear highest when water is in shortest supply.

The Yates approach maximises yields during drought years. Concerned with ensuring the yield of Maguga Dam over long periods, Olivier et.al. consider that yields should decrease during drought years (1 year in 5 post-Maguga). The discrepancy in farm management strategies which results from different statements of shortage indexes is largely a dam operation and management problem which can only be evaluated more fully with post-dam experience. Thus, the apparent discrepancy in shortage index results cannot be resolved at this time.

The concept of water for "firming-up" SIS therefore may be misleading on these technical grounds. The shortage indexes of 0.35 and 0.68 show that SIS is not short of water when compared with downstream users where shortage indexes of 4.0 and greater are common. Olivier et.al. calculate the mean annual shortage at SIS to be 3.6 x 10^6 m^3, which is only two percent of the mean annual demand. SIS does have some years of significant shortage, nonetheless. From Yates (Table 9.3) SIS experienced an average monthly shortage of 43 percent during the 1982/83 water year.

The bald fact, however, as suggested above, is that without the dam the shortage index (however measured) will become larger as an unavoidable consequence of development. The post-Maguga shortage index of 0.96 from Yates does not consider that under the stepped-draft rule of operation, the post-Maguga shortage indexes will not continue to increase as a function of new development on the Komati. If the post-Maguga shortage index is relatively stable, detailed study of the historic shortage index to quantify the benefit of Maguga to SIS is thus rather pointless: the future shortage indexes resulting from continued development and appropriation of Komati Basin water are of relevance, however, to future water planning.

It may be worth repeating in this context, therefore, the nature of the stepped-draft rule of operation of Maguga Reservoir. Yields from the Stage I dams at Driekoppies and Maguga have been calculated in two ways, depending on whether the dams are operated to give constant or stepped yields. The constant draft rule assumes that the dams are operated to yield a constant volume year after year. Constant draft operation of the dams would yield 168 x 10^6 m^3 from Driekoppies, and 282 x 10^6 m^3 from Maguga.

Stepped draft operation of the dams means that for 80 percent of the years of the project life the dams are operated at a higher yield than is available under constant draft operation, and at a lower yield from 20 percent of the years. The reservoirs are managed so that in the years of lower yields, the lower draft is 70 percent of the upper draft. Stated another way, in all years, the yield is at least equal to the lower draft, but in four years out of five, a much greater volume of water is available.

Under the stepped-draft operation, the upper stepped-drafts of the dams would be 196 x 10^6 m^3 from Driekoppies, and 366 x 10^6 m^3 from Maguga. When the dams are operated to augment the unregulated runoff which will occur below the dams, the combined system yield is 569 x 10^6 m^3 (119 x 10^6 m^3 more than the constant draft for at least four years out of five). It is this 569 x 10^6 m^3 which is used for the proposed draft water distribution at section I.F. above.

Other implications of the constant draft and stepped-draft operating rules, apart from yields, are that the constant-draft operation is relatively expensive per unit of water, but of course provides a lower probability of shortage. Stepped-draft operation results in more water, therefore a lower cost per unit of water, but shortages will occur during some years. Shortages mean that only 70 percent of the upper draft will be available. Figure 5 of the Basin Development Plan (Olivier et.al, op.cit Volume 1 of 1) shows a simulated comparison of these two draft rules, plus a third option called a partially controlled upper draft rule.

The simulation is based on available rainfall and runoff records for the period 1921 to 1979. The drafts shown there are rates in cubic metres per second, not volumes as presented above. When operated under the constant rules, the draft from Maguga Dam is 8.95M^3/sec. When operated under the stepped-draft rule, the upper stepped draft (available on average for four years out of five) rises to 11.6M^3/sec. The lower stepped draft (available on average one year in five) is 70 percent of the upper draft, or 8.47 M^3/sec. The upper partially controlled draft is 14.44 M^3/sec. When operated under this rule, the dam supplies a large volume of water during many years, but during years of drought, the dam is dry and water yield drops to levels dependent on the flow of water in the river. The stepped draft operating rule has been selected for planning purposes.

There have been recommendations that Swaziland press for an agreement with RSA regarding releases across the western border on the Komati of 5.15 M^3/sec. In return, Swaziland would agree to release 1.5 M^3/sec. at the eastern border.[1] Some agreement on cross border flows would appear to be essential to ensure that any dam in Swaziland would continue to receive an assured flow at an agreed level even if dams are eventually built upstream at Boekenhoutrand or Hoogenoog. Present agreements require Swaziland to release only 1.27 cumecs to RSA downstream from Swaziland, but RSA upstream has no obligation to release water to Swaziland. As suggested earlier, however, it would seem best to this Consultant that an agreement be made between the countries regarding <u>total</u> new additions to this system <u>plus</u> run-of-river flows. Each country then has X MCM guaranteed to do with as it pleases. Those national maximums upstream of the SIS Weir would, by definition, permit certain downstream flows.

4. <u>Water "lost" to the Mbuluzi</u>

There seems little to comment on this issue. The SIS production system is well- and long-established. The only recommendation would of course be to economise in the use of water and reduce, as possible, runoff and seepage losses. A charge for water used may be of relevance to achieving this objective.

5. <u>Incorporating the SIS System into the Overall Komati Basin Management Process</u>

Now and into the future the water needs of the SIS operation will loom large in any planning and regulation of Komati Basin water supplies. It is imminently logical that the entire SIS operation--weir, canals, pumps, reservoir, etc.--come under the control of a Basin Authority (or whomever will operate the dam/reservoir systems). Legally enforceable responsibilities, understandings, and rights would need to be established.

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1 This flow of 1.5 M^3/sec. is consistent with an expansion of SIS's reservoir.

6. Relevance of the 49 MCM

Four points have now been established which will be discussed more thoroughly at Chapter VI below. One is that the 49 MCM thought to be provided for "firming-up" is not really provided at all; certainly there is no solid evidence at this point to substantiate that need. Secondly, however, a detailed review of new water available post-dam and already-made commitments of that water indicate that there are not 49 MCM in the arithmetic. Thirdly, with a modest increase in its reservoir capacity, SIS could now provide for all of its own water requirements.

Finally, it certainly cannot be shown that reserving any volume of water for SIS firming-up is as economic as that same water put to some other use. In any case, it no doubt will be 10-15 years before Swaziland can take up its full entitlement; this leaves time for these decisions.

7. SIS weir measurements

As stated at I.G above some difficulties were encountered with the actual flow rates as distinct from those embodied in Legal Notice No. 51 of 1981. They do not influence this analysis.

VI. CONCLUSIONS AND RECOMMENDATIONS

A. Conclusions

Based on the results of the enquiries and studies described in Chapter V Section B above, this section will collate what conclusions appear to be available as they relate to the matter of SIS's firming-up water requirements. In addition to comments on the economics of such a water use, a variety of other related items is also addressed.

1. Yields, water use, and economics: conclusions from the economic analysis

It is of course a moot point as to whether or not the rather primitive information manipulation at section V.B.2 above can be considered "analysis"!! Nonetheless, what has been established is that nothing really can be established! The entire package of economic and financial material available (not hydrological!) is a combination of weak statistics; complicating elements which confound decent interpretations and inferences; and a plain absence of proper numbers. Such an information environment should be stretched only so far and no further.

In sum, there is no economic justification possible at this time by which SIS should be provided with new water for firming-up existing production areas. The water would be available of course, post-Maguga, until used up for other purposes (if so used up).

2. SIS weir measurement and the Water Act

The studies to improve the Komati water licencing system for water permits should continue. The new Komati Irrigation Project will require a properly document licence, as will any run-of-river withdrawals prior to Maguga Dam water becoming available.

3. Water mangement

a. SIS Reservoir: capacity expansion

Recent documentation prepared for the JPTC has pointed out that a very modest increase in the capacity of SIS's Sand River Reservoir (7×10^6 m^3), for which it has been designed, would pretty well solve SIS's water shortage problem. Recent investments in improved capacity elsewhere in their system have reduced a variety of historical bottlenecks which have inhibited SIS's ability to take fuller advantage of run-of-river flows when they were available:

> "Detailed analyses of the water availability at IYSIS were performed--and it was found that with the recent enlarged main canal and more effective use of the pumpstation the requirements of IYSIS can be met with the same assurance as from a dam at Singuen or Maguga provided also that the releases past the CDC weir can

be limited to 0,28 cumec (10 cusec) instead of the current 1,28 cumec (46 cusec). This release is considered to be the minimum acceptable release for environmental reasons and to meet the requirements for domestic and other uses, in particular the future domestic water requirements in the Nkomazi Region in the RSA."

"For the water demands up to 1995 and using the observed hydrology adjusted for future increases in afforestation a shortage would have been experienced at IYSIS only during October 1983. It would furthermore have been possible to overcome this by increasing the size of Sand River dam by only 7 x 10^6 m^3, which is well within the original provisions for raising. With the anticipated increases in water demands to the year 2010, again using the foregoing hydrology shortages would have been experienced at IYSIS only during September 1983 and October 1983, which could again have been overcome by increasing the size of Sand River dam by only 16 x 10^6 m^3 in total, which is still less than what was provided for originally."[1]

b. Komati Basin Management of SIS Water

As already suggested in several connections, it seems logical to conclude that the management of the water used by SIS must now become integrated with the umbrella management of the entire Komati system as envisaged by the JPTC. Such an overall management would ensure SIS sufficient water, and would still allow minimum flows downstream of the SIS weir. Management of the weir itself becomes increasingly important since rights to any water by all present and future Komati water users are described as shares of the river's flow at that weir. It is in everyone's interest to have that system under JPTC jurisdiction.

The incorportation of the SIS system into an overall Komati operating system would also have a major positive impact on yields..." However, the incorporation of a dam such as Sand River dam into the system, and therefore under the control of the operating authority, could contribute significantly to the system yield: up to 20 x 10^6 m^3/a as an initial approximation."[2] That "contribution" is very nearly half the amount discussed initially for firming-up SIS water supplies, and is sufficient to irrigate, for example, some 1500 additional hectares.

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1 Olivier et al, Possible Revisions to First Phase Proposals... (Johannesburg, March, 1985) pp.8-9

2 Ibid.

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This Devres study team has not been able to identify any documentation, JPTC or otherwise, which describes the structure and workings of a Basin Development Board (or some such name) which, among many other things, would manage all reservoirs in the system. Some brief comments are made in that direction, however, in Chapter IV.C of Volume II. We are given to understand that the JPTC is now discussing just such a structure, and would command such progress.

c. "Lost" water

The closer examination of the heavy water volumes running off to the Mbuluzi would of course be helped if SIS water were incorporated into a larger network. Such studies could then become integrated with other studies needed in the Basin of a similar nature. The economics of adding another mm/ha at the margin, especially if that water has a price, would also be relevant to these matters.

4. Getting the most for the M^3 of new water

a. Yield/price/cost studies

The heart of the matter at SIS is the determination of the financial results, ups and downs, of changes in water supplied to the crops, especially sugar cane. Decreases in water supplies, especially if predictable (which they would be post-Maguga), can often be accompanied by certain cost savings. Conversely, increased water applications may call for more costs/ha or per unit of yield increase.

The following guidelines could perhaps assist in designing a study at SIS to elicit more exact information along those lines:

- Characterise the existing historical yield situation relative to the amounts of irrigation water effectively applied;
- Develop yield response vs. water effectively applied relationships, giving due consideration to other factors influencing yield potential; i.e. climate and soils;
- Estimate the true maximum commercial yield potential if all reasonable limits on growth are eliminated, i.e. water and fertilizer.
- On an estate-wide basis, model the plantation costs to achieve this maximum potential yield to determine if it represents net profit improvement to the enterprise;
- Compare the overall water supply requirements for maximum potential yield and relate to available supplies and other competitive uses.

The study would need to proceed on a field-by-field basis and would require a great deal of micro-analysis and the availability of good records. A significant amount of agricultural judgement is involved in determining yield potentials. Ultimately, the study involves computerized simulations of the entire estate as decisions on irrigation naturally affect nearly all estate operations.[1]

b. Charging for water

It is apparently GOS policy to begin charging for water post-Maguga in the effort to recoup all or part of the costs of new water development, especially the costs of dams. Elsewhere in this report we have made some comments on water charges (Annex 6, Volume II). As well, the financial structure of the proposed irrigation project studied in detail in Volume II allows for a water charge to be paid to Government. Whether a charge should be made to SIS, and its level, clearly must rest upon the financial and equity considerations discussed in the Annex. Possible levels of that charge are explored in that Annex. Such charges could occasion further study of water saving systems, perhaps the switch to citrus and other true crops (mango, papaya, avocado) where the net returns/M^3 are so very much higher.

B. Recommendations

This final Section distills the various analyses and enquiries into two main sets of recommendations. Those at Section 1 deal with "water"; needs, costs, amounts, and the like. The section collates all of the various "routes" to answer the prime questions of how much water, for what purpose, and at what cost.

Section 2 then pulls together the wide miscellany of other suggestions and recommendations resulting from this Komati study.

1. Recommendations regarding water

This section collates a variety of analyses on the need for more water, and its costs. These include those on land available shares and future population shares, and those on new irrigation activity and firming up water requirements. To these will be added further analyses of land and population shares, analyses of already understood cost shares (20 percent of Phase I dam costs for Swaziland), and analysis of MAR shares. All of these are then brought together in one integrated supply and need (demand) analysis. It will be seen that all of these many routes lead to the same destination e.g. a future need for 150-210 MCM annually at a total system dam cost share of E50-80 million.

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1 Section B.2.i. below discusses water rights and, within that, the need to measure the value added per M^3 of water used; this permits the "chopping off" of water to its least productive uses in times of shortage. The SIS situation is made-to-order for this type of analysis.

a. Understandings on cost sharing: land and population

Annex 4 to this Main Report analyses, in some detail and into the future, the relationships between good land available for irrigation, future population numbers, and future water needs. The balance of this section draws partly upon that Annex 4.

That Annex 4 wrestled its way through available data on future population, on potential irrigation land available, and several other variables in the effort to identify what requirements land and people would have for water at a future date, namely, the year 2010. These future scenarios, or Cases, were then integrated with water volume, Phase I dam cost, and price/M^3 information. That "Base Case" was, of course, 105 MCM coming to Swaziland for a dam share cost of E40 million. By "equity" unit pricing, Swaziland's share of the total new water available of 105 MCM was raised to 114.0 MCM for the cost of E40 million using a Stage I average of E0.351/M^3 rather than the E0.381/M^3 now being "charged". Further steps applied land shares and population shares to allocate water, each different level of allocation to Swaziland being given a cost using the "equity" unit price.

The conclusion emerges very strongly that Swaziland must obtain significantly more water resources than the 105 MCM under current discussion over Phase I just to permit minimum irrigation farming, and regardless of other needs (forestry, thermal power etc.). The three Cases (future scenarios) which emerged to the top are as shown in Table I-11. It should be noted, nonetheless, that nearly all cases examined (other than the "Base" Case) provided Swaziland with the need for more water than the 105 MCM under current discussion.[1]

Cases V.A and V.B use different population projections--V.A used the Olivier et.al. Consultants' 2010 population estimate;[2] V.B uses a 2010 population, somewhat greater, developed by this Devres study team. Case III.B is built up from Olivier et al information on hectarages of irrigation land (very much lower than other set of figures showing irrigation land available and used in other cases not shown here; see Annex 4 for details.)

The analysis is now clearly building a house on very shaky statistical foundations. Nonetheless, biases and errors will generally be consistent so that comparisons and contrasts are reasonably valid. All three Cases call for a volume of water very much in excess of the 105 MCM of the "Base Case". All Cases cost more: E44-61 million. But the cost per capita of 2010 population is miniscule: a E219-E304 "cost" for an annual water supply in 2010. The cost per hectare of potential irrigable land in perpetuity is also not too high, remembering that not all that land will be irrigated, as indicated in line 5. Even if all of the Swaziland water shown in each Case was used only for

1 The only exception was a Case based upon faulty data in earlier documents and therefore it does not really count.

2 The JPTC Consultants did not have the results of the recent Population Census. They understandably under-estimated severely the Swaziland population in the Komati Basin in the year 2010.

Table I-11: Comparison of Costs Per Capita and Per Hectare of Water Supplies in the Year 2010

	Item	Case V.A.	Case V.B.	Case III.B.
1.	Annual volume of water achieved for Swaziland (MCM)	124.3	172.7	140.8
2.	Dam share/cost using equity unit pricing (E million)	43.629	60.618	49.421
3.	Dam cost share per capita in basin using Devres Year 2010 population estimate	219	304	244
4.	Dam cost share per hectare of irrigable land potential (E)	1,176	1,631	1,310
5.	Area possibly irrigable with that volume of water - hectares (@ 1500M^3/ha)	8,267	11,400	9,400
6.	Dam cost Swaziland share (line 2) divided by area irrigable (line 5) (E/ha)	5,322	5,351	5,213

Source: Annex 4

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irrigation (nothing for forestry etc.), only a range of 8,300 - 11,400 ha could be serviced. The dam costs for those hectares range from E5,213 - E5,351/ha. Continuous irrigation efficiencies might expand areas irrigated and reduce per/ha dam costs. As well, after, say 3,000 ha of irrigation, perhaps relatively more employment and foreign exchange earnings are generated by other water uses e.g. forestry, thermal plants (with associated mines), etc.

b. Water use alternatives: synthesizing demands and supplies

This Section has three purposes. The first is to collate the various options available to Swaziland with respect to the longer-term use of Komati Basin water--"needs", or "demands". Second, it will then examine the options available for longer-term supplies. Third, these demand and supply options are then synthesized and costed.

(1) Water demands for economic activities

Four types of water need by economic activity are addressed here (irrigation, forestry, thermal plants, and miscellaneous). The irrigation analysis has shown that each 1,000 ha of new irrigated cropping consumes some 13.5-15.0MCM of water annually. Soil and other analyses suggest that up to 6,000-8,000 ha of reasonably good soils (not exceeding pumping lifts of 50-60 metres) could be so irrigated. If all were so put down, this would consume some 84-120MCM annually and add some 20-25 percent to the nation's irrigated area.

As well, given market price trends over the next several decades, Swaziland could put up to at least 40,000 ha of otherwise underutilized SNL lands to exotic forests. These consume some 6MCM per 5,000 ha so the need would be for about 47-50MCM, adding 35-40 percent to the lands so planted in Swaziland. Finally, a third consumptive use could be water utilization in coal-fired thermal plants. It has been difficult to acquire reasonably definitive data on this activity. Estimates range from 13-15MCM for a 50MW plant down to 5MCM for the same, more modernised, facility. Given Swaziland's power needs into the future a 150-200MW plant or a combination of smaller plants could be envisioned in the Basin using, say, 15-30MCM. The miscellaneous use category covers a wide variety of municipal and related uses.

Demand Summary

Activity of Demand	Range of MCM Needed Annually
1. Irrigation	84-120
2. Forestry	47-50
3. Thermal Power	15-30
4. Other (municipal, processing, etc)[a]	5-10
Total[b]	151-210

a Estimates
b Excludes "firming up" needs, discussed below.

(2) Supplies

These possible demand (or "need") levels[1] may then be placed in the context of overall supplies which could be available in the Komati Basin over the next several decades. Documentation prepared by Olivier et.al. Consultants provides the data used in Table I-12. Effectively, six further dams are contemplated for the entire Komati/Lomati system. Their net yield at 80 percent assurance at full development is some 821.6 MCM.[2] Using September 1983 cost estimates, total cost for all 6 (including Phase I dams at Maguga and Driekoppies) is E337.1 million. It is appreciated that both water supply and cost data are of a first order nature. Any biases or inconsistencies in those data however are probably valid over the entire package.[3]

1 It will be noted that this word as used here is not the economists' "demand" which signifies an effective demand backed up in the market with a coin in one's hand--"need" is very different.

2 Given the pending water shortages it is considered somewhat of a "luxury" to work on water supplies at greater than 80% assurance.

3 The E200M used as the cost of Stage I dams in other analyses is an upgrading in 1984 of the 1983 cost estimates shown in Table VII.1. All 6 dams are costed at their 1983 prices for this analysis to maintain consistency. Upgrading would no doubt give reasonably proportional increases over all 6 dams in any case.

SWAZILAND: ECONOMIC STUDY OF POSSIBLE USES OF
ADDITIONAL WATER ON THE KOMATI RIVER

Table I-12: Storage, Yields and Costs of Six Possible Komati Dams

Cost Line No.	Future Dams	Net Storage MCM	Net Yield at 80 percent Assurance	September 1983 (E million)
1.	Boekenhoutrand	278.9	155.0[a]	84.1
2.	Maguga	259.7	261.7	63.7
3.	Singuen	111.0	112.0	39.7
4.	Tonga	117.0	52.0	51.4
5.	Driekoppies	236.9	195.5	67.6
6.	Vlakbult	75.2	45.4	30.6
7.	Total	1,078.7	821.6	337.1

[a] Devres Staff Estimates

Source: JPTC, Proposals, Table 3

The Phase I dam package may then be contrasted to these Basin totals as follows:

Line (No.)	Item	Net storage (MCM)	MCM net yield 80% assur.	Sept. 1983 Cost (EM)
1.	Total for six dams (Line 8, Table VII.1)	1078.7	821.6	337.1
2.	Stage I Dams (Maguga and Driekoppies)	496.6	457.2	131.3
3.	Line 3 as % line 2	46.0	55.6	38.8
4.	E/M³ line 1. above	0.31[illegible]	0.410	
5.	E/M³ line 2. above	0.264	0.287	
6.	Line 5 as % line 4	84.3	70.0	

Line 3 indicates very clearly that the specific Stage I dam selection, while no doubt made heavily or even primarily on engineering and hydrological grounds, was also excellent economics--some 55.6 percent of the Komati system's net yield at full development is achieved with only 38.9 percent of the total system dam costs.[1] These relative economics are demonstrated more clearly at lines 4 to 6. The total Basin net yield (at 80 percent assurance) costs E0.410/M³; Phase I dams provide their equivalent water for only E0.287/M³, or only 70 percent of the system as a whole. The equivalent calculation for the other 4 dams, combined, would thus approximate a unit cost of about E0.470/M³.

These are meaningful differences indicating clearly that, if the staged dam development programme is adhered to, each additional M³ used must be cumulatively more productive to cover the likewise cumulatively rising dam production costs of those water supplies. That becomes more difficult since the best of the associated resources are used earliest e.g. best lands, best locations, lowest pumping lifts, and so on.

(3) Marrying demands and supplies

It is now possible to synthesize these demand and supply packages. They are highly compatible and, as well, consistent with the recent (and apparently current) negotiating environment.

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1 This does not necessarily mean that total capital costs to deliver that water to its end users would also indicate the same dam building priorities e.g. heavy canal investment costs could alter relative delivered water costs markedly.

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The "demand" analysis suggested a desired longer-term need of 151-210 MCM. Expressed as a percentage of net system supplies available (of 821.6 MCM), these are 18.25 percent - 25.60 percent. Applying these percentages to the 1983 dam system cost estimate of E337.1 million, we arrive at a Swaziland share of total system costs (to pay for its specific water needs) of E61.25 - E86.30 million.

Further, and cross-checking as it were, the currently considered 20 percent-80 percent (Swaziland - RSA) cost sharing may be applied to system supplies likely available:

Swaziland 20%:	of net yield (821.6 MCM)	=	164.32 MCM
:	of dam costs (E337.1M)	=	E67.42M

These figures coincide very well indeed with the "demand" analysis (151-210 MCM) and the cost figures (61.25 - E86.30 million).

The naturalized (pre-development) mean annual runoff (MAR) of the Komati to the confluence with the Crocodile is 1433.2 MCM. Swaziland contributes about 25.5 percent of this. Of the 370.1 MCM naturalized MAR from the area drained by the Lomati River Swaziland contributes some 48.0 percent. Of the combined total, Swaziland contributes 30.1 percent.[1]

Applying that to yield and cost data:

Swaziland 30.1%:	of net yield (821.6 MCM)	=	247.3 MCM
:	of dam costs (E337.1M)	=	E101.5 M

These figures are very much greater than those developed in previous analyses.

c. "Firming up" water demand

No account has been taken in these estimates of future demands for this purpose, especially for SIS operations. As indicated in earlier sections, it is this Consultant's opinion, in the light of the rather conflicting evidence available, that no separate allowance of any consequence is really justified. Not that there may not be a problem; there undoubtedly is felt to be by SIS management. The data just have not been brought forward. In any case, it would appear that modest on-estate investments, especially a slight expansion of Sand River reservoir capacity, could ameliorate the SIS problem.[2]

This notwithstanding, should a subsequent set of studies indicate that the net returns to Swaziland of water reserved for that purpose provided a greater return on the water investment than in new irrigation, in forestry, or in thermal power production, then clearly it would be economic to use water in

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1 Olivier et.al., Basin Development, Vol.2, Table 4.23 and Figure 4.2

2 Government could even guarantee a loan to SIS for this modest investment. It would then be prudent to bring their reservoir into the controlled overall system. See detailed discussion in Chapter V above.

that way. There is time, after all; decisions regarding moving from 30,000 ha of new forest to 35,000 ha of new forest, or from 4,000 ha to 5,000 ha of new irrigated land, etc. are many years away.

d. Economics of new irrigation

This report's Volume II dedicates itself entirely to the analysis of an irrigation project proposed on the Komati River. The basic project is 3,000 ha (three IDUs) of combined smallholder-nucleus estate farming--a total of 1,800 ha of nucleus estate and 1,200 ha containing 600 settler families. Adding 2 more IDUs to bring the project of 5,000 ha improves modestly the financial and economic rates of return of the base project.

Without allowing for the Swaziland share of Phase I dam costs (probably E40 million), but including all other investments costs, resettlement costs, all crop production costs, and all project variable and direct costs, the financial and economic rates of return of the base project before shadow pricing and sensitivities are 8.6-10.2 percent. With a 10 percent increase in costs the rate of economic return is still 8.6 percent; and with a 10 percent increase in revenue the rate rises to 11.4 percent. Shadow pricing of labour (economic value 50 percent of market rates) gives an economic return of 11.6 percent. These financial and economic results are summarised in this Volume I at Chapter IV above.

There then remains the matter of paying for the dam. Basic policy issues must be resolved here. These include charging all beneficiaries, current and future, for Komati water; or charging only some users e.g. any new irrigation projects. If this latter, then this 3,000 ha Komati Irrigation Project will have to bear the full brunt. If, on the other hand, other consumers are to share (forestry, peak hydro-power, existing irrigated estates and farms, sugar processing plants, thermal plants, etc.), then clearly the charges for dam financing against this irrigated project may be reduced proportionately. The possibility of charging other users, including SIS, are discussed at length at Annex 6 of Volume II (Cost Recovery). The matter of deciding on how much to charge is clearly related to the Value Added (VA) derived from each M^3 (or 1,000 M^3 or 1,000,000 M^3) in these alternative uses. Those issues are touched on briefly at Section C.10 below.

What we have done to accomodate the need to pay for the dam is build into the irrigation project's financial structure a series of charges which can, in fact, be added back to the gross margin to increase net benefits. These enhanced net benefits can then be used for any purpose government decides, including the financing of subsequent projects, and of course for retiring the debt for the dam.

Examination of the financial materials will indicate that, for both the smallholder and the nucleus estate in each IDU we have built in certain basic production costs--labour, fertilizer, charges for the use of equipment, charges for processing and marketing, charges for O & M on the irrigation system, etc. We have also built in a water/irrigation charge. All of these vary by crop. All of these were also deducted from farm revenues before gross

margins (GM) were calculated. The GM is to be used to cover project capital and overhead costs, and dam costs if so desired. To that GM we may now add back some of the items which are, in fact, project revenue.

Without repeating all of the analysis here, but needing to make the point that this use of water is not only economic but also can cover "extra" costs outside itself such as the E40 million dam share, a few summary numbers will suffice. The base project is three IDUs spread over time. Annual net financial returns peak at PY 15 when the third IDUs tree crops are fully mature. From that point on net returns annually are in the range of E5.0-7.0 (about E2540/cropped hectare), though sagging somewhat the last few PY due to a rising level of re-investment in facilities. That net return covers all directly related project capital, overhead, variable and operating costs. As of PY 11, in fact, the value of crop sales exceeds all investment and operating costs; crop sales only begin in PY 6, the project commencing 5 years earlier with dam design and construction. That amount of net return will just cover dam costs spread over the first seven PY, leaving a financial rate of return of only 2.3 percent.

If we add to the net return, however, some of these costs which have been deducted to achieve that net return, or to achieve the GM on the project, then those revenue and cash flows improve immensely. Working with smallholder farming budgets, for example, the total return to a 2 ha farm (3 ha cropping) is some E14,000 annually at full development (once tree crops are at maturity). If that family does all its own work, and hires no one, that rises to nearly E15,000 (add back labour costs). If they employ all the labour needed, on the other hand, it drops proportionately. Deducting all variable costs (including labour), this leaves a GM for the farm of some E5,000. Labour costs can be added here for a net family income of some E6,000.

Those deductions to achieve the GM have included four charges paid to the estate:

1. Machinery/equipment rental and use;

2. Charge towards maintenance and repair of irrigation system;

3. Charge towards processing and marketing;

4. An irrigation water charge

These accumulate to an average of E5471 for the farm (E1827/ha) paid to the estates as revenue. Since there are some 562.5 ha cropped (on 400 ha-200 families), the management of each IDU is receiving, at full development, a revenue from smallholders of E1,027,688 annually, some 16 percent of which is a water charge, per se. For three IDUs in the basic project, that is a total of E3.1 million annually at full development.

Cost recovery on the estate works in a similar fashion. Equivalent figures on one IDU are E2241/ha cropped for the three operational charges; and E491/ha cropped for water charges. The GM of E2543/ha cropped thus more than doubles to E5275/ha cropped with these "returned" funds. These returned funds

amount to E3.6 million annually on one IDU, and nearly E11 million annually at full development of three IDUs. Addition of the E3.1 million from the smallholders gives some E14 million annually as of PY 20, with a gradual build-up to that as of PY 8. If all of those funds went to the dam, it would be paid off very quickly indeed. If half of them only were so directed, the debt would be retired about PY 20 with a very viable project as well.

In sum, this use of new irrigation water is highly productive. It is so, however, only on the assumption of effective and disciplined management of all resources involved, especially financial. And, as suggested above, other users probably should contribute.

e. Synthesis of needs and costs

(1) Introduction

Four major and different routes, or analysis packages, have now been taken to attempt to arrive at answers to this study project's basic issues: how much Komati Basin water does Swaziland need and for what purposes; and how much should she pay for it? Centering on the economics of alternative uses, one route was the pre-feasibility level analysis of an irrigation project which could be of two sizes, a basic project using 40 MCM of new water and a larger possibility consuming up to 63 MCM. That summarized analysis is presented at Chapter IV (supported by Volumes II and III).

A second route was the examination of the economics of "firming up" SIS production by allocating them 49 MCM of new water. Much of that analysis was dismissed, however, as not relevant at the present time since not even the 49 MCM could be "located" in the hydrological information, and the SIS water system can now "drought proof" itself. That discussion is at Chapter V above.

A third package has been the attempt to argue for more or less water at a greater or lesser cost on the strength of Swaziland's share of the Basin's irrigable land potential, and on its share of the Basin's future (2010) population.

Then, above, the total Komati Basin development scenario was also examined. All six proposed new dams are looked at for their combined water contributions and costs. The current Stage I water and cost sharing formulae are brought to bear on the totals, as are shares of MAR.

This section's purpose is to integrate all of those packages as a base to making "water" recommendations to the JPTC. Continuing to recognize that each subsequent stage in this analysis edges just that little bit further into the remoteness from basic data accuracy: Table I-13 collates information presented in the immediately preceding sections or Chapters.

(2) The synthesis

The numerous independent "routes" generally arrived at rather similar conclusions and thus become, as it were, mutually supporting/ reinforcing. Regardless of basic reason, there is a need for, or a right to,

Table I-13 Komati River Basin Water Needs and Costs

Item	Water Consumed (Needed) MCM	Possible Dam/Dam System Cost (E Million)	Cost Per M^3 (E)
Irrigation			
Base Project (3,000 ha)	40	14	0.351
Enlarged (5,000 ha)	63	22	0.351
Possible (up to 8,000 ha)	112	39	0.351
Needed for farming households in year 2010			
Conservative population estimate	124	44	0.355
Devres population projection	173	61	0.353
Based on Swaziland share irrigable land	141	49	0.348
Possible needs based on economic feasibility criteria			
Total 100% - 100%	151 - 210	61 - 83	0.404-0.393
Of which:			
Irrigation 56% - 57%	84 - 120	34 - 47	0.405-0.392
Forestry 31% - 24%	47 - 50	19 - 20	0.404-0.400
Thermal 10% - 14%	15 - 30	6 - 12	0.400-0.400
Other (Misc) 3% - 5%	5 - 10	2 - 4	0.400-0.400
Based on total Komati system supplies, of which Swaziland 20%	164	67	0.409
Based on Swaziland share of Basin MAR (30.1%)	247	102	0.413

Source: Devres Staff Estimates, August 1985

141-210 MCM. A very realistic and even understated assessment of population growth shows a need for 173 MCM, without any other use except smallholder irrigation. Shares of irrigable land and an "equity" 20 percent of total future supplies both provide needs/rights to 141 MCM and 164 MCM respectively. And all of these independently arrived at estimates, however crude they may be, fall within the range of 151-210 MCM established by summing constituent additional economic possibilities (forestry, thermal, etc.). The share of the MAR gives a very large figure of 247 MCM.

These water volume conclusions are accompanied by a range of dam capital cost commitments, E49-83 million, with the weight falling about E70 million. This could be considered as a basic cost toward employing, feeding and otherwise taking care of the Basin's increment of 30,000 - 40,000 people. That is a core dam investment of E1,750 - 2,333 per capita, an investment returned many times over just in taxes paid by smallholders and those employed whom are earning because of the water investment in the first place.

f. Recommendations regarding water use alternatives

This final "water" recommendations section expresses itself in the form of three displays and one table. The implicit assumptions underlying this terminal analysis are, first, that the main uses of new water in the Komati Basin--irrigation, forestry, thermal--are economic; second, all developments suggested are needed to service expanding future populations; and, third, that Swaziland has an established right to these levels of water--those rights have been thoroughly documented in earlier sections of this report, including Annex 4 to this Volume I.

These "packages" are presented under the headings of "absolute minimum" Swaziland use; possible "best" or moderate use; and probable "maximum" economic use of water. The first provides barely sufficient employment and resource development activity. The second is more satisfactory economically, can be implemented with reasonable ease, and uses more of a spectrum of natural resources; in this Consultant's view this is the minimum case for which to bargain for Komati River water supplies at full (and future) development. The "maximum" case stretches to their limits the good land available for irrigation farming and what could be released from other uses for afforestation--there are no limitations on coal supplies for a very long time, however.[1]

Figure I-2 presents the "absolute minimum" case, needing some 112 MCM. It has 6000 ha of smallholder-nucleus estate irrigation (six IDUs @ 1,000 ha each); 20,000 ha of afforestation; and one 150 MW coal-thermal plant. Water consumption by sector is shown on Table I-14. Note that these "minimum"

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[1] Mhlume, for example, has massive coal deposits. There will be a railway shortly so that thermal sites can be somewhat discretionary. See A.S. Goudie and D.P. Williams, The Atlas of Swaziland (Mbabane: The Swaziland National Trust Commission, 1983), pp.69-70.

requirements exceed slightly those volumes which could be acquired under Case III.A (Table I-11) but are meaningfully less than those provided in Case V.A. Swaziland should pay E39.3 million for the 112 MCM @ E0.351/M^3)[1]

Figure I-3 presents a possible "best" and moderate case for 127 MCM. Irrigation has been left at 6000 ha, forestry raised to 30,000 ha, and 2 x 100MW power plants have been installed. The water consumption breakdown is at Table I-14. This volume is almost the same as the water acquired under Case V.A. The 127 MCM would cost Swaziland, at the E0.351/M^3 equity rate, some E44.6 million, barely more than Swaziland (perhaps) is going to pay for the 105 MCM now agreed to (in principle) for E40 million.

Finally, Figure I-4 presents the possible "maximum" economic case, with 158 MCM needed. As noted at Table I-14, another 17-19 MCM could be added to this if really desired. These volumes are in excess of Case III.B's 140 MCM. With the additions, however, the 174-176 MCM resembles closely the 173 MCM of Case V.B. It will be remembered that that amount of 173 MCM was based purely and simply on Swaziland's 2010 population share of total Komati Basin population as calculated by Devres. The 158 MCM, at "equity" pricing of dam costs, would come to some E55 million; the larger amount of 176 MCM would cost Swaziland E62 million.

It is important to note that these scenarios, or packages, are purely exemplary. They are "building blocks" for each sector--1000ha IDU for irrigation, 5,000 ha units of afforestation, 50MW thermal plants--and they can be put together by resource development planners and policy makers as they see fit. The displays are not designed as alternative blueprints; they are "think-piece" options.

2. Other recommendations: studies and related activities

a. General

This final section's purpose is to collate the various recommendations spread throughout the report. Most are suggestions for further studies. Their results would either clarify the decision-making regarding Komati water development, or would otherwise help accelerate the implementation of water-using development activities once begun.

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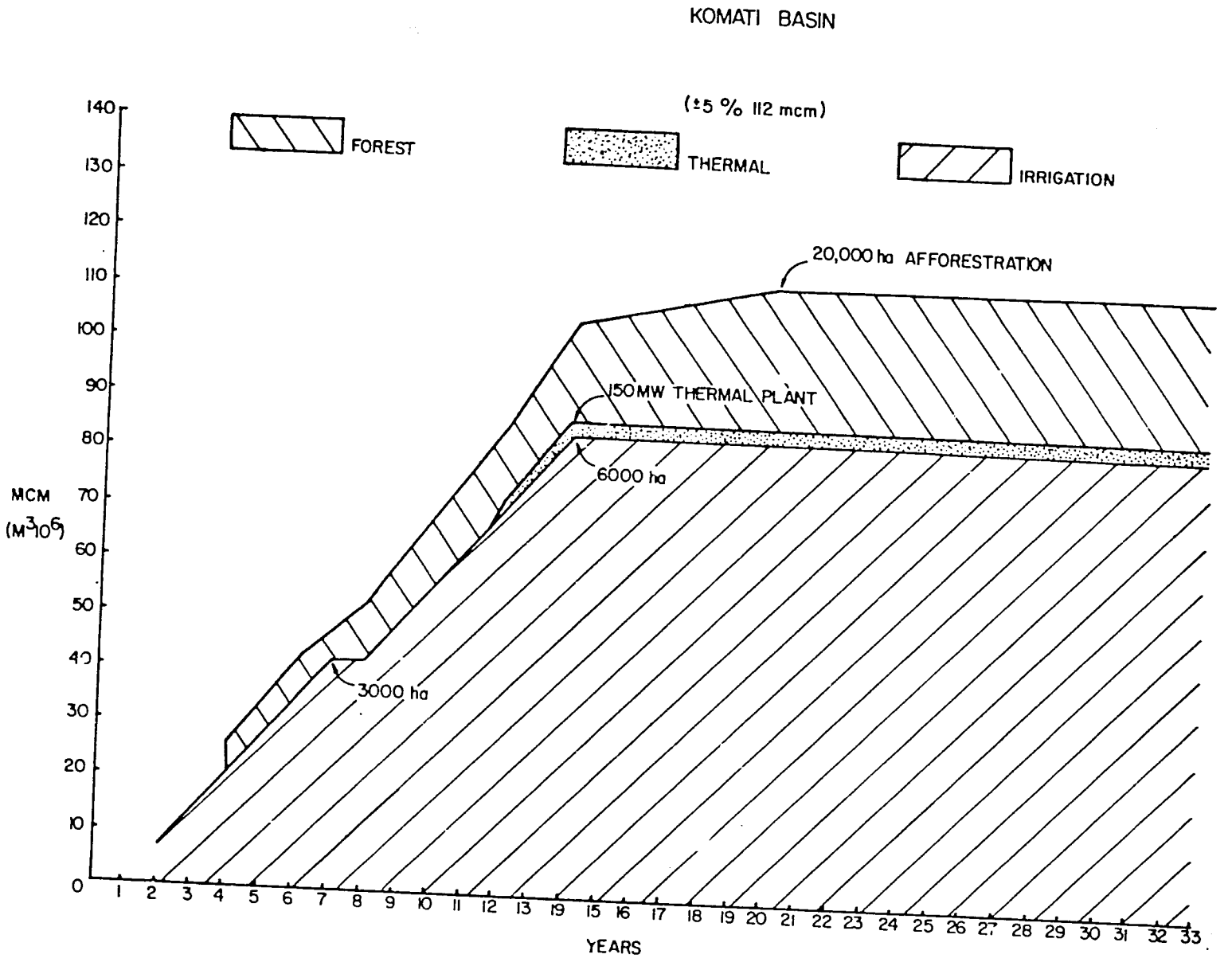
1 Assumptions underlying and conditioning each of the three scenarios are indicated with each display.



SWAZILAND: ECONOMIC STUDY OF POSSIBLE USES OF

Notes to Figure I-2

1. Water Consumption

   a. Each 1000 ha of irrigation requires 14 MCM annually.

   b. Each megawatt of power produced requires 20,000 M^3 annually (figure from E.V. Richardson, Swaziland Irrigation (Rapid Appraisal): Water Management Synthesis II Project (Fort Collins, Colorado : Colorado State University, July, 1985), p.3. Other estimates range up to 60,000M^3 - 80,000M^3. Some of these higher estimates have been used elsewhere in this report.

   c. Each 1000 ha of exotic afforestation requires 1.3 MCM annually pre-reservoir. This has not been adjusted to a post-reservoir equivalent (about 60-65 percent) since the entire matter of the relationship between forestry use, MAR, and reservoir management still requires detailed study--see, for example, sections C.7 and C.8 below.

   Note: These water consumption assumptions are identical for all three displays.

2. Phasing of Water Use

   a. Irrigation

      -- first 3,000 ha project established over project years (PY) 2-7 @ 500 ha/year. Maguga Dam PY 1-6; assumes some water available run-of-river and from dam during construction to start first years of irrigation.

      -- second 3,000 ha project PY 9-14

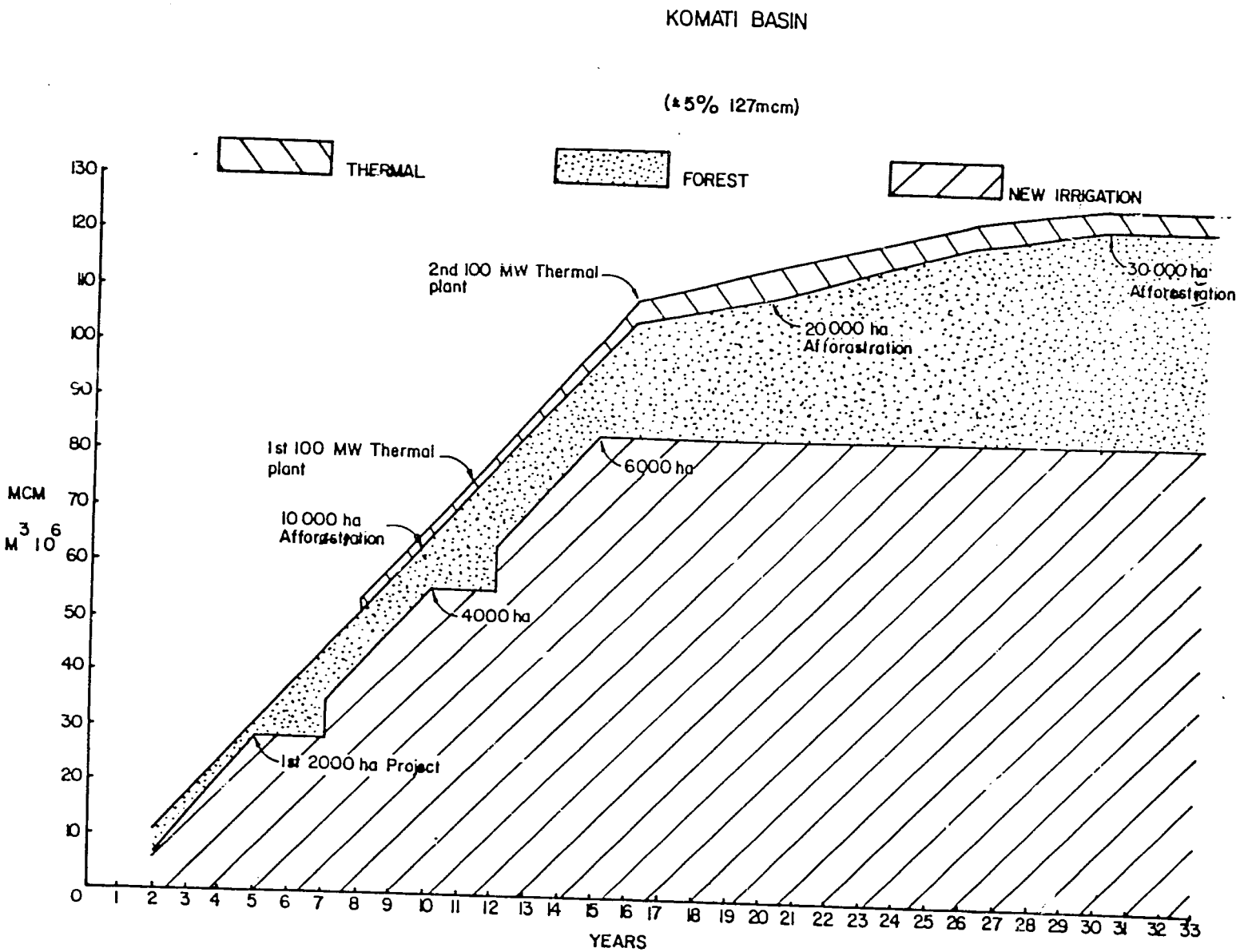
      -- Total 6,000 ha

   b. Forestry

      -- 2,000 ha every 2nd year through PY 20, total of 20,000 ha. Streamed as a straight line on Figure.

   c. Thermal

      -- one 150MW plant constructed over PY 9-11 with 50MW coming on each year over PY 12-14.



SWAZILAND: ECONOMIC STUDY OF POSSIBLE USES OF ADDITIONAL WATER ON THE KOMATI RIVER

Notes to Figure I-3

1. Water consumption assumptions as at Figure I-2.

2. Phasing of Water Use

   a. Irrigation

      -- total of 6,000 ha phased as 2,000 ha over PY 2-5; 2,000 ha PY 7-10; 2,000 ha PY 12-15.

   b. Forestry

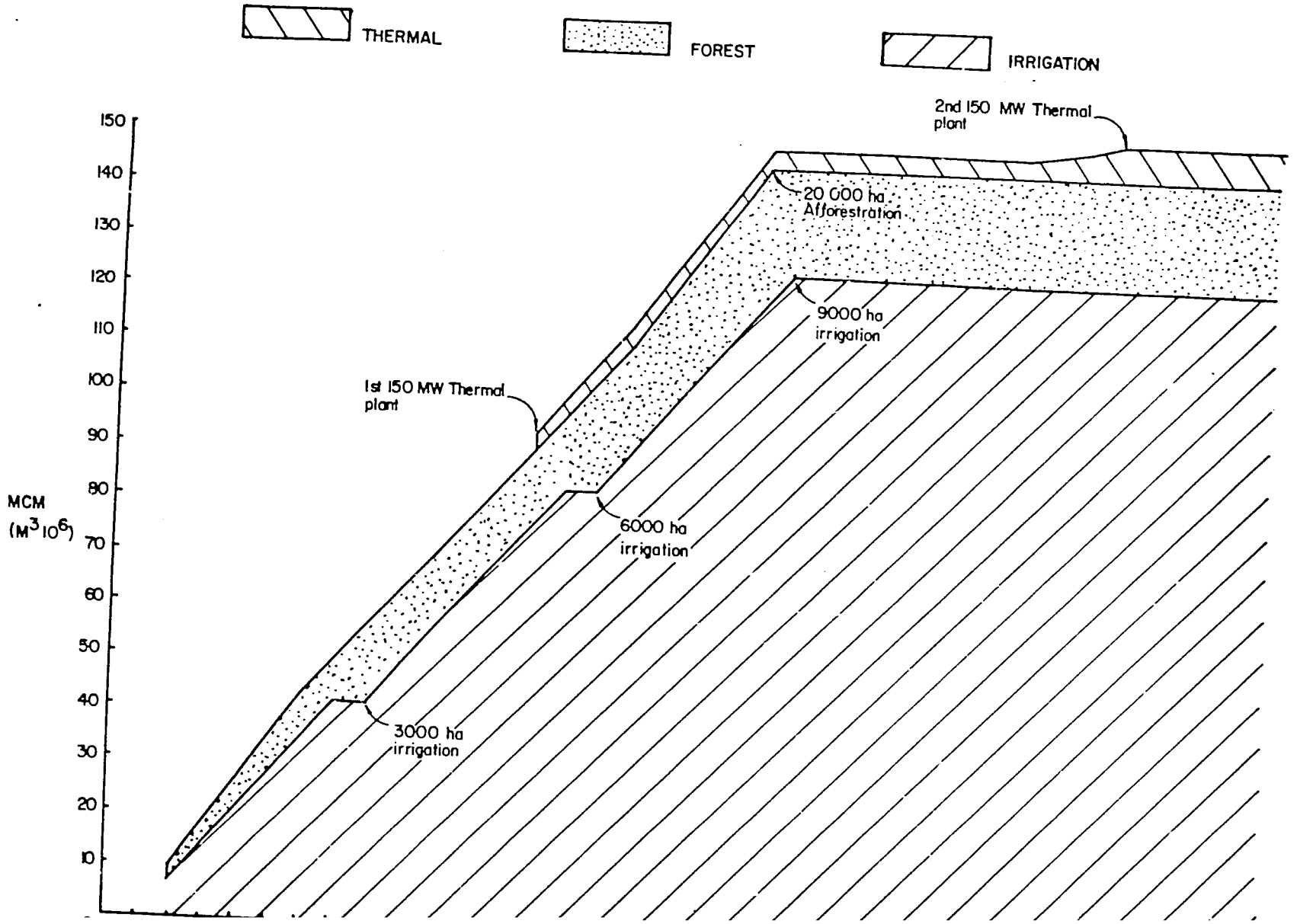
      -- total of 30,000 ha; 2,000 ha every second year as of PY 2.

   c. Thermal

      -- 2 x 100MW plants; 1st constructed over PY9-10 and on stream (using water) PY11-12; second constructed PY13-14 and on stream PY15-16. About one-third designed for export from the national grid.

KOMATI BASIN

(±5 % of 158 mcm)



Notes to Figure I-4

1. Water consumption assumptions as at Figure I-2.

2. Phasing of Water Use

   a. Irrigation

      -- Total of 9,000 ha; three projects each of 3,000 ha (3 IDUs); 1st project developed over PY2-7; 2nd over PY9-14; 3rd over PY16-21.

   b. Forestry

      -- Total of 20,000 ha; 2,000 every 2nd year starting PY2; last 2,000 ha planting PY20.

   c. Thermal

      -- 2 x 150MW plants; 1st built over PY9-11 and on stream @ 50MW/year PY12-14. Second built PY26-28 and on stream PY29-31. About half of output designed for export from national grid.

SWAZILAND: ECONOMIC STUDY OF POSSIBLE USES OF ADDITIONAL WATER ON THE KOMATI RIVER

Table I-14: Three Scenarios for Alternative Uses of Komati Water Over the next 30-35 Years

	Use Scenarios		
	I Absolute Economic Minimum	II Possible & Moderate "Best"	III Probable Economic Maximum[a]
		(MCM)	
Programme development year when utilization reaches maximum consumption	20	30	31
Water Consumption at that time and thenceforth			
Total	112	127	158
Of which			
: Irrigation	84	84	126
: Forestry	26	39	26
: Thermal	3	4	6

a Thermal probably understated consumption which could push up total by 4 - 6 MCM. Also could add another 10,000 ha of forest; in which case add 13 MCM for a good total of 175 - 177 MCM

Source: Devres Staff Estimates, August 1985

b. SIS water use/economic study

As discussed at Chapter V above, it has proven difficult to assess properly, even in an initial way, the firming up water requirements of SIS. It becomes important to build up an information base by which such decisions may be made with more vigour. We have suggested in that Chapter that a water use/yield/net return study be undertaken, and provide there some suggestions as to the nature of such a study. The results would not only help SIS management, but would also be useful in many other connections, including decisions on water rights--see section C.10 below.

c. National Water Management Plan

The need for an overall water development strategy was recognized some time ago in Swaziland, as evidenced by a variety of studies attempting to inventory and otherwise assess the nation's water resources and development possibilities. These go back up to several decades, the most recent being that of the US Army Corps of Engineers.

In spite of these initial survey efforts, and several more detailed studies on specific rivers, the nation still does not have an overall guiding strategy which would assist with answering such basic questions as: do we develop the Usutu first, or the Komati; where can we get more from our land and people resources by planning water development better; what package of alternate water uses would serve the population best over time in terms of income distribution and the regional nature/location of development; and so on.

In the light of the more recent studies in particular (Tate and Lyle on the Usutu; Devres on the Komati) the need for an overall Master Plan is now even more apparent; left hands and right hands must work together. Above all it would devise criteria by which to make these decisions and screen options. It is understood that GOS is contemplating the active pursuit of resources for developing such a Plan. We would endorse that fully.

d. Basin level water management organisation

Whichever river basin or basins will receive further development effort, it (or they) will require an established authority, or agency, or Board, or Development Corporation--call it what one likes--to maintain an effective operating and planning control over that Basin's development. Some suggestions along those lines have been made in Chapter IV.C (Organisation and Management), in Volume II. The first one established no doubt would become the model for subsequent basin authorities. They would undoubtedly require the operational cooperation of all countries sharing the watershed and would become, in fact, operating international agencies. Aside from managing the reservoirs in an integrated way, and otherwise ensuring proper water administration, the organisation would have technical and economic staff to work, constantly, on new development options, water saving prossibilities, and the like. It would not be in anyone's interest to attempt

to manage a basin's development by telephone from Mbabane and Pretoria. The nature and scope of such an organization would naturally be conditioned by the inter-country agreement for that Basin.

e. Fishery/aquaculture studies

It has been suggested that studies be conducted on pre-dam and post-dam fisheries issues. There are two purposes. One is to see what negative impacts new dams will have on existing fisheries: the deterioration of selected fisheries habitats, and the closure to migration routes to some species often result from dam construction. The studies would suggest ways in which such negative impacts could be mitigated or precluded.

More specifically however, studies can be conducted which would suggest ways to enhance the commercial and sports fishery in the post-dam improved and altered aquatic environment. In particular a fishery might be possible in Maguga Reservoir. As well, there could be aquacultural possibilities on any new irrigation scheme. Such ponds are incorporated into aquacultural cropping rotations in many parts of the world; they provide village and household protein, and are a source of significant income. Numerous international agencies have become quite specialized in such studies; they would undoubtedly be interested in studying these matters here. One in particular would be Canada's International Development Research Centre.

f. Water use for energy generation

It has not been possible to study more thoroughly the matter of water use for hydro-power at Maguga Dam nor for coal-fired power plants in the Komati Basin (which has the coal). A quick examination of Swaziland power development, its needs into the future, and the changing alternatives available to supply those needs, would suggest that not too long from now, and perhaps by the turn of the century, one larger (200 - 250MW) or several smaller (50MW) coal thermal plants will be needed. It has not been possible either to identify with any precision just how many M^3 of water are needed for each megawatt produced; estimates vary immensely depending upon recycling and other technologies employed. That is why estimates used in this report are so crude, and differ from place to place to allow for a range of possibilities.

It is considered to be in Swaziland's own interest to investigate this possible use of Komati water in the future. Such power generation would no doubt, for the most part, be an import substitution activity, reducing a dependence; its coal mining would create significant employment; and it would use a resource--coal--which otherwise does not appear to have a burning future. Power exports to Botswana, Lesotho and Mocambique are possible.

The possible use of Maguga Dam for hydro-electric power has been identified. Two options appear available. One is to generate base load power, using only water which is being spilled to meet other (mainly irrigation) demands downstream. Is this technically possible?

Secondly, could the facility be used for peak power if it required spilling water which is not needed downstream for other purposes, hence wasting (or consuming) it? And what are the costs and benefits of these options? Finally, could any power generated, if fairly cheap, be used for any irrigation activity (pumping)? These matters also should be studied; they could affect dam design, irrigation area locations, and financially affordable pumping lifts.

g. Water use for forestry development

Section III.B.5 above discussed briefly the possible advantages of further forestry development in the Komati Basin on SNL land. There is no need to repeat that discussion here. The initial impression is that such a use for water would be highly economic, in the same way the past and current use of water for that purpose is clearly productive for Swaziland. The particular issues requiring more detailed examination relate to current land use in the high potential areas, and the economics of smaller timber blocks somewhat more widely scattered on areas of otherwise not productively used land. The study would naturally include an examination of the means to minimize any resettlement required. Usutu Pulp Company experience would perhaps be relevant in this connection. Forestry development could be accelerated should the suggested reservoir studies (8 below) indicate that more trees will not affect materially (or at all) the water available for other purposes, again depending on comparative economics.

h. Maguga reservoir management and sedimentation studies

Many technical and hydrological question marks apparently still surround the nature of operations of Maguga Reservoir. Specific questions relate, for example, to the impact of enhanced forestry water consumption on both MAR and storage. The relationship between existing and new agricultural demands is still unclear, as is the nature of water use for base hydro-power generation as distinct from water requirements for peak load power production. Many of these basic hydrological issues should be studied further and soon, before work goes forward on planning further water use (more on this at 11 below).

Underlying these concerns is the need to avoid the over-extending of consumptive uses of new water; such over-extensions always have negative implications when water supplies are constrained. If this region follows the 50-100 year hydrological/metereological regimes of elsewhere, the region could "dry up" markedly. The argument can already be made that this over-extension is exactly what has happened in the Komati Basin over the good run-of-river years of the late 1960's and the 1970's--surely we should learn from this experience and not overextend again.

A constituent part of these reservoir studies must also be a variety of sedimentation studies. Sediment yield data are extremely weak and hypothetized. Sediment yields are probably higher than imagined. And, "if the storage losses which are estimated...prove to pose a threat to the economic viability of a specific reservoir more detailed investigation of the specific

case would be justified."[1] Professor Rooseboom uses various formula to calculate that sedimentation losses in Maguga Reservoir would be, at year 10, some 17.5 MCM and 44.4 MCM at year 50. These are the equivalent of losses to irrigation some 1,300 ha and 3,000 ha respectively. At year 30 after reservoir development, some 31.3 MCM would be lost.

Clearly, if these data are correct, planners had best not count on committing large investments using water which just won't be there "down the road." How does such loss of reservoir space affect hydro-power generation? How does it influence the ability to guarantee deliveries to existing or new irrigation schemes, especially when the rate of assurance drops? Perhaps the dam can be designed to flush annually at peak during the rains? (A lá first Aswan dam).

It is recommended most strongly that the results of the 1984 Agricultural Census be published with all despatch. Manpower and budget shortages could be overcome with external assistance to the Central Statistical Office. All project work and policy-making in the country would benefit.

i. Study of water rights

The Devres TOR ask the Consultant (Section 4.3.C.c.) to estimate how water is to be apportioned under conditions of water shortage. Presumably this has two time dimensions, one pre-Maguga Dam, and the other post-reservoir. Since there is really only one prime user on the Komati pre-Maguga, that case needs little further consideration. Indeed, run-of-river shortages are now (1985) compensated for by SIS having sufficient canal/pumping/reservoir capacity to cope with even very severe shortages.

Post-Maguga Dam/Reservoir, however, there could be multiple users. Some will be irrigation farmers--SIS; and one, two, three possibly up to five, 1000 ha IDUs each of which could be a separate project entity with different crops and crop water requirments. Other users could include crop processing plants (sugar) and coal thermal plants. Forestry water users would not be involved; you cannot stop rain going to trees. So there is the probem of inter-sector allocations as well as inter-unit/inter-project allocation's within sectors.

This study team can contribute little to the matter of inter-sectoral water distribution. Theoretically, one cuts back from those users where value added/M^3 is least; as a matter of principle, reductions should progressively equate value added lost. Figure I-5 conceptualizes this matter. In financial terms, power generation undoubtedly gives reasonably high VA/M^3, possibly E6-E10/M^3. Within that, peak hydro no doubt comes at the higher end, with thermal probably at E6-E7/M^3. Economically, values would be about the same since there would be (imported) substitutes for power generation lost. Peak hydro-power in any case would be ruled out under water shortage conditions.

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1 Prof. Rooseboom, Sedimentation Studies Consultant report to the JPTC, (Johannesburg, November, 1981). p.5. A major economic benefit of afforestation; of course, is the economic value of a longer life for the reservoir.

There could be a range in the thermal power sub-sector, however, depending upon the nature of the technologies used. Presumably the more sophisticated (generally newer) technologies of water use and recycling produce more VA/M^3 water used. In Figure I-5, the three different plants are represented as having three different levels of VA/M^3 of water used. If the decision is made to shut them down, then sequentially they would be No.1, then No.3, then No.2. But even the lowest VA/M^3 plant contains more VA/M^3 than the most productive agricultural operator. The economic values would probably be higher for the thermal since the raw material, coal, is in such abundant supply (and would have a low economic price).

Within the agricultural irrigation sub-sector the same principle holds; cut back first on the production that yields least per M^3 at the margin. In the display, existing crop areas should reduce water on No. 1 first since VA/M^3 is lowest there, then to the crops 2, then on 3. The same principle applies to crops on new irrigation schemes. Let it be repeated that the values of production/M^3 shown here are purely guesswork for each crop, and relatively between crops--it is merely the principle which is being established here. Water for processing must no doubt be less optional since without the processing all or most VA would be lost for the crops so handled.

Yet even within this general economic framework, there could be more micro-level consideration regarding irrigation. During periods of forecasted water shortage, priorities for getting water could also be set as follows:

1ST: EXISTING AREAS OF MATURING CROPS

Rationale : In this case the farmer has a full commitment of time, effort and funds. Failure to bring the crop to full maturity would result in serious financial consequences. Farmers should be encouraged to harvest early if possible.

2ND: EXISTING AREAS OF GROWING CROPS

Rationale : In this case the farmer has a significant investment to protect. Further, many crops in this stage of growth can be maintained with comparatively light water applications, particularly cane and citrus.

3RD: NEW PLANTINGS

Rationale : New plantings are especially sensitive to moisture stress. Surface irrigation systems are particularly inefficient when the farmer attempts to apply light rounds at planting. Farmers should be discouraged from new plantings until the water shortage has been ameliorated.

In addition to setting priorities, the actual allocation per hectare should be based on new crop requirements. This tends to reward and encourage the farmer who uses efficient methods of application. As the IDU is designed

presently, the farmer can choose either surface or overhead irrigation from the pressurised mainline. He should be encouraged to rent, if necessary, the required overhead irrigation equipment to handle his farm during shortage periods.

Extension officers should counsel farmers on the concept of "deficit irrigation." The concept suggests that as farmers normally seek maximum yield, the incremental contribution of successive units of applied water becomes less and less. In the context of the water shortage, the last applied units of water would return more crop if applied to some other field or crop.

The actual application of the priority system would require an up-to-date crop accounting in order to establish allocations. Special metering valves are available which will actually turn off flows when the farmer has drawn his allocation. Tampering with the valves could subject the farmer to legal action. Farmers should not be allowed to sell their allocation. Extension officers should be responsible for administering the programme, and the nucleus farm would be subjected to the same allocation formula.

These are very general considerations. Much more work must be done on this subject in Swaziland.

j. Accelerating design level studies for Komati project feasibility analysis

As required, the TOR for the next and final (design) stage of studies for a Komati Irrigation Project have been drafted--Annex 3. These encompass a variety of subjects. Among them, however, are several which, in the nature of things, are going to take longer to effect than the other components. This is partly because they take longer to launch, not just to accomplish once started. It is recommended that work on these components commence with all deliberate speed.

One of these in the TOR is the soil study/land capability classification exercise. This is costly, extensive, and takes time to organise and implement. Because an external donor would no doubt need to provide funding, it could very well take 12-24 months, or longer, to begin such studies, even if effort started now. Were project planning for other areas also being considered, the same external organisation could effect economies of time and staffing by doing more than one area (e.g. also do Big Bend on the Usutu).

Another range of studies in the TOR which will take some time to find the right people for, and then conduct, are the basic socio-economic studies. Numerous highly intractable elements are included here, such as accomodating livestock, land tenure and land rights, and the rather drastic altering of power/responsibility structures which generally accompany even modest-sized modernization projects. A project as large as the one contemplated--3,000 - 5,000 ha, with many thousands of people involved--is bound to occasion a nest of socio-economic issues which will serve, in time if not immediately, to reduce interest and manageability, and thus productivity. Satisfactory studies of this nature are not conducted overnight; they should usually be spread over several years.

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Perhaps the study which should begin as early as any other, thirdly, is the Maguga Reservoir Use Study mentioned at 8 above. The TOR for such a study are not included with the rest; this Devres team was not required to do so. Nonetheless, the results of such studies could have a significant bearing on the nature, size, timing and location of water-project uses.

ANNEX 1

EXTRACTS FROM

JPTC, KOMATI RIVER BASIN DEVELOPMENT:

PROPOSALS FOR THE INITIAL DEVELOPMENT OF THE

WATER RESOURCES OF THE KOMATI RIVER BASIN AND

PROVISIONAL LONG-TERM DEVELOPMENT PLAN,

MBABANE, SEPTEMBER, 1983

ANNEX 1

Extract from JPTC, Komati River Basin Development: Proposal for the Initial Development of the Water Resources of the Komati River Basin and Provisional Long-Term Development Plan, Mbabane, September, 1983

"Commencing in July 1981 two firms of consulting engineers have performed a detailed study of the water damands from and the water resources of the Komati river basin to its confluence with the Crocodile river at Komatipoort.

Presently the major consumers of water are irrigators, thermal powerstations on the Transvaal highveld and extensive exotic afforestation. No storage dams regulate the water used for irrigation, which is therefore conducted at a very low level of assurance. The potential for irrigation development and afforestation for exceeds the utilisable water resources while the needs of the increasing population and for additional supplies to powerstations must also be met.

A provisional system of six new dams is proposed. The total system, including the existing dams, will yield 940 x $10^6 m^3/a$ at various levels of assurance, in addition to the water use of 101 x $10^6 m^3/a$ by afforestation. These will meet the long-term water requirements from the Komati river basin while still retaining some reserve, albeit at high future cost, for use possibly also in Mocambique. The development will be executed in phases and it is proposed that dams be constructed immediately at Maguga on the Komati river in Swaziland and at Driekoppies on the Lomati river in the Nkomazi Region in the Republic of South Africa, to allow the utilisation of 710 x $10^6 m^3/a$ in total at various levels of assurance, in addition to the water use of 101 x $10^6 m^3/a$ by afforestation. This would result in stabilising all existing use and allow for a modest increase in development. The cost of these two dams will be R131,3 million at current prices and both dams can be completed by 1990. A hydro-electric powerstation of 12MW capacity and providing 60 GWh/a can be installed at Maguga." (p.iii)

"RECOMMENDATIONS

It is recommended that the Governments of the Kingdom of Swaziland and the Republic of South Africa agree to the following:

-- A provisional long-term plan for the development of the water resources of the Komati river basin. This plan includes new dams at Boekenhoutrand, Maguga, Singuen, Tonga, Driekoppies, Vlakbult and possibly Ngonini to provide for a total net storage of between 100% and 150% of the afforested Mean Annual Runoff.

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-- The immediate implementation of the first phase of the development comprising dams at Maguga on the Komati river in Swaziland and at Driekoppies on the Lomati river in the Nkomazi Region in the Republic of South Africa. The gross storage capacities of Maguga and Driekoppies dams are provisionally set at 295 x $10^6 m^3$ and 251 x $10^6 m^3$ respectively and are estimated to cost R63,7 million and R67,6 million respectively at current prices.

-- Based on the intended short-term expansion of irrigation development part of the additional water available from the first phase development be allocated in equal shares to the RSA and Swaziland viz. 40 x $10^6 m^3/a$ to each state, for additional irrigation development.

-- The remaining utilisable water (36 x $10^6 m^3/a$) be held in reserve for later allocation of the basis of proposals to be submitted by the JPTC for consideration and agreement by the governments.

-- Implementation of any subsequent phase of the provisional long-term development plan and the allocation of additional water secured therefrom be based upon a need for additional water, experience of operation gained from the first phase and further studies conducted by the JPTC, subsequent to which proposals will be submitted to the two governments for consideration and agreement." (p.iv)

"The mean water shortages amount to 17,3% of the mean annual water demand along the Lower Komati river upstream of Komatipoort in the RSA, 4,1% of the mean annual water demand in the Lomati river catchment in the RSA and 1,9% of the mean annual water demand along the Komati river in Swaziland at IYSIS.

During the most critical quarter of the year water shortages are expected to occur on average twice every 3 years along the Lower Komati river, twice every 5 years along the Lomati river and once every 6 years at IYSIS.

The Shortage Index*, which accounts for both the severity and frequency of annual shortages, has been found to be 4,13 along the Lower Komati river, 0,33 along the Lomati river and 0,35 at IYSIS, compared to a generally acceptable level of 0,25 on an unregulated river. The Shortage Index however also fails to reflect the impact of the severe seasonal shortages outlined hereinbefore, which could have a crippling effect on irrigation farming.

The foregoing confirms that the water supply situation within the Komati river basin is inadequate to sustain the present irrigation development at an acceptable level of assurance.

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* Shortage Index $= \sum_{1}^{n} \frac{(\text{Water Shortage during Year})^2}{(\text{Water Demand during Year})} \times \frac{100}{n}$

where n = Number of years of record

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Serious shortages are also expected to occur along the Incomati river in Mocambique because of the large water use along both the Crocodile and Komati rivers.

POTENTIAL FUTURE WATER DEMANDS

The potential water demands within the Komati river basin to develop the full potential have been found to far exceed the utilisable water resources.

The population of the Komati river basin is expected to increase to 792,000 persons by the year 2010, distributed as shown in Table A.1.1. The corresponding total water demand for domestic municipal, industrial and mining purposes within the basin, excluding the water demand based on heavy industries associated with irrigation, mining (e.g. thermal power generation) and afforestation has been assessed at 60,4 x $10^6 m^3/a$ by the year 2010. By the year 2010 a total of 7,5 x $10^6 m^3/a$ will also be transferred from the Lomati river for use by the municipality of Barberton. The enlargement of this water supply system is due to commence shortly. Similar other small storage schemes may in future be found to be convenient. Including the existing water supply to the powerstations on the Transvaal highveld and the 101,5 x $10^6 m^3/a$ consumed by afforestation the demand for water from the Komati river basin at a high level of assurance is expected to increase to 316,4 x $10^6 m^3/a$ by the year 2010.

Under present limits the RSA will issue permits for a further 6,301 ha of afforestation in the Lomati river catchment downstream of Swaziland. The total afforestation potential of the Komati river basin amounts to 339,900 ha which is distributed as shown in Table I-A-1. Full utilisation of the remaining potential would therefore result in a further 220,300 ha of aforestation and a total potential water demand of approximately 288 x $10^6 m^3/a$ of the utilisable water of the Komati river basin.

The potentially irrigable soils within the Komati river basin amount to 230,800 ha, distributed as shown in Table 1 and have a potential water demand of 2257 x $10^6 m^3/a$. The higher quality irrigable soils (Class 1) alone account for 148,500 ha as shown in Table A.1.1 and would require approximately 1394 x $10^6 m^3/a$ to irrigate.

In addition to the aforementioned potential water requirements there is a growing need for more water from the Komati river basin for thermal power generation within the Republic of South Africa by powerstations situated on the coalfields of the Transvaal highveld, inside or outside the Komati river basin.

It is expected that the livestock numbers will not increase significantly beyond their present number because of the already high gross livestock density of 4,2ha/ELSU. The water use will therefore remain at 3,8 x $10^6 m^3/a$.

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Due to the increasing population of the Komati river basin and the need to establish agriculture based on irrigation it is apparent that considerable additional irrigation must be developed within the near future and is expected along both the Komati and Lomati rivers within Swaziland and within the Nkomazi Region in the RSA.

Unless storage is created within the Komati river basin this additional irrigation development will be harmful to existing development.

Arising from the pulp industry considerable pressure has also been placed on the Directorate of Forestry of the RSA to increase the previously established permit limits for afforestation within the Komati river basin.

It is known that considerable irrigation potential exists along the Incomati river in Mocambique and that consideration is being given to augmenting the water supply to Maputo from the Incomati river. Construction of the Corumane dam on the Sabie river in Mocambique is currently in progress to permit the development of approximately 36,100 ha of irrigation along the Sabie river before its confluence with the Incomati river.

POTENTIAL UTILISABLE WATER WITHIN THE KOMATI RIVER BASIN

General

The natural (virgin) mean annual runoff (MAR) of the Komati river at Komatipoort has been assessed at 1433 x $10^6 m^3/a$ of which the Lomati river contributes 369 x $10^6 m^3/a$. The contribution to the natural MAR by the RSA and Swaziland is shown in Table I-A-1.

The utilisable groundwater potential of the Komati river basin has been assessed at 11 x $10^6 m^3/a$, which is insignificant in relation to the overall water resources.

The unregulated flow of the Komati and Lomati rivers is capable of sustaining considerable irrigation development as is evidenced by the extent of the existing development, albeit presently at high risk. To reduce the risk to the existing development to an acceptable level it is therefore necessary to regulate the flow of the rivers of the Komati river basin by means of storage and to provide additional storage to meet future increases in water demand.

After provision of the above storage it will however still be possible to utilise the unregulated flow of the rivers at an acceptable level of assurance without direct reliance on storage. The greatest potential for utilising the unregulated flow exists along the Lomati river within Swaziland where the utilisable water for irrigation at Ngonini has been assessed at 45 x $10^6 m^3/a$ at 80% assurance, after allowing for the effects of afforestation and the future abstractions by Barberton. At the northern border of Swaziland along the Lomati river this increases to approximately 54 x $10^6 m^3/a$ at an 80% assurance.

Table I-A-1: Komati River Basin: Miscellaneous Statistical Data

Description	Total	RSA			Swaziland
		Mswati & Nkomazi	Remainder RSA	Total	
Area (km^2)	9 567	18,9	60,2	79,1	20,9
Natural MAR($10^6 m^3$)	1 064	19,4	51,9	71,3	28,7
Population (No.):					
--1982	238 000	54,0	21,1	75,1	24,9
--2010	590 300	64,5	13,7	78,2	21,8
Livestock (ELSU)	186 900	22,2	47,2	69,4	30,6
Current Effective Irrigation (ha)	31 035	5,9	54,4	60,3	39,7
Current Afforestation Permitted (ha)	81 684	2,0	78,8	80,8	19,2
Afforestation Potential (km^2)	2 855	10,8	67,4	78,2	21,8
Irrigation Potential (ha): --Class 1	133 700	18,2	73,3	91,5	8,5
--Class 2	6 600	11,7	49,2	60,9	39,1
--Class 1 and Class 2	199 700	16,1	65,3	81,4	18,6
Potential Irrigation Water use inside Basin ($10^6 m^3/a$):					
--Class 1	1 201	25,3	62,9	88,2	11,8
--Class 2	678	12,7	39,7	52,4	47,6
--Class 1 and Class 2	1 879	20,8	54,5	75,3	24,7

Source: JPTC, Komati River Basin Development, (Mbabane, September, 1983), Table 1.

During the interim period before the full lengths of the Komati and Lomati rivers are controlled by means of dams considerable use will still be made of the unregulated flow of the rivers since the upstream dams will be used to augment and thereby maintain the river flow downstream.

DAM SITES INVESTIGATED

A total of 14 sites for new dams have been investigated as shown in Figure 2 (not enclosed with these extracts.)

With the exception of Singerton and Mzimnene dams on the Mhlambanyatsi and Mzimnene rivers respectively, only dams on the Komati and Lomati rivers were investigated since these rivers present the most opportunities for creating significant beneficial storage. A major factor that governed the investigation was the availability of water from the sub-catchment supplying the dam, cost and the location relative to points of significant water demand, both present and future.

LONG-TERM DEVELOPMENT PROPOSALS

The positions of the existing and future dams and river diversions contained in the provisional long-term development proposals are shown in Figure 2 (not included). The salient features of the existing dams and the proposed new dams at a net storage capacity of 1215,4 x $10^6 m^3/a$ (approximately 97% of the afforested MAR), are given in Table I-A-2. The proposed system of dams will have a total yield of 817 x $10^6 m^3/a$ at 98% assurance, in addition to the 101,5 x $10^6 m^3/a$ of utilisable water consumed by the 119,633 ha of afforestation envisaged under the present permit system.

The total capital cost of the proposed long-term development plan is estimated at R337 million at current prices and excludes the value of Nooitgedacht and Vygeboom dams, which has been assessed at R49 million.

The proposed long-term development plan entails a relatively large number of dams. This is however due to the high costs of some of the larger dams such as Silingane and Ronel, where it has been found that the capital cost of dams at both Maguga and Singuen and at both Valkbult and Tonga is less than that of dams at Silingane and Ronel respectively. A further problem with Ronel dam is that it will require the resettlement of three entire villages in the Nkomazi Region in the RSA.

The need for Ngonini dam is not immediately apparent, but it has been included in the plan at this stage because of the potential for deferring some of the initial cost of providing storage at Driekoppies will require the resettlement of approximately 2 000 persons (300 dwellings).

The sizes of the dams at Singuen and at Tonga have been restricted because of potential inundation of Balegane in Swaziland and the proven coal fields in the Nkomazi Region in the RSA respectively. The size of the dam at Maguga has been determined by the topographical features of the site, which at

Table I-A-2: Komati River Basin: Features of Dams Proposed for Long-Term Development Plan

DAM	Net Storage (10^6 m³)	Gross Storage (10^6 m³)	NET YIELD (10^6 m³/a)[a]		Present Cost (10^6R)	AREA INUNDATED (km²)			Swaziland
			98% Assurance	80% Assurance		Nkomazi	RSA Remainder RSA	Total	
EXISTING DAMS									
Nooitgedacht	67,8	79,4	33,1	N.A.	49,0[b]	-	9,3	9,3	-
Vygeboom	68,9	85,4	108,2	N.A.		-	7,8	7,8	-
Shiyalongubo	(2,3)[f]	(2,5)	(4,3)	(4,8)	(N.A.)	-	-	(0,7)	-
Sand River	(44,1)	(50,3)	(-)	(-)	(N.A.)	-	-	-	(7,0)
FUTURE DAMS									
Boekenhoutrand[c]	278,9	288,0	131,8	N.A.	84,1	-	15,3	15,3	-
Maguga	259,7	295,0	208,5	261,7	63,7	-	-	-	10,0
Singuen	111,0	112,0	86,4	112,0	39,7	-	-	-	16,4
Tonga	117,0	122,0	41,0	52,0	51,4	22,5	-	22,5	-
Ngonini[d]	(50,0)	(60,0)	(104)	(120)	(36,4)	-	-	-	(6,0)
Driekoppies	236,9	250,7	167,5	195,5	67,6	34,6	-	34,6	1,4
Vlakbult	75,2	78,1	40,4	45,4	30,6	7,8	7,8	15,6	-
TOTAL	1 215,4	1 310,6	816,9	666,6[e]	386,1	64,9	40,2	105,1	27,8

[a] After allowing for the utilisable water use by afforestation, amounting to 101,5 x 10^6m³/a

[b] Assessed value

[c] Including Theespruit diversion

[d] Included as possible eventual addition to the system

[e] Total for only those dams that will supply mostly irrigation requirements

[f] Excluded from totals since not contributing to the yield of the total system as considered.

Source: Ibid

this stage appear to limit the potential storage capacity to approximately 295 x $10^6 m^3/a$.

The need for both Singerton and Mzimnene dams has faller away since the consumers that would have benefited from these dams can be supplied from the proposed system of dams at lesser cost. Stabilization of the Mhlambanyatsi river, which supplies the Kaalrug Irrigation District, will be more economically achieved by a pumped augmentation from Driekoppies dam." (pp.5-10).

"It is envisaged that all the water demands of the Komati river west of Swaziland to the year 2010 will be met from Nooitgedacht, Vygeboom and Boekenboutrand dams. The proposed long-term development plan will therefore be able to supply a water demand west of Swaziland of 258 x $10^6 m^3/a$ at 98% assurance in addition to the utilisable water consumed by afforestation upstream of Boekenhoutrand dam and upstream of the Theespruit diversion, after allowing for additional releases of 15 x $10^6 m^3/a$ from Boekenhoutrand dam to sustain a reasonable flow in the Komati river for ecological reasons. This release is fully recoverable at the next downstream dam viz. Maguga. Allowing for the increased water demands for domestic, municipal, industrial and mining purposes west of Swaziland to the year 2010 Boekenboutrand dam will therefore provide an additional 79 x $10^6 m^3/a$ at 98% assurance for other demands such as at the thermal powerstations in the RSA.

Providing for the domestic, municipal, industrial, mining and livestock water requirements of 66,5 x $10^6 m^3/a$ at 98% assurance to the year 2010 downstream of Diepgezet on the Komati river and along the Lomati river, the remaining dams viz. Maguga, Singuen, Tonga, Driekoppies and Vlakbult will yield 615,1 x $10^6 m^3/a$ at an average 80% assurance for irrigation use, including the additional release of 15 x $10^6 m^3/a$ from Boekenhoutrand dam. When the reservoir levels become critically low a 30% reduction in the mean irrigation water requirements will have to be made, with an average risk of occurrence of 20%.

Approximately 29,6 x $10^6 m^3/a$ is expected to flow to Mocambique in the form of transmission and distribution losses along the Lower Komati river, while approximately 30 x $10^6 m^3/a$ of the water supplied to IYSIS will be returned to the Mbuluzi river as transmission losses and seepage return. Subject to further refinement it has been accepted that elsewhere in the basin river transmission losses will be reregulated by downstream dams and irrigation distribution losses will be compensated for by return seepage.

The available water for additional irrigation therefore amounts to approximately 155 x $10^6 m^3/a$, which will permit the development of approximately 14 000 ha of additional irrigation at an application rate of 1 100mm/a. The proposed long-term development plan allows considerable flexibility in the distribution of the new irrigation development within the Komati and Lomati river catchments.

The 155 x $10^6 m^3/a$ available for additional irrigation is equivalent to 126 x $10^6 m^3/a$ at 98% assurance and together with the 79 x $10^6 m^3/a$ additional water secured at Boekenhoutrand dam the equivalent of 205 x $10^6 m^3/a$ will be available for allocation between the RSA and Swaziland.

Greater water demands will largely have to be met by improvements in the utilisation of the water, mainly by better utilisation of rainfall and the use of more efficient irrigation systems since the additional water that can be made available from the Komati river basin by larger storage is provisionally being reserved for use by Mocambique. This additional water can only be obtained at relatively high cost because of the long carry-over periods required to utilise the remaining runoff, which cost will therefore increase the overall unit cost of water within the basin and this will have to be accounted for in cost allocations to the various states.

Implementation of the entire long-term development plan is however not required immediately because of the lower present level of water demand and the consequent unnecessary capital expenditure. A phased development scheme is therefore proposed in order to satisfy the existing water demands and to also allow for increases in water demand before commencement of a subsequent phase. Phased construction has the further major advantage that it can be adapted to suit variations in future water demand patterns.

DEVELOPMENT ALTERNATIVES

A total of 17 alternative systems of dams were investigated by the consulting engineers. The system of proposed dams for long-term devlcopment as discussed in the preceding section was however found to meet all the existing and expected future water demands at the lowest cost when considering the relative costs of pumping water to the Transvaal highveld from Boekenhoutrand dam instead of from Hooggernoeg dam and the potential problems associated with resettlement of people at Ronel dam.

Ruigte dam is poorly situated to meet the water demands within the Nkomazi Region in the RSA and is potentially underlain by a coal field. Diepgezet dam will create serious environmental problems and will flood the Diepgezet mine.

It has also been found that the inclusion of Maguga and Driekoppies dams in the various alternatives always results in the lowest cost of water secured, considering the existing points of water demand. The inclusion of these two dams in the first phase development discussed in Section 9 of this report retains sufficient flexibility to permit the later construction of any of the other dams within the system (with the exclusion of Diepgezet and Silinganc dams) to meet possible changes in the future water demand patterns.

PROPOSED FIRST PHASE DEVELOPMENT

The proposed first phase development is required to satisfy the present water demands at an acceptable level of assurance and to allow for increases in both primary water consumption (largely domestic) and a moderate expansion of irrigation development in accordance with the requirements stated earlier.

With shortages experienced on both the Komati and Lomati rivers these cannot be overcome by means of a single dam, although a single dam could selectively alleviate some of the shortages. The cheapest dams upstream of the points of major demand are at Maguga on the Komati river and at Driekoppies on the Lomati river as discussed in the previous section. The initial yields of Maguga and Driekoppies dams will be 282 x $10^6 m^3/a$ and 168 x $10^6 m^3/a$ respectively at 98% assurance and 366 x $10^6 m^3/a$ and 196 x $10^6 m^3/a$ respectively at 80% assurance and a 20% risk of reductions of 30% in the mean irrigation water when the dams reach critically low storage levels. When the dams are operated to augment the unregulated runoff occuring downstream of them the combined system yield increases from 450 x $10^6 m^3/a$ to 510 x $10^6 m^3/a$ at 98% assurance and from 562 x $10^6 m^3/a$ to 640 x $10^6 m^3/a$ at 80% assurance. Allowing for transmission losses within the rivers it is expected that the combined utilisable yields of the two dams are approximately 439 x $10^6 m^3/a$ and 569 x $10^6 m^3/a$ at 98% assurance and 80% assurance respectively.

A single dam at Maguga would only meet the present water requirements at IYSIS as well as along the Lower Komati river with an 80% assurance and a 20% risk of reductions of 30% in the mean irrigation water demand with a reserve of approximately 27 x $10^6 m^3/a$. This reserve would meet the additional primary water requirements until approximately 1995 and permit the development of approximately 1 100 ha of new irrigation. A single dam at Driekoppies would only be able to meet approximately 90% of the existing water demands of the irrigators riparian to the Lomati river and along the Lower Komati river at 80% assurance in addition to the existing primary (domestic) water demands. This would not permit any further expansion within the basin, except at a further reduced assurance.

It is therefore evident that dams are required in the Komati river basin at both Driekoppies and Maguga in order to meet present water requirements on the basis of best joint utilisation of the water by the RSA and Swaziland. Details of Maguga dam built to a gross storage capacity of 295 x $10^6 m^3/a$ are shown in Figure 6 and 7 (not included) and details of Driekoppies dam built to a gross storage capacity of 251 x $10^6 m^3/a$ are shown in Figures 8 and 9 (not included). The sizes of both of these dams may require some revision pending the further optimisation studies to be performed by the consulting engineers.

The construction of these two dams will however only meet current water demands along the Komati river and irrigation riparian to the Lomati river at an assurance level of 98%, without any allowance for increased water demands. Consequently the increases in water demand due to increases in primary (mostly domestic) water demand and expanded irrigation development will have to be borne by a continuously decreasing assurance of the supply for irrigation, unless the water can be utilised more beneficially.

Reserving 22 x $10^6 m^3/a$ for the expected increase in primary water demand to the year 1995 an additional 116 x $10^6 m^3/a$ will be available for increased irrigation development, at which stage all the irrigation water will have to be supplied at an assurance of 80%. Besides being available downstream of the proposed dams some of this water can also be abstracted upstream of the dams where the unregulated flow permits e.g. the Lomati river in Swaziland.

It is therefore proposed that 36 x $10^6 m^3/a$ of the aforementioned 116 x $10^6 m^3/a$ not be apportioned at this stage but also be kept in reserve for future negotiation when either the RSA or Swaziland has reached the limits of the proposed initial allocation of the additional 80 x $10^6 m^3/a$ for expanded irrigation development as set out in Section 14 of this report and to allow for a possible reduction in the yield of Driekoppies dam should subsequent optimisation studies indicate that Driekoppies dam should be smaller, with a consequent later increase in the size of Vlakbult dam or the later construction of Ngonini dam, or both.

With the proposed two new dams at Maguga and Driekoppies it is possible for both the RSA and Swaziland to proceed with new development on either the Komati or Lomati rivers. "(pp.10-16)".

ANNEX 2

TERMS OF REFERENCE FOR

A FEASIBILITY STUDY OF AN IRRIGATION PROJECT

IN THE KOMATI BASIN IN SWAZILAND

(TOR for the Devres study team)

ANNEX 2

Terms of Reference for a Feasibility Study of an Irrigation Project in the Komati Basin in Swaziland [1]

1. INTRODUCTION

1.1 The current fourth National Development plan has identified irrigation development as a priority area of National Development planning in Swaziland. The plan calls for the development of the country's irrigation potential to ensure that the maximum economic and social benefits are gained from this development.

Under the auspices of the Joint Permanent Technical Committee (JPTC) of the governments of Swaziland and South Africa, proposals have been made for the long-term development of the water resources of the Komati River Basin.

1.2 OVERVIEW

The development of this basin is planned in two stages. The first stage forsees the construction of two dams (one in each country), in order to firm up present flows to meet existing needs and to provide for further development. Stage two would involve the construction of irrigation schemes on the land rendered productive with a steady water supply. Preliminary studies have identified potentially 5,000 ha that could be irrigated in Swaziland.

Thus far, negotiations with South Africa have only addressed the issue of the dam construction. To date the initiation of planning of the possible irrigation projects within Swaziland, downstream from the proposed dams, has not been implemented. To rectify this situation, a feasibility study needs to be conducted to begin stage two in the development of the Komati River Basin.

1.3 SUMMARY OF PURPOSE

The purpose of this feasibility study is to ascertain the viability of irrigation development in the Komati basin. This must be established before binding decisions regarding the allocation of the dam water and cost can be made. The results from the feasibility study would aid the government of Swaziland in their negotiations with the South Africans by providing information that indicates the economic soundness of a large capital investment in a dam and subsequent irrigation project.

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[1] Note that the style used in this Annex is as received from USAID; it is not necessarily consistent with the Devres style followed elsewhere in this report.

2. BACKGROUND

2.1 POLICY OBJECTIVES

(a) To expand productive employment opportunities in the country in order to cope with the foreseen increases in the labour force and taking into account the inadequacy of income-earning opportunities in the traditional dryland agriculture system.

(b) To improve the productivity of smallholder agriculture through the up-grading of technology, strengthening of management and manpower skills and augmenting land and water resources applied in conjunction with labour.

(c) To expand the base for government revenues and foreign exchange earnings/savings through export promotion and diversification and import substitution activities.

(d) To encourage self-reliance in the Swaziland economy with emphasis on increased self-sufficiency in basic food production.

(e) To promote faster economic growth with social justice.

2.2 ACTIVITIES

A. INTERNATIONAL WATER DISCUSSIONS AND NEGOTIATIONS

In the mid-1960's concern arose regarding the upstream exploitation and development by South Africa of common rivers and the consequently adverse effects these developments were having on cross-border flows into Swaziland. Swaziland acceded to the agreement then existing between South Africa and Mocambique which provided for consultants and co-operation towards the joint beneficial use of the rivers of common interest. At this time South Africa had exploited only 11 per cent of the water resources of its part of the catchment areas.

Subsequently, Swaziland made efforts to secure assurances from South Africa that normal dry season flows would be maintained. However, since no common basis for apportionment could be found, no agreement has been reached and a detailed memorandum of proposals made by South Africa in 1976 was considered unacceptable. By this time South African exploitation of the water resource was approaching 30 per cent of its part of catchments.

The continuing problem in these negotiations has been the absence of any agreement concerning equitable apportionment. The South African position is that, without having comprehensive storage facilities in place on their side of the watershed, they are

unable to fully guarantee any releases. This means that in the interim, South Africa continues to develop its water storage facilities according to its needs and with inadequate regard for down-stream users. It was on this issue that ministerial negotiations were held with South Africa in 1979, at which time the establishment of the JPTC was agreed.

The terms of reference of the Committee were to discuss, plan and recommend to the respective governments optimal water resources apportionments and development projections, while observing the parameters and guidelines of the Helsinki rules of 1966. Mozambique joined the technical committee in 1982.

B. WATER RESOURCES PLANNING

It has been evident since the completion of the UNDP water resources survey in 1970 that further irrigation development would be dependent on cross-border river flow agreements with neighbouring countries and a planned programme of dam construction based on these agreements for each river basin. Schemes proposed in the 1970's, with the exception of the dam at Mnjoli for Simunye, were marginal propositions and, in the absence of major storage facilities, impractical. However, as a result of declining cross-border flows from South Africa and the increased domestic demand for water, a re-assessment of this resource became a priority during the period of the Third National Development Plan (1977-82). Consequently, a series of research activities were initiated.

In 1979 the United States Corps of Engineers were retained to prepare the terms of reference for the development of a comprehensive water resources and related development framework plan for consideration and in support of negotiations with South Africa on the apportionment of common waters. South Africa had already undertaken a similar study on its side of the common watersheds.

In 1981 the Corps of Engineers, having subsequently agreed to undertake the study for which they were initially commissioned to formulate the terms of reference, released their findings. This study completed the background to water development by updating the National water balance, identifying river basin potentials, including hydro-power and singling out two areas of immediate concern. These were the Komati basin in the north of the country and the Usuti/Ngwavuma basin in the south.

C. KOMATI BASIN

The Corps of Engineers confirmed that the Komati run-of-river flows were already over-exploited by South Africa and Swaziland and concluded that, if the situation was not to deteriorate further, remedial action was necessary. Consequently, a further

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study was initiated by both countries through the JPTC, and the consultants Henry Olivier and Associates, in association with Chunnett, Fourie and Partners, employed for this purpose. The Corps of Engineers were retained by Swaziland to monitor progress on the study.

This study was completed in September 1983 and contained definite proposals for a phased construction programme on the Komati and Lomati rivers which will re-established the water flow necessary to sustain the existing substantial irrigation developments on these rivers and provide for a modest expansion. The proposals were submitted to Cabinet in April 1984 and were duly approved.

The proposed construction programme calls for two dams to be built, one on the Komati river at Maguga in Swaziland, and on the Lomati river at Driekoppies in the Republic of South Africa. These two dams are conceived as a single project by the South Africans even though it entails two dams, one of which lies within the Swaziland border. From the map it can be seen that the Lomati and Komati rivers begin in the Republic, travel through Swaziland and then converge further down stream once they flow back out of Swaziland (figure 1).[1] Hence, this proposed project will enable South Africa to irrigate one large basin down-stream from the dams, North of Swaziland (figure 2). Swaziland, on the other hand, could irrigate two separate basins within its borders: The Lomati and Komati basins.

D. POTENTIALS USES OF THE INCREASED WATER SUPPLY FROM THE DAMS.

D1 NEW IRRIGATION

In late 1984, the government requested the Corps of Engineers to re-examine the feasibility of an irrigation project in the Komati Basin. On the basis of their 1981 report and further desk work, a brief document was presented to government in February 1985. The project area selected for the analysis was on the left bank of the Komati river. This area was selected over the Lomati area for several reasons including: Availability of class 1 soils (3,600 ha on Komati, compared to 1,200 ha on Lomati); slope gradients (Lomati 3 to 4 times steeper than Komati); number of canal crossings (significantly more on Lomati); and contexual - Maguga dam would be located on the Komati river about 47 km upstream from the diversion site selected for the analysis. The identified project involves a 56 km main canal from which it was estimated that an area of approximately 5,000 ha can be reached.

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[1] Note : Figures not included with the TOR

D2 FIRMING UP EXISTING SCHEMES

Another, more immediate use of the water by Swaziland is to firm up its existing irrigation schemes in the Komati basin. Swaziland has become aware of late that the effect of increasing water use by South Africa on the Komati river has been to decrease the normal flows entering into Swaziland and so presents an ever increasing hazard to irrigators in Swaziland, particularly to the Swaziland Irrigation Scheme (S.I.S.) who rely on run-of-river flows (figure 2).

SIS has at present an estimated mean need for 172 MCM PA. In the drought years 1981, 1982, and 1983, SIS experienced shortages. Although South Africa released some 10 MCM in each of the former years to assist SIS in 1983 South Africa required all the available water and therefore could not release any to Swaziland. Thus SIS, in a severe drought year, was short of its normal irrigation requirement by some 70 MCM.

It is expected that if action is not taken Swaziland could experience a shortfall in mean need of at least 45 MCM by 1990, and at a frequency of one year in five. The shortage could be much greater in any given year, in fact it could exceed 70 MCM. With such declining flows and hazards, it is estimated that SIS would have to reduce its area under irrigation by at least 3,000 ha. Since SIS is a sugar producing scheme, this reduction would result in a serious loss of foreign exchange as well as jobs. In 1984 prices, a reduction of 3,000 ha would have meant a revenue loss of E12,7 million and 385 jobs, a considerate loss for a country the size of Swaziland.[1]

E. WATER AND COST APPORTIONMENT

The total cost of both dams was estimated in September 1983 at E131.3 million. The 1983 proposal suggested that the water be distributed as follows:

Total estimated yield from both dams 560 MCM

Swaziland share:

1)	To firm up present needs (SIS).....	49 MCM
2)	For new development.....	40 MCM
Total	.....	89 MCM

1 No doubt the word intended in this last sentence is "considerable".

South African share:

1)	To firm up present needs.....	395 MCM
2)	For new development	40 MCM
Total.....		435 MCM
Surplus--unallocated reserve--still to be negotiated		36 MCM

Since publication of this 1983 report, on-going work by the consultants (directed by the JPTC) has revealed that first, the estimated cost of the dams at September 1984 is E200 million and second, the unallocated reserve is now estimated at 43 MCM. The upper net yield is 10 MCM more than they originally thought. On the basis of an 80:20 percent division of costs (South Africa:Swaziland), Swaziland's estimated financial input amounts to E40 million and includes payment for 16 MCM of the unallocated reserve. This 16 MCM has been provisionally assigned by the consultants for working purposes. However, Swaziland could obtain 23 MCM or 50% of the reserve if deemed desirable, with a consequent financial input. Note that the 20:80% cost shares have been agreed in principle at the JPTC, but are not final or binding at this stage in the negotiations.

F. TIMING

The South Africans have finalized their own financing plans for the proposed joint dam development and are pressing the Swaziland Government to make a decision. They had wished to sign an agreement this August 1985. Delays in preparation of final cost estimates has postponed this signing until October 1985 and it could be delayed for a few months, depending on progress. To maintain positive relations with South Africa the government of Swaziland will wish to comply with the desires of the South Africans as much as possible. The pressure from the South Africans is mounting and hence the urgency of this feasibility becomes all the more apparent. Swaziland cannot make a well informed decision at this point, and they have neither the time nor the resources to obtain the level of accuracy and detail of data they would like to base their decision on. For the moment, therefore, the best solution is the small-scale feasibility study proposed. It will provide some data, albeit rough estimates with which the Swaziland government can use to make the best decision possible under the current constraints.

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G. USUTU/NGWAVUMA BASIN

Because of the time limitation, it is envisaged that the consultants will rely heavily on a study done recently on this basin, which is geographically similar to the Komati. The model used in this study should also be the one applied in the proposed study. In the case of the Usutu Basin, the traditional sector and government employed consultants to undertake a reconnaissance study of the entire basin. The consultants's report of December 1982 found some 50,000 ha of land suitable for irrigation in the Lower Usutu basin but identified sufficient water for irrigating only 35,000 ha. The proposal involves the development of irrigation units using the nucleus/smallholder model, supported by the construction of regulating dams. This nucleus/smallholder model attempts to incorporate the economic advantages of medium scale farming with the needs and policy objectives of assisting small scale farmers. The goal is to create a medium sized, centrally managed farm that will support the smallholders both by generating a reliable cash flow to the project and by providing extension and other services to the surrounding small scale farmers. In this manner it is hoped that government can obtain a reliable return on its investment in irrigation infrastructure and at the same time promote the commercialisation of small scale agriculture.

The analysis and supporting data contained this particular report are extensive and comprise the latest relevant estimates for the country. Hence, the report will be a primary data source for the consultants.

3. PURPOSE

3.1 VIABILITY OF PROJECT

Determine viability of total water development project in three stages:

A. Address agronomic, economic and social aspects

B. Examine advantages of firming up existing irrigated land (SIS)

C. Synthesize parts A and B to assess the viability of overall project.

3.2 GUIDES FOR NEGOTIATIONS

The report should aid the JPTC in their negotiations with the South Africans by providing hitherto unavailable data and information about the Komati basin.

A. COST SHARING

The report should assist the JPTC determining whether the current cost sharing arrangement is advantageous, reasonable and economically justifiable.

B. UNALLOCATED RESERVE

The JPTC will use the study to help determine the extent to which Swaziland will claim their portion of the currently unallocated reserve.

C. The study should aid the JPTC in establishing definite guidelines with South Africa on water rights to guarantee adequate and fair distribution of water when the demand exceeds the available supply.

3.3 DEFINE THE TERMS OF REFERENCE FOR DESIGN/PLANNING PHASE

ADDRESS THE FOLLOWING ISSUES:

A. Land tenure

B. Specific design

C. Plans and options to be developed

D. Expertise needed and time requirements

E. Any other items necessary to proceed to implementation stage.

3.4 DESCRIPTION OF ECONOMIC ANALYSIS MODEL

Include all data inputs and sources, assumptions and calculations in the final report so that the Swaziland Government can subsequently duplicate and update the results.

4. METHODOLOGY

4.1 GENERAL

The desire for accurate information by the JPTC must be balanced against the urgency with which they need this information. Given the brevity of the study, detailed costings and data collection are not expected.

Many documents and studies exist that deal with subjects relevant to this feasibility study. In particular, the Usutu/Ngwavuma study mentioned earlier will be an excellent reference source. It is envisaged that the consultants will refer to this document for much of their sociological, historical, and modelling information. Additionally, the consultants should make use of the work done

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thus far by the United States Army Corps of Engineers (USCOE). Discussion with the USCOE who have been closely involved with this issue for some time, would greatly enhance and expedite the process of information gathering. All available and relevant documents will be supplied by the government of Swaziland to the consultants. Where original work is required, the consultants are expected to make as reasonable an estimate as possible, given the time constraints.

4.2 VIABILITY OF PROJECT

The viability of the total water development project will need to be determined in three stages. The first will address the agronomic, economic and social aspects of the proposed 5,000 ha of irrigated land. The second will examine the advantages of firming up the water supply to existing irrigators in Swaziland (including SIS), and the future implications to these irrigators if this is not done. The third phase will be a synthesis of the first two to determine the viability of participation in the overall project.

A. PROPOSED NEW IRRIGATED AREA

The USCOE has provisionally identified approximately 5000 ha of land that can be provided with irrigation water by a gravity flow canal served by a diversion in the Komati River downstream from the Maguga dam. (Figure 2) The amount of water that will be available ranges from a low of 40 MCM annually to a high of 63 MCM. The range is a function of the degree of participation that the Swaziland government finally chooses which will dictate how much of the unallocated reserve will be utilised for the new irrigation area.

The analysis of the new area should include scenarios for use of both the high and low values for water supplies with the following considerations being included at each level.

A1 AGRONOMIC FEASIBILITY

Potentially crops for the area, which crops have market potential; mix of crops considering soils slopes, water amounts, water supply reliability, and long term soil conservation and productivity. Rationale and assumptions for each choice should be given both for recommended and rejected crops.

A2 BASIC CROP ECONOMICS

Each identified crop should be analyzed for costs of establishment, costs of production, yield and farm value. This data should be presented in tabular form

on a per hectare basis and should constitute overall crop budgets. Estimates of employment levels for each crop selected should provided.

A recommend crop list should be prepared for the total area to be irrigated and overall production cost/return estimates calculated.

A3 RESETTLEMENT COSTS

The consultant will determine the costs of resettlement on the following bases:

1. Assumption: that all people presently living in the area will be resettled;

2. Population data: 1976 census, updated;

3. Costs: Usutu basin study; Simunye Development; Luphohlo Hydro Scheme.

A4 ECONOMIC/FINANCIAL ANALYSES

1. The Consultants will define, for the identified project sizes (40 and 53 MCM), using the nucleus/smallholder model and the crop recommendations, over periods of 30 years.

   A. Economic rate of return analysis (err)

   B. Financial rate of return analysis (frr)

   C. Sensitivity analyses on err and frr.

2. Modifications made to financial costs in the economic analysis should include:

   - Public utilities and social services considered as benefits;

   - Smallholders housing considered a benefit, paid for out of income

   - Net value of land in its current use treated as a cost;

   - 20 percent foreign exchange costs returned to government with two year delay, as share of SACU revenue pool;

- Labour to be given a shadow wage rate.

3. COST INFORMATION

A. CAPITAL COSTS:

DAM	-	Portion of Swaziland's share attributable to irrigation project.
IRRIGATION PROJECT	-	Diversion work, main delivery system distribution system (in-field). Land preparation, drainage, farm infrastructure (office workshops, vehicles, housing for managers, etc.) Public utilities and service s Smallholder housing.
CONTINGENCIES	-	Physical price.

C. NET VALUE OF LAND IN ITS CURRENT USE

D. RESETTLEMENT COSTS

4. BENEFIT INFORMATION

A. REVENUE FROM CROP SALES (VALUE)

B. INCREASE IN GOVERNMENT REVENUE (VALUE)

C. EMPLOYMENT EFFECTS

D. SOCIAL BENEFITS

E. INCREASE IN FOREIGN EXCHANGE EARNING/SAVINGS

5. SENSITIVITY ANALYSES.

A. ECONOMIC:
10% Increase in cost
10% change in revenues
Zero shadow wage rate
Decrease in cropping intensity
Exclude all housing and resettlement costs.
Apply water charges to irrigators

B. FINANCIAL:
10% Increase in costs
10% change in revenues
Decrease in cropping intensity
Exclude all housing and resettlement costs.
Apply water charges to irrigators

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B. FIRMING UP EXISTING IRRIGATION DEMAND

The most immediate use of the water from this dam scheme is the firming up of the existing water demands by the Swaziland Irrigation Scheme (SIS). During the recent drought, the vulnerability of SIS became readily apparent. The potential hazard posed by future droughts, coupled with the decrease in water flows from the Republic of South Africa has led to the proposal that a portion of the dam water be used to guarantee the water supply of SIS.

The purpose of this part of the analysis, therefore, is to specify the effects on water availibility and irrigated areas in Swaziland if no dams are built, and on that basis, examine the cost and benefits of the firming up component of the total project. The analysis should examine scenarios for both 30 and 50 years hence. The costs involved will comprise the proportion of Swaziland's share of the dam development costs attributable to firming, and any other attributable costs. The benefits shall comprise the value of net additional crop production in the dams versus no dams scenario. The employment effects should also be examined. A sensitivity analysis on water charges that could be charged by government to the irrigators (existing) should also be performed, after discussion on this matter with government officials.

C. OVERALL VIABILITY

In order to assess the advisability of Swaziland's participation in the proposed joint development with South African an appreciation of the overall viability of the project is required.

The consultants are therefore required in this section to both summarize and synthesize the two previous sections (A and B), and present an analysis of overall viability. On the assumption that the results of this analysis will not be that the project is unviable, the consultants are required to summarise limits and assumptions that will ensure the level of viability as ascertained.

4.3 GUIDES FOR NEGOTIATIONS

The government of Swaziland is currently conducting negotiations from a position of weakness due to the lack of information on the area presently being considered. The issues of cost sharing, unallocated reserve and water rights are all being negotiated without any specific data to back up any stance the Swaziland JPTC should choose to assume.

A. COST SHARING

An important function of this report will be to provide Swaziland JPTC with information the government can use as supporting evidence to their negotiations on the price of Swaziland share of the dam. In the current tentative agreement, it is understood that Swaziland will pay roughly 20% of the price of the dam. This 20:80 ratio cost breakdown (Swaziland:South Africa) is based on working

assumptions on the amount of water that will accrue to Swaziland. Should it be found that an irrigation scheme is non-viable at the current negotiated price level of the dams that provide the water for the scheme, then the members of the Swaziland JPTC would have evidence with which they could negotiate to lower Swaziland's share of the cost. Since development of the South African basin north of Swaziland, it is in their interest to negotiate, and thus a reduction for Swaziland is possible. Assuming that there are reductions in the water apportionment is not envisaged at this point.

B. UNALLOCATED RESERVE

The other issue that needs more supporting information is the question of the unallocated reserve currently estimated at 45 MCM. The South African consultants have tentatively suggested that 64.5% or 29 MCM go to South Africa and 35.4% or 16 MCM go to Swaziland. Swaziland is theoretically entitled to as much as 50% of the 45 MCM unallocated reserve, although Swaziland's cost share of the dam would increase accordingly. The Swaziland JPTC needs more information as to whether the additional water will be worth the additional cost.

C. WATER RIGHTS CONSIDERATIONS

The primary considerations are those concerning the division of available water when/if supplies are inadequate to meet either total demand (annual) or periodic demand (seasonal - monthly - weekly).

How the shortages will be apportioned between the participants, the projects (within Swaziland) in both total amounts and flow patterns must be stipulated.

The above is also true if the down stream demand exceeds the delivery capacity of the system or any part thereof.

Similar consideration will involve the diversion and 56 km delivery canal to the 5000 ha but this is a consideration for the canal design/planning phase.

4.4 TERMS OF REFERENCE FOR THE DESIGN/PLANNING STUDY

In cooperation with the Swaziland Government officials, and after this current study/report is in the final stages, the consultants will prepare detailed terms of reference for the anticipated detailed and planning study for the new irrigation area. This terms of reference should include issues to be addressed such as land tenure, specific designs, plans and options to be developed, expertise needed and amount of time required and other items that will be needed to facilitate recruitment and provide initial information to the design team.

These terms of reference will be an integral part of the final report.

4.5 DESCRIPTION OF ECONOMIC ANALYSIS MODEL

In anticipation that certain inputs into the economic analysis will change after completion of the study (notably dam costs), it is required that the consultant present in detail their economic analysis model in hard copy form, in such a manner that the government can subsequently duplicate their results and hence make appropriate amendments to the inputs as required.

This detailing of the model should include the following elements:

A. Complete list of data inputs and sources
B. List of assumptions underlying the analysis
C. Listing of calculations made.

5. TECHNICAL ASSISTANCE NEEDS

5.1 PERSONNEL

		TEAM/EFFORT	SCHEDULE
A.	Team Leader	12 weeks	June/July/August
B.	Agronomist/ Irrigation	6 weeks	June/July
C.	Agricultural Engineer/ Irrigation	4 weeks	June or July
D.	Data Analyst/ Economist	12 weeks	June/July/August
E.	Marketing	2-3 weeks	June or July

F. Local Hire Secretarial and Data Assistant.

5.2 DUTIES/QUALIFICATION

A. TEAM LEADER

The team leader will be responsible for coordinating of the efforts of the team and preparation/editing/finalizing of the report to the Swaziland government. The team leader will also provide the economic analysis with the assistance of the data analyst and input from the participating specialists. The team leader will be the major contact with the Swaziland Government in presentation and discussion of the draft report as well as discussions about Swaziland government policy issues both National and International.

ANNEX 3

TERMS OF REFERENCE FOR

THE DESIGN/IMPLEMENTATION STAGE

OF THE KOMATI RIVER IRRIGATION PROJECT

ANNEX 3

Terms of Reference for the Design/ Implementation Stage of the Komati River Irrigation Project

A. Introduction

The TOR which the Devres team is working from call for the documentation of these subsequent and final TOR studies prior to actually implementing the Komati Irrigation Project. More specifically we were asked to address the following issues (TOR Section 3.3):

- -- land tenure
- -- specific design
- -- plans and options to be developed
- -- expertise needed and time requirements
- -- any other items necessary to proceed to implementation stage.

We have, in fact, divided these TOR into the following sections:

- -- Soils and Land Capability Studies
- -- Agronomy and Crop Studies
- -- Irrigation Design and Distribution Studies (on Project)
- -- Organization and Management Studies
- -- Market and Marketing Studies
- -- Examination of Means by Which the Project May Assist National Efforts
- -- Socio-economic Studies.

While the first three of these are rather standard ingredients in such TOR's for irrigation projects, the last four are generally not included. Our brief familiarization with this project (and many others) suggested strongly, however, that these are all areas in which this project could come to serious grief; they also need detailed attention.

It should also be pointed out that the level of detail provided here varies immensely between these seven areas. The Devres team's time resources were stretched very thinly, and there were, perforce, only modest resources devoted to several elements of these future studies. In the case of the first three study areas, the Devres team relied heavily on the equivalent documentation in the Tate and Lyle studies on the Big Bend South project. The last four are in fact more in the way of list of elements to look at, or references to other parts of this Komati pre-feasibility study to be copied, deepened and updated at that future time. We have <u>not</u> costed these future study efforts.

We have also recommended that several of these studies be given priority in terms of their commencement; they take longer or are more complicated. Included are the soils and land capability studies, and various elements of the socio-economic studies.[1]

B.. Soils and Land Capability Studies

1. Soils

Well before initiating the Komati River Irrigation Project, it would be necessary to conduct a detailed soil survey, soil classification, and land capability analysis of the entire project area. Although major soil units have been identified, it is clear that there is a wide variability in the area's soils which needs careful appraisal and identification. This heterogeneity has major implications for irrigation delivery designs and costs.

Project area soils should be analyzed for the following characteristics:

- Physical properties
- Chemical attributes
- Salinity
- Effective soil depth
- Water retention capacity

The soil (and the irrigation water source) should be tested for the presence of phytophthora organisms and for any other possible source of disease.

Soil surveys should be conducted at 1/5,000 scale using the available orthophoto maps as base maps. It is necessary to forecast the mapping both at 1/5,000 scale (on orthophoto maps) and on new base maps at 1/10,000 scale (latter on two sheets).

Soil observations should be at the rate of one per four or five hectares and the soil profile depth for this purpose should be 1.5 metres or more or to the soil bedrock. The soil profile characterization and description should use the nomenclature of the USDA Soil Survey Manual.

In the case of V-Set and K-Set soils with deep soil profiles, it would be necessary to have deep borings to a depth of 3-5 metres at a rate of about one per two hundred to two hundred and fifty hectares. All soil horizons from these borings should be analyzed for the properties indicated above.

Ground water analysis should be conducted for pH, soluble cations, soluble anions, soluble boron, total dissolved salts and electrical

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1 Also included, though not discussed in these TOR, were Maguga Reservoir Management studies.

conductivity. While ground water is not particularly plentiful in the project area, it could be used as modest supplementary water supplies on occasion.[1]

Soil units suspected of being saline or alkaline should also be analyzed for pH, electrical conductivity, and exchangeable sodium percentages.

In major soils, a minimum of three pits per major soil class should be visually observed for morphological, physical and chemical soil properties. It is recommended that at least one pit per 200 hectares should be dug in the proposed area for soil sampling and observation.

A minimum of 2 sites per major soil unit should be selected for conducting infiltration tests. The double ring infiltration method should be used. It is also recommended that undisturbed soil core samples be taken from each representative horizon within the rooting zone to determine moisture availability and conductivity.

All observations should be entered on orthophoto maps and should be identified by a number and a coding symbol showing the soil characteristics to facilitate mapping. Soil coding should be similar to the method used by the Department of Agricultural Technical and Extension Services, Zimbabwe. Soil mapping should be on the basis of series, phases, or, as necessary, as complexes of stated percentage compositions.

2. Land capability

In addition to soil maps, land capability (or "irrigability") maps at 1/10,000 scale should be produced. Irrigability classes should be assessed. In view of the high variability of certain soil characteristics (notably depth), and their associated soil qualities, it is required that data on each observation point should be accurately recorded. In addition to the 1/10,000 scale soil and land capability maps, two sets of 1/5,000 scale maps (on orthophoto map bases) are required, one set showing all the field assessments as described above and the other set showing the derived land capability class both according to the Zimbabwe system and to the United States Bureau of Reclamation (USBR) system: in the latter case they should show both surface and overhead irrigation capabilities.

Maps required are as follows:

- 1/10,000 scale map showing perimeter of area and vegetation;

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1 Information from D. Jenkins, Hydrologist, Water Resources Branch, Mbabane. Olivier et.al. assumed no such resources available. A Canadian team apparently should be arriving soon to conduct a test drilling programme. They could give some priority attention to this project area, perhaps, if this area has any priority potential--most unlikely, however.

- 1/10,000 scale map showing soils and topography (5m vertical intervals);

- 1/10,000 scale land capability map (with topographic contours at 5m vertical intervals);

- 1/5,000 (orthophoto) maps showing soil and land capability coding for each observation point; and

- 1/5,000 (orthophoto) maps showing Zimbabwe and USBR land capability classification for individual observation points;

3. Staff training

It is apparent that Swaziland lacks the technical manpower and other resources to conduct a comprehensive soil survey and classification study of the proposed project area. It is thus recommended, long before the initiation of the irrigation project, that a separate activity be initiated to establish a soil testing and plant analysis laboratory, and to obtain for a short-term the services of a well-qualified and experienced soil survey and classification specialist.

At the beginning of that activity, immediate steps should also be taken to identify a Swazi professional, preferably with an M.S. degree in Soil Science, for a Ph.D. programme overseas with specialization in soil survey and classification. Soil survey and soil classification of the project area could form the Ph.D. thesis topic. After working with the expatriate specialist for 18-24 months, the selected professional should go to a pre-determined overseas university to complete his/her Ph.D. programme. Upon its completion, the professional should be in charge of developing an appropriate soil survey and soil classification programme for the entire nation. He/she should also be responsible for initiating and organizing a training programme for technicians and others required for such a venture.

C. Agronomy and Crop Studies

On the basis of known agronomic and economic parameters, it has been proposed in the Devres pre-feasibility analysis that 1,000 hectares be developed as the initial stage; that is one module or one IDU (Irrigation Development Unit). This will expand to 3,000 ha (three IDUs) to consume some 40 MCM, and possibly to 5,000 ha (5 IDUs) to consume 63 MCM.

To implement the essential provisions of the irrigation project, it is necessary to collect the following data:

1. A field survey should be designed to conduct a study to determine the number of farmers engaged in farming and herding in the project area. It would also be necessary to prepare plans and costs of resettlement. This is discussed further at Section VIII below;

2. All agronomic and economic data used in this current pre-feasibility study should be re-analyzed and re-evaluated for their accuracy and representativeness, including the sources from which they were derived. Many data are weak and would in any case be rather obsolete up to one decade from now.

3. The crops recommended for production include citrus, mango, papaya, avocado, cotton, maize, cabbage, tomatoes and potatoes. It would be important to study further their export potential to domestic, RSA and overseas markets. All aspects of handling, storage and processing of the agricultural produce should be studied in detail (discussed at more length in Section VI below; these 2 studies must be linked).

4. Studies should be conducted to determine the optimum water use and cropping intensities.

5. Seasonal labour requirements on an individual crop basis should be established; then aggregated for the project. They should also be studied for smallholder farms.

6. Nature, rates, times and methods of fertilizer (primary, secondary and micro plant nutrients) application in relation to the optimum economic yields of the recommended and future potential crops should be determined.

7. Identification of potential new cash crops and their methods of field production and management practices should be determined under both estate and smallholder conditions.

8. Identify crop rotations for different crop mixes for agronomic and economic considerations. Variations over time should be analysed.

9. Data should be collected on the photoperiodic response of crop plants to determine the optimum planting dates.

10. Suitable pasture and range space should be identified and documented, especially using marginal and/or degraded land in the project area and its vicinity.

11. A study should be conducted to develop an integrated pest control system to avoid the excessive use of chemicals, and to reduce environmental pollution and costs.

12. Study of interrelationships between the agronomic factors such as the selection of cultivars, crop varieties, yields and production techniques, on the one hand; and soils characteristics in relation to physical and chemical properties, land use classification and moisture holding capacity, on the other.

13. A detailed investigation should be conducted to determine the feasibility of growing winter wheat in the project area with special reference to soils, specific site, cultivars and other relevant factors.

D. Irrigation Design and Distribution Studies (On Project)

1. Project description

Feasibility study for the stabilized supply of irrigation water from the Komati River Basin and related regulating dams to a 3,000 ha (to possibly 5,000 ha) irrigation project on the north bank of the Komati River in the north and west of Bordergate. Study method to employ discrete 1,000 ha modules or irrigation development units (IDUs); these can be sequenced over time to achieve a 3,000 ha or a 5,000 ha project.

Related studies to determine the optimum in-field irrigation techniques and field lay-outs as required to operate the enterprise effectively. Also, additional studies as required to confirm the following:

- Basic crop water requirements (work with agronomic studies)
- Climatic, soil, and terrain influences on system selection and design
- Correct design and sizing of pumping stations, main distribution pipelines, and balancing reservoirs

Feasibility level studies related to all infrastructure works such as housing, farm buildings, utilities, access roadways, sub-surface drainage, erosion control, and land clearing and preparation.

2. Preamble

The Komati River Irrigation study identified a net area of some 3,000 ha (to possibly 5,000 ha) in the basin as being the first project of a long-term development programme in the lowveld. The study demonstrated the economic viability to Swaziland of the Maguga Dam as a means of providing "new" water supplies with subsequent benefits through the establishment of prototype nucleus-smallholder farming units. The study also addresses in a preliminary manner the relative merits of a water supply through a long gravity canal vs. abstraction directly from the Komati River through pumping units on the project.

The objective of the feasibility study is to firm up these outline plans and designs to the point where the exact nature and costs of the works can be established in sufficient detail to allow decisions to be made regarding the commitment of capital and operating finance, and thence tendering.

Special consideration must be given to the relationships between individual development units, their maximizing the use of the best irrigable land, and the potential for sharing physical and human resources so as to

optimize the overall effectiveness of the entire basin development. Additional emphasis should be placed on understanding and allowing for the cultural impact of the development on the entire region.

The following scope of work applies to each of the 1,000 ha IDU's comprising the total project.

3. Scope of work

a. Project boundary

The preliminary design will be expected to define accurately the project boundaries giving due consideration to soil, terrain, general lay-out, and irrigation system requirements.

b. Crop water requirements

System design capabilities will be determined with due consideration for basic crop consumptive use, anticipated cropping patterns, method of irrigation, and field lay-out efficiencies. The sizing of the water abstraction facility, pumping units, main lines, and balancing reservoirs will take this into account.

An estimate must be made of the probable return flows to the river from all sources. This will allow for an estimate of the net water actually "consumed" by the project, and subsequent planning for the water use downstream.

c. River pumping state and pipelines

The location and design of the river pumping stations will be decided after a review of possible sites giving due consideration to the following factors:

- logistical location of the site relative to the general layout
- wide seasonal variations in river stage
- high silt loads in the river
- general stability of the river bank and susceptibility to flooding

d. Main, sub-main and distribution pipelines

The design and specifications of the buried permanent supply pipelines will be developed with due consideration for the following factors:

- Capacity as determined by a study of crop, domestic, crop processing, and livestock needs.

- Pressure ratings as required to meet all operational, terrain, and surge requirements.

- Size and material specifications based on optimization studies considering owning and operational costs.

- Location as required to meet field lay-out and in-field distribution system demands.

- Related valving design to modulate operating pressures, provide surge and safety protection, and isolation as required for efficient system maintenance.

Scale lay-out drawings will be made and reviewed relative to topographic and site investigations. Attention should be paid to appropriate methods of construction and long-term maintenance concerns. Site investigations are required to permit accurate estimates of construction costs.

e. Water storage

The design of the balancing reservoir should be developed with due consideration for the (probably) daily variations in demand caused by irrigation schedules, domestic and livestock needs, and any industrial requirements. Reservoir location should be selected after considering the system pressure requirements, site conditions, and economies of construction. Such a reservoir could possibly serve more than one IDU.

Topography surveys and site investigations must be carried out at proposed sites to ensure design adequacy and allow for construction cost estimates. Attention must be paid to minimizing seepage losses, maintenance costs, and health and nuisance problems.

f. Field lay-outs

On the basis of detailed topographic and soil survey information, preliminary field lay-outs will be completed. Due account should be taken in these lay-outs to the following factors:

- Scale of farming practices by the smallholder and nucleus farm.

- Possible conversion of nucleus farm lands to smallholder (or vis versa) at a later date.

- Special requirements for effective operation of the irrigation system (surface or overhead).

- Development of soil and water conservation practices.

- Effective inter-relationships with all field operations, i.e., cultivation, fertilization, weed control, harvesting, system repair, maintenance, etc.

- Integration of livestock needs with smallholder areas.

- Special lay-out and performance needs for the effective farming of specified cropping patterns.

- Availability of suitable soils and the special needs of any problem soils.

- Climatological imposed considerations e.g. violent storms/ rains.

g. In-field distribution system

From the preliminary lay-out, more precise in-field investigations will be made, working with agronomists, to determine the proper irrigation system selection. These investigations should include determinations of soil depth, moisture retention characteristics, and water intake rates. These data, combined with all other field lay-out considerations, should allow for proper system selection. A distinction between nucleus farm and smallholder requirements may be appropriate. A partial listing of general system alternatives is as follows:

- Surface
  - Borders
  - Basins
  - Graded furrow
  - Corrugations;

- Overhead
  - Hand-move
  - Buried or portable solid set
  - Travellers (both hard and soft hose)
  - Center pivots and linear move; and

- Drip or Micro
  - Emitters
  - Micro sprinklers
  - Tapes.

Within each of these general system alternatives, there is a variety of options ranging, for example, from buried concrete pipe to gated aluminium pipe to towable centre pivots, etc. System costing should include all tools, equipment, vehicles etc. as required to operate and maintain the system.

Final consideration must be given to the general level of technology that can be maintained on the project. Decisions should be avoided that saddle the project with dead-end technology for the next 30 years. The system finally selected should have the basic potential to evolve into ever more modern phases that allow, for example, for 1) improved labour and water economics; 2) automatic application of growth chemicals (fertilizers, fungicides,

herbicides, ripeners, etc.); and, 3) micro-climate control as required by specific crops. The project must be designed for an absolute minimum of maintenance.

h. Land development

The standards and methods to be adopted will be defined and cost estimates prepared. Detailed surveys of representative area will be carried out as required to establish methods and procedures.

i. Sub-surface drainage

From the preliminary lay-out, individual fields will be studied for soil and topographic conditions that will require sub-surface drainage. Drainage technologies will be studied and a system selection made that is compatible with general lay-out requirements. Ultimate disposal of the drainage flows will be identified. Cost estimates to the project will be established.

j. In-field structures, roads, drains, etc.

Preliminary designs, based on the requirements established by the field lay-outs, will be carried out in sufficient detail to enable cost estimates to be made.

k. Regional drainage, erosion and flood control

Due account will be taken in all preliminary designs and cost estimates of the need for adequate drainage and flood control works relative to the project's location in the total watershed. The design objective is to provide soil and water conservation on the project and to protect the project, both fields and structures, from damage by storm run-off or inundations. Facilities siting must address the question of vulnerability to damage. Diversion structures up-slope of the project may be required as well as suitably designed down-slope waterways. None of these possible costs have been included in the pre-feasibility analysis.

The design must also consider the desirability of strategically located windbreaks for protection to the fields and as a source of firewood. Windbreaks should be of species which will not harbour pests or diseases injurious to fruit or field crops.

l. Efficiency of Water Use

Reconnaisance plans concluded that the water resources of the Komati Basin are inadequate to serve all of the potentially irrigable land available. Consideration should therefore be given to ensure the efficient use of water. This consideration should be reflected, for example, in 1) the choice and design of the irrigation system; 2) the choice of crops to avoid high consumptive use crops; 3) the use of effective water management practices; 4) potential use of return flow systems; and, 5) effective retention of rainfall.

m. Water-related diseases and nuisance problems

Attention will be given in the design of all works to ensure that irrigation development will not lead to an increase in water-related disease among the population of the project area. Further attention will be given to the avoidance of nuisance problems and a concern for general public safety. Several experience to date elsewhere in the lowveld suggests strongly that irrigation spreads bilharzia and malaria especially.

n. Roads, utilities and communications

The requirements for additional works for both the nucleus farm and the smallholders will be established and costed. This includes a network of in-field, primary and secondary roads. It also includes water, sanitation and electrical service to housing, shops, offices, and pumping facilities. Groundwater resources in the vicinity of the project will be studied as a possible source of potable water. Sewerage out-flows will be processed and disposed of in an acceptable manner.

o. Domestic and agricultural infrastructure

Nucleus farm employee housing will be based as far as possible on GOS standards as appropriate for the level of employment.

A physical plan for the nucleus farm housing village, offices, and farm shop complex will be prepared and alternative approaches to lay-out and construction methods will be examined, costed and recommendations made. Water supply and sanitation will be provided appropriate to needs.

A nursery complex will be designed and costed. The complex shall provide a secured area with required cultivation and irrigation services. The area shall be sized and established to provide a stock of resources as needed to meet orchard planting schedules and, in due course, a range of agricultural research activities.

p. Consolidated cost estimates, economics and programme

Detailed cost estimates for the proposed works will be prepared at fixed and escalated prices. The overall economics of the scheme will be analyzed after consideration of agricultural benefits. A programme of works in the form of a critical path analysis will be presented. A time-frame will be recommended that is realistic given site logistics, materials and contractor availability, and institutional commitments to the project.

A series of drawings and specifications will be developed suitable for direct use in the solicitation of bids from contractors. Recommended actual contract documents will be included.

E. Organization and Management Studies

As with the marketing studies discussed at F. below, the consultants conducting the next (feasibility) study must, in essence, update the concepts contained in this pre-feasibility study. In particular, they must examine the "failure to" list in Chapter III.A of Volume II.

In addition to the overall upgrading and updating, the following management issues should receive special attention:

- -- Land Management
- -- Water supply/distribution systems
- -- Structures and civil works
- -- Rolling stock, machinery, equipment
- -- Agriculture production systems
- -- Handling and processing of output
- -- Selection, establishing and monitoring of smallholders
- -- Provision of services
  - extension (crop and water use)
  - machinery (cultivation, harvesting, etc)
  - credit (production, marketing)
  - marketing
  - transport (on and off project)
  - cash recoveries (water charges, etc)
- -- Budgetting, financial management
- -- Personnel management, labour management

With the smallholder credit function, special attention should be paid to the following; it is assumed that the Swaziland Development and Savings Bank (SDSB) will be the operating organization:

1. Would it be likely that a capital/deposit ratio or any other basic constraint could preclude the issuance of credit?

2. Are there likely to be sufficient qualified (SDSB) staff to service such a large project?

3. Would the SDSB be prepared to establish a branch office right on the project site so that project management itself would not require a credit officer?

4. Would funds used for smallholder credit be at market rates or concessionary (subsidized) rates. Perhaps these could be the former to start, working towards a market rate once the smallholder's farm was at full development.

5. Production, or cropping, credit is customary. What about marketing credit if some marketing and transport is not handled through the project's marketing system?

6. What type of financial controls and monitoring systems are normally established? Are they effective?

7. How do extension personnel normally get involved in smallholder credit, especially on existing small irrigation schemes? Do they supervise its use? Help provide inputs purchased? Do they collect debts?

8. The Komati Project smallholders will probably not have title to the land they farm. Under existing SDSB rules, their land thus cannot be used for security. Cattle are difficult, and the smallholder will probably not have heavy equity in machinery and equipment. Only the crop itself therefore may be used as security. How does SDSB collect this security if the borrower defaults?

9. Gross income of the smallholder on the project may approach E6000-E7000 annually (winter and summer crops) and perhaps E3500 - E4500 as a net. This no doubt would influence the limit on credit he would be allowed. What criteria are used to establish these limits? For any one crop there is naturally the need to finance all the inputs, or yields will not be high and repayment becomes difficult. So an annual ceiling can sometimes mean not enough credit for one or two crops. How are limits established?

10. Given the organized nature of this project, each smallholder will have a running account with the project's management (as at Vuvulane) for input supply, machinery services, etc. and other debits; and credits when that smallholder's produce is sold through the marketing office. Would the SDSB be amenable to becoming part of this process?

11. Perhaps an option is to let project management do it all, and SDSB make annual working credit advances to the project authority?

F. Market and Marketing Studies

This project's viability is highly sensitive to the nature of its marketing systems. A full two years before production begins a large and sustained effort must be made to sort out and establish effective management systems and marketing processes. These are highly skilled tasks.

In sum, the entire marketing report--Volume III of this report--must be updated and adjusted to the circumstances of the early--or mid-1990's, or whenever this project is scheduled to begin. There is no need to repeat that model here. Volume III spells out the findings and recommendations in those directions.

G. Examination of the Means by which the Project may assist National Efforts

1. Introduction

Over the course of this pre-feasibility analysis it became increasingly clear that such an irrigation project could be designed to serve two broad categories of beneficiaries. One of course would be those individual

people and groups on site or in the Basin--benefits would include enhanced and more reliable incomes and welfare for smallholder families, nucleus estate employees, and seasonal/temporary workers. Indirectly, the income and employment multipliers would see many more achieving these economic and social benefits in the project area.

But there is a second, and broader dimension. Properly designed and planned, this irrigation project could service a wider community of interests. Some of these are mentioned here and there throughout this report. They are collated here to make the point that every possible benefit should be garnered from such a relatively large commitment of national resources. Benefits at a broader level can be achieved through research, education and other linkages.

There has not been time for the Devres team to explore these numerous possibilities in any depth. They are nonetheless very real and their relevance and importance are obvious. In every case the Komati Irrigation Project could be used as a model, a pace-setter, or a prototype. They are listed here, not necessarily in any order of priority. It is this study team's hope that the more vigorous pursuit of these matters will be a constituent part of the next (design stage) Terms of Reference.

2. Activity areas

a. Extension worker training in smallholder agriculture;

b. Aquaculture development;

c. Agroeconomic research on irrigation farming
   : estate
   : smallholder
     - farm systems research link to Malkerns
     - other (and see 4. below)

d. Research on fodder production/stall feeding/dairy

e. Seed multiplication to open current bottlenecks

f. New economic crop experiments

g. Technical work on water saving at all levels

h. Evolution of more satisfactory smallholder credit systems

i. Evolution, through testing, of "micro" technology for smallholder á lá Asian

j. Establishment of effective marketing information systems to assist development of the proposed national system.

k. Training of technical and managerial cadres who would become available to an expanding number of irrigation projects

H. Socio-economic and Institutional Factors

1. Introduction

To design and implement a successful irrigation project it is necessary to take account of social, cultural and institutional factors, as well as the purely technical and economic. This section describes the information required to be obtained during the design stage on social-institutional and pre-project economic factors such as land-tenure, project area demography and the net value of current agricultural production. A range of other issues is also addressed.

2. Land Tenure

Land tenure and land relations are particularly important issues which in the past have caused complications on other irrigation projects, particularly on issues related to the length and security of leaseholds and conflicts between traditional and irrigation project authorities.

The first issue that should be addressed from a sociological perspective is that of resettlement. While, in general, the people of Swaziland are accustomed to resettlement, they are not always happy about it. Indeed, there are important social and economic costs associated with resettlement. While the economic costs are relatively easy to determine this is not so with the psychological and social costs; these must be taken into account to forestall future problems. As little information currently exists on these issues, it would be necessary to determine the nature and extent of the social costs involved in resettlement so that project design would attempt to minimize these costs.

Next, it is necessary to determine the type of land tenure arrangement that will govern smallholder cultivation on the project (as well as the right of a government/project authority to use SNL). A variety of landholding arrangements have been applied on other irrigation projects with differing results. A careful evaluation of the outcomes of particular types of landholdings arrangements will be necessary to establish an appropriate landholding arrangement for the Komati Basin project. For example, an extended tenure granted to smallholders will have the advantage of providing the farmer with security the thereby ostensibly encouraging maximum potential development by the holding.

On the other hand, granting an extended tenure may make it difficult to eject a farmer who is not performing as required by the project. In addition, a limited tenure arrangment may be socially desirable from the point of view of spreading the benefits of irrigated farming by rotating the leaseholdings among the wider group of smallholders. This would be done at intervals of 20 - 25 years, for example.[1]

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1 The Late King is said to have been in favour of rotating leasehold pattern in relation to the Makhonyane Irrigation Scheme for equity reasons. (Information obtained from Fion deVletter).

A related issue is the procedure for selecting candidate leaseholders. Obviously a variety of criteria could be applied for this selection process but the success of the project depends upon a careful determination of appropriate selection criteria. For example, it would be necessary to weigh the advantages and disadvantages of selection alternatives such as the following:

- First priority for smallholders displaced from the project area;
- Priority for farmers likely to be most successful because of proven ability;
- Consideration for establishing contracts with women who are often the primary food producers in Swaziland, and are more likely to be resident in the rural homestead; and
- Lowest priority for strangers to the area?

Another important issue requiring investigation is whether or not the smallholder cultivator will regard the landholding on the irrigation project as the primary residence. Evidence exists that people are more likely to regard participation on such a project as a commercial enterprise and to maintain a separate residence elsewhere.[1] Depending upon the answer to this question, very different implications are involved for project design and implementation. Development that could be anticipated with non-resident cultivators include conflicting labour demands between residence homestead cultivation and project site farming, on the practice of using hired labour by non-resident leaseholders. On the other hand, smallholders can regard their landholding on the project as their primary residence, the project design would have to consider issues such as, for example, the arrangements for maintaining livestock holdings.

Finally, there is the much broader issue of the governance of the irrigation project and the nature of the relations to be established between the traditional authorities and the project authority in order to minimize conflict. The new irrigation authority will not be introduced into an institutional vacuum. Therefore, it is imperative that information should be obtained on the best way to secure the acceptance and cooperation of the traditional authorities for the irrigation project. Further, project institutional arrangements should be designed to ensure the continued participation of traditional authorities for project governance. This may be one way of minimizing potential conflicts of interest but other ways must be sought as well. This type of cooperation would be useful also in the event that problems arise and/or disciplinary action is required with regard to leasehold arrangements as people are more likely to be responsive to traditional authorities.

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1 Margo Russell provided this insight; the Vuvulane Project experiences this to a considerable extent.

In summary, it is recommended that during the design stage a thoroughgoing review and evaluation be made of current social-institutional arrangements on existing irrigation projects to anticipate difficulties that may have arisen before. This evaluation should be used to design more realistic and workable institutional arrangements for the Komati River Irrigation Project.

The social-institutional issues to be investigated are summarized as follows:

- The social costs of resettlement? What are they and how can they be minimized?
- The type and duration of leasehold arrangements for the nucleus farm and smallholder;
- The basis for smallholder candidate selection with the possibility of establishing contracts with women as primary agricultural producers;
- The attitude of smallholders towards establishing a primary residential homestead at the project site; and
- The history and nature of relationships between traditional authorities and modern irrigation authorities.

3. Demography

A demographic survey is recommended for the feasibility study to supplement data available from the 1984 Agricultural Census with data on (a) homestead size and composition, and (b) employment levels and patterns. Population statistics and enumeration of homesteads available from the Census would be adequate to determine the extent of resettlement that would be required to implement the irrigation project of the size selected. However, additional data would be required on homestead size and age and composition of family members. This is necessary to determine the potential for recruiting successful smallholder farmers and other wage workers for the nucleus farm from among the local population.

For example, it would be useful to know whether families interested in joining the irrigation project would be able to meet the anticipated labour requirements for successful smallholder cultivation from among their own family members or would supplementary labour be required? Similarly, to what extent would the nucleus farm labour requirements be met from the local population/smallholder families on the project/commuter workers from outside the area.

Part of the answer lies in the level and patterns of employment in the area and the wages earned. Therefore, the second major focus of the demographic survey should be on employment and the amount and sources of

income. Estimation of family income would have to be supplemented with economic data on farm production, the requirements for which are set out in the next section.

4. Agricultural output and family incomes

As few data were available on agricultural production specific to the project area, for the pre-feasibility study it was necessary to estimate the value from aggregate production data on SNL as a whole. However, a more accurate estimate based on on-site data would be more useful. It would be particuarly valuable for estimating average homestead incomes. Thus, an economic assessment is recommended for the feasibility study. The focus would be on (a) estimating the net value of agricultural production, and (b) average homestead income from on and off-farm earnings.

On-farm homestead income could be estimated through individual homestead farm budgets. Drawing up model budgets would require data on combined agricultural and livestock production, crop and livestock yields, amount and value of input usage, farm level prices for output sold and the estimated amount and value of production consumed on-farm. Net value of agricultural production in the area could be obtained either by aggregating net incomes over number of homesteads or alternately by calculating per hectare value of production and multiplying by the amount of land in cultivation.[1]

Finally, estimated on-farm incomes must be combined with off-farm earnings to estimate total average household incomes. This information is vital for assessing the level of returns that would offer appropriate incentives to attract smallholder farmers to the irrigation project.[2]

5. Other factors

Permeating the above basic assessment matters is a range of dynamic and related elements which can be mentioned in this final section: as special and very specific issues they may or may not bear high relevance to a future project. They must be addressed, nonetheless:

a. What happens to that share of the population requiring resettlement who cannot be accomodated on the project, or who do not want to participate;

b. Should all new settlers have the same plot size, regardless of ability and/or interest?

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1 It is necessary to take account of the fact that there are some relatively successful commercial farmers in the area although their exact number is not known. Their earnings would likely be higher than the average.

2 It would also be an integral part of the policy-making with respect to water charges for smallholders--see detailed discussion in Annex 6, Volume II.

c. Discipline: what sort of structure/process is needed to ensure maximum economic use of land and water provided to the smallholder? Maximum yields are needed to achieve viability.

d. What form of smallholder organization is the most appropriate--farmers group, coops?

e. What are project impacts on health

-- spread of disease, especially bilharzia and malaria;

-- improvement of diet.

f. How does one handle smallholder housing?

I. Technical Assistance Needs

Personnel	Time/Effort
Soils and Land Capability Studies	
Soil Scientists	16 person months
Land Capability Specialist	8 person months
Technical Assistant	12 person months
Agronomy and Crop Studies	
Agronomist	6 person months
Horticulturist	3 person months
Technical Assistant	2 person months
Irrigation Design and Distribution	
Agriculture Engineer	6 person months
Crop-Water Requirement Specialist	2 person months
Civil Engineer	4 person months
Draftsman	9 person months
Technical Assistant	9 person months
Organization and Management Studies	
2 General Management Specialists	7 person months
Credit Management Specialist	6 person months
Processing and Packaging Specialist	6 person months
Extension and Farmer Training Specialist	6 person months
Market and Marketing Studies	
Market Analyst	3 person months
Sociological and Economic Studies	
Rural Development Specialist	6 person months
Agricultural Economist	6 person months
Hydrological Studies	
Hydrologist	12 persons months

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ANNEX 4

WATER SHARING AND COST SHARING CONSIDERATIONS BASED ON M^3 WATER COSTS, LAND AVAILABLE, AND FUTURE BASIN POPULATION

ANNEX 4

Water Sharing and Cost Sharing Considerations

Based on M^3 Water Costs, Land Available,

and Future Basin Population

A. Background

This report is designed primarily to assist Swaziland members of the JPTC bargain more effectively with their RSA counterparts. This general mandate has acquired further substance from continuing dialogue between Devres team members and GOS officials.

Quite aside from more straightforward pros and cons using strictly economic criteria to compare water use options (new irrigation, firming up, thermal plants, forestry, etc.), there is a further dimension to the package of arguments which could be needed and/or used. These relate to longer-term equity considerations for water sharing which are not strictly economic and are more judgemental. These centre on, for example, the supply of related resources which will be available, especially irrigable land; and on the number of people who will be living in the different parts of the Komati Basin.

This annex addresses these issues. It naturally relies heavily on the studies accomplished by other Consultants. Sources of data used are fully referenced. Methodologies are documented fully. These preliminary analytical steps discussed here were advanced, as an iterative process, in the Main Report, Volume I.

B. Initial Methodologies and Results

1. The "Base" Case I

Statistics used here are provided by the TOR, and JPTC documentation, some of which has been updated and improved in recent months. The two dams of the Phase I development are thought to yield 570 MCM. Some 444 MCM are slated for firming up existing run-of-river supplies (395 MCM for RSA, 49 MCM for Swaziland). That leaves 126 MCM for new uses.

Total dam costs are now estimated at some E200m. This provides an M^3 of water annually for E0.351 (E200m divided by 570 MCM). Using that M^3 value, the following results:

Firming up RSA:	395 MCM	x E0.351	=	E138.645m
Swaziland :	49 MCM	x E0.351	=	E 17.199m

Additional development-total	:	126 MCM x E0.351	=	E44.226m
of which : for RSA	:	40 MCM x E0.351	=	E14.040m
: for Swaziland	:	40 MCM x E0.351	=	E14.040m
unallocated Reserve	:	46 MCM x E0.351	=	E16.146m
of which : Swaziland	:	16 MCM x E0.351	=	E 5.616m

Thus the total Swaziland allocation is 105.0 MCM (40 + 49 + 16). This should therefore cost E36.855m at an average of E0.351/M^3. However, as now allocated, RSA gets her share of 465 MCM for E0.344/M^3 (E160m/465 MCM), or 98 percent of the average M^3 price. Swaziland pays E0.381/M^3 (E40m/105MCM), or 109 percent of average.

These data are indicated as Case I at Table I-A-3 Column (6) shows that the water now agreed for Swaziland (as has been the cost sharing) should really in fact have cost E36.855m using an "equity" and consistent price of E0.351/M^3. The nascent "saving" should have been E3.145m.

2. Sharing water by equity pricing: Case II

Case II at Table I-A-3 adjusts the water supply which snould come to Swaziland if they nonetheless paid the E40m. It means, in sum, that Swaziland should receive a further 9 MCM if unit "equity" pricing is maintained. That brings it to 114 MCM (105 + 9) for E40m.

3. Sharing by irrigation land available: Cases III and IV

These cases are variations based upon shares of different types of land available in the Basin to the RSA and to Swaziland.[1] Case III breaks into two separate parts. Case III A allocates the 570 MCM over the combined area of Class I and Class 2 land available. This gives Swaziland 18.6 percent of the water or 106 MCM. Olivier et.al. calculated the Mean Water Requirements for the land. Given differences in climate, rainfall etc, these calculations give Swaziland 24.7 percent of the entitlement, or 140.8 MCM.

Using the M^3 price for Swaziland now in the understanding (E0.381), Swaziland would pay just over E40m for that Case III, a volume of 106.0 MCM. At an equity price of E0.351, however, Swaziland would pay only E37.206 for that water, saving E3.180m. Case III A resembles the base Case I. Case III B, however, is quite different. At E0.381 the 140.8 MCM would cost E53.645m, at E0.351 only E49.421: thus a "saving" of E4.224m. With only one exception (Case V B), this Case III B provides the most water using Olivier et.al.'s own estimates of water requirements for Class I and 2 land available.

Case IV is based upon the Olivier et.al. definition of areas of good land which, using various criteria (amount of lift etc) can, in fact, be subject to future irrigation. Called "Hectares of Irrigation Potential", such areas are smaller than those used in Case III in both the RSA and Swaziland. They are relatively smaller in Swaziland, however. The Consultant's data show

1 Information for Case III is from Table 3.10, Vol. 1 of 5, Basin Development ... and is entitled "Gross Possible Future Field Edge Irrigation Water Requirements". Case IV data are from Table 1 of the JPTC summary volume of September 1983 entitled Proposals ...

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Table I-A-3: Water Cases Adjusting Volumes and Costs for Base Case[c]

		Annual volumes for Swaziland[a] (MCM)	Costs to Swaziland: on existing (suggested) division of water E/M³	Total (Em)	on price parity w/RSA per m³ produced E/M³	Total (Em)	savings (Em) (col4 - col6)
I	Base case as per current understanding as expressed in TOR	105.6	0.381	40.000	0.351	36.855	3.145
II	Adjusting Case I to achieve av. price per m³ and get E40m worth of water	114.0	0.351	40.000	0.351	40.000	0
III	Irrigated Land Available						
	A. Land share	106.6	0.381	40.386	0.351	37.206	3.180
	B. Water share	140.8	0.381	53.645	0.351	49.421	4.224
IV	Hectares of Irrigation Potential						
	A. Uncorrected data	56.4	0.381	21.488	0.351	19.796	1.692
	B. Corrected data	106.6	0.381	40.615	0.351	37.417	3.198
V	Using Pop. Data for Year 2010						
	A. Uncorrected data	124.3	0.381	47.358	0.351	43.629	3.729
	B. Corrected data[b]	172.7	0.381	65.799	0.351	60.618	5.181

[a] Total volume made available is 570MCM. Volumes shown are for Swaziland only. RSA would receive difference in each case between 570MCM and figure shown here.
[b] Population adjusted on basis of no new project going in. See text.
[c] All sources and computation analyses in text.

Source: Devres Staff Estimates, August 1985

only 9.9 percent of the total in Swaziland (13,946 ha) and 91.1 percent in RSA (126,353 ha) --total of 140,300 ha. Using these shares, Case IV A indicates only 56.4 MCM for Swaziland.

These data appeared grossly inconsistent with other sets of proportions. The drop from the Case III A level of land available is too uneven e.g. for the RSA, the hectares of irrigation potential are 46.6 percent of those of irrigation land available (Case III A 126,353/270,900); for Swaziland, the equivalent ratio is only 22.5 percent (13,946/61,900).

The data provided were thus re-examined carefully. There would appear to be a calculation or typing error in the Olivier et.al. manuscript, distorting the picture. The total potential irrigation area of the combined soil types is given as 199,700 ha, yet the Class 1 are given as 133.700 ha and the Class 2 as 6,600 ha. Those data total only 140,000. The (approx.) 60,000 ha difference would appear to be in the hectarage of the Class 2 soils; their total should be 66,600 ha, bringing them back in to proportion. The results then are:

	R.S.A	Swaziland	Total No.	Percent
Class I	122,335	11,365	133,700	66.7
Class 2	40,559	26,041	66,600	33.3
Total	162,844	37,406	200,300	100.0
Percent	81.3	18.7	100.0	

By applying the 18.7 percent to the 570 MCM, Swaziland then obtains 106.6 MCM of new water, about the same as in Case III.A and at virtually the same overall cost--at "equity" pricing, this still only costs E37,417m, less than in the base Case I.

4. Sharing by anticipated basin population in the year 2010: Case V

Olivier et.al., presented population projections to the year 2010 as follows:[1]

	1982		2010	
	No.	Percent	No.	Percent
Swaziland	59,262	24.9	128,620	21.8
R.S.A.	178,738	75.1	461,380	78.2

Thus Swaziland would receive 141.9 MCM on the basis of the 1982 population share (24.9 percent of 570 MCM). Using the 2010 data, however, that volume drops to 124.3 MCM (21.8 percent of 570 MCM). That is Case V A.

[1] Data from Table 1 of Proposals ... Ibid.

This Consultant had serious reservations, however, regarding the assumptions made by Olivier et.al. to obtain these population data. They divided the Basin into five discrete units, as follows:

A. R.S.A. upstream of Swaziland

B. Mswati Region

C. Nkomazi Region

D. Remainder of RSA downstream of Swaziland

E. Swaziland.

There are no problems with the assumption made for A and D. Regions B and C, however, are resettlement areas of rapid recent growth which will slow down markedly. For the Mswati Region the overall growth to 2010 is at 4.04 percent with only 2.8 percent after the year 2000--this means what must be close to a 6 percent plus rate for 1982-2000 and that is far too high. The problem is similar for the Nkomazi Region where the equivalent figures are 3.92 percent (1982-2010), 2.8 percent (2000-2010) and close to 6 percent (1982-2000). This is the most heavily populated of the total RSA populations in the Basin; those excessive rates thus weigh heavily in the total.

In addition to an exaggerated overall RSA rate of population growth, the growth rate in Swaziland appears to have been underestimated. Olivier et.al. apparently were required to use population figures which became outdated with the more recent Census results. Their analysis appears very reasonable in that case. They used a 2.2 percent rate to bring older population data up to 1982, then a 1982-2010 rate of 2.8 percent. In the light of the recently published census data, however, we would suggest the following:

	Olivier et.al. Figures	Devres Revised Figures
Mid-1982 Population	59,300	65,000
Rate of increase to 2010	2.8%	3.2%
Year 2010 Population	128,400	200,834
Olivier et. al. also used	(126,620)	

The recent census provides a national average rate of growth over the recent period of 3.4 percent and the rate itself appears to be increasing. The 3.2 percent used above thus is highly conservative, it allows for some outmigration and no increases in existing estate agriculture which would attract more people. It also assumes no new irrigation projects which would increase the Basin's Swaziland population by many thousands.

Nonetheless, even using the revised and still conservative Swaziland figures and the Olivier et. al. (exaggerated) RSA figures one arrives at:

	1982		2010	
	No.	Percent	No.	Percent
Swaziland	65,000	26.7	200,834	30.3
R.S.A.	178,738	73.3	461,380	69.7
Total	243,736	100.0	662,214	100.0

Applying those shares to the 570 MCM gives Swaziland a 1982 volume of 152.2 MCM and a year 2010 volume of 172.7 MCM. That latter figure is used as Case V B, the "corrected" population case. In spite of its highly conservative nature, and the undoubted overstatement of RSA population, it will still provide nonetheless a water share considerably in excess of any other case. At an "equity" price per M^3 it would cost Swaziland some E60,618m.[1]

C. Subsequent Analysis: Per Capita Water Available and Per Capita Using 2010 Population

1. Water and costs per capita

Using Table I-A-3 information, Table I-A-4 searches for the per capita volume of water available using both sets of 2010 population data (Olivier et. al., Devres) and the total volume of water provided in the eight Cases. Columns (2) and (3) reflect the M^3/capita in 2010. As the Devres population figure for 2010 is higher by about one third, the per capita water available annually is proportionally lower (64 percent).

With the "equity" cost per M^3 of water of E0.351, Columns (4) and (5) reflect the per capita costs of the water under the two sets of population assumptions. Case IV A is clearly not relevant, so it is dropped herewith. Under the higher growth rate assumption (Column (5) the per capita front end cost of water ranges from E184 to E299; the costs are proportionately higher for the "uncorrected" population projection in Column (4).

2. Water, costs and land per capita (Table I-A-5)

A further and final exercise also proves revealing. Irrigation land available data (Case III A) and hectares of irrigation land (Case IV B) are used to provide per capita area available in the year 2010 under the two population assumptions. Under the low growth assumption there are 0.29 ha/capita of irrigation potential; the higher 2010 population permits only 0.19 ha/capita. Thus, for a family of, say, 8 people, in the last case, there

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1 Cases IIIA, IIIB, VA, and VB are brought into the main text of Volume I in several places in Chapter VII B--Recommendations.

SWAZILAND: ECONOMIC STUDY OF POSSIBLE USES OF
ADDITIONAL WATER OF THE KOMATI RIVER

Table I-A-4: Per Capita Values of Land and Water Options Available

Land water options available		Per Capita Values using Year 2010 Population numbers: uncorrected pop Nos. 128,620	Per Capita Values using Year 2010 Population numbers: corrected pop Nos. 200,834	Water costs using average value of water of o.351/m³ using Pop. data: uncorrected pop Nos. 128,620	Water costs using average value of water of o.351/m³ using Pop. data: corrected pop Nos. 200,834
1. Irrigation land available - Share for Swaziland 61,900ha(Case IIIA)		0.48ha	0.31ha	0.48ha	0.31ha
2. Hectares of irrigation potential - swaziland (Case VIB) - 37,406ha		0.29ha	0.19ha	0.29ha	0.19ha
		M³ available per capita		Cost in E per capita	
3. New Water Available: 8 Cases (data in columns 2 & 6 Table I)	I	816	523	287	184
4. Adjusting Case I to achieve av. price m³ and get E40m worth of water.	II	886	568	311	199
5. Irrigated land available - Land Share	IIIA	824	528	289	185
6. Irrigated land available - Water Share	IIIB	1,095	701	384	246
7. Hectares of Irrigation Pot. - Uncorrected data	IVA	439	281	154	99
8. Hectares of Irrigation Pot. - Corrected data	IVB	829	531	291	186
9. Using Pop. data for year 2010 - Uncorrected data	VA	966	619	339	217
10. Using Pop. data for year 2010 - Corrected data	VB	1,343	857	471	299

Source: Devres Staff Estimates, August 1985

Table I-A-5: Farming Household Size and Water Costs in 2010

Line No.		Size of Household: 4 persons	8 persons	12 persons
	Slow Population Grow Scenario			
1	Irrigated land available (0.48/cap.)	1.92	3.84	5.76
2	Hectares of Irrig. Potential (0.29/cap)	1.16	2.32[a]	3.48
3	Lowest Per Capita Water Cost (E287)	E1148	E2296	E3444
4	Highest Per Capita Water Cost (E471)	E1884	E3768	E5652
5	Water Need for Irrig. land available (line 1 x 1.5 M^3/ha)	2.88M^3	5.76M^3	8.64M^3
6	Water Need for Irrig. potential land (line 2 x 1.5 M^3/ha)	1.74M^3	3.48M^3	5.22M^3
7	Cost at lowest water rate (E287) (line 5 x E287)-irrig. land available	E827	E1653	E2480
8	Cost at highest water rate (E471) (line 5 x E471)-irrig. land available	E1356	E2713	E4068
9	Cost at lowest water rate (E287) (line 6 x E287)-Ha of irrig. potential	E499	E999	E1497
10	Cost at highest water rate (E471) (line 6 x E471)-ha of irrig. potential	E820	E1639	E2460
	High Population Growth Scenario			
11	Irrigated Land Available (0.31/cap)	1.24	2.48	3.72
12	Hectares of Irrig. Potential (0.19/cap)	0.76	1.52	2.28
13	Lowest Per Capita Water Cost (E184)	E736	E1472	E2208
14	Highest Per Capita Water Cost (E299)	E1196	E2392	E3588
15	Water Need for Irrig. land available (line 11 x 1.5 M^3/ha)	1.86	3.72	5.58
16	Water Need for Irrig. potential land (line 12 x 1.5 M^3/ha)	1.14	2.28	3.42
17	Cost at lowest water rate (E184) (line 15 x E184)	E342	E684	E1026
18	Cost at highest water rate (E299) (line 15 x E299)	E556	E1112	E1668
19	Cost at lowest water rate (E184) (line 16 x E184)	E210	E420	E630
20	Cost at highest water rate (E299) (line 16 x E299)	E341	E682	E1023

[a] Underlined numbers are those discussed in the text.

Source: Table I-A-4.

would be 1.52 ha available (8 x 0.19 ha). That is not a great deal, and after allowing for all other land uses in a region (roads, schools, shops, act) that might drop to an average of only 1.3 or so for a household of 8 persons. It is also recognised that not all of the population will farm; indeed, the loss to other uses, and the share of people not farming, could be proportional, thus leaving these ratios about the same.

The population density figures alone should undoubtedly stimulate energetic bargaining over future water supplies. But they can be associated with water costs and household farm sizes, as shown at Table I-A-5. The table's information is somewhat akin to "taking a sledge hammer to a fly," or, perhaps, "overkill"-- Nonetheless: Taking, for example a farming household of 8 persons, they would have only 2.32 ha of potentially irrigable land (line 2) under the slow population growth assumption. The water required for that farm is 3.48M³ (line 6). At the lowest water rate possible, that farmer would pay E999 (line 9) and at the highest rate E1639 (line 10). Those costs are of the dam costs to acquire that water on an annual basis. He is thus paying E431/ha or E706/ha once for that water very year. He should be satisfied to pay, say, E100/year for 4-7 years, or even forever, to cover that debt.

The more stressing case occurs under the more rapid population growth scenario (using the Devres growth assumption). That equivalent farmer has only 1.52 ha of land, needs only 2.28 M³ of water annually, and pays only from E420 to E682. The greater population density thus reduces irrigable land available, thus agricultural water needed per family, and therefore costs to him. His costs per hectare are from E276 to E449. The "worst" case is the family of 12 people who have only 2.28 ha and pay E276 to E449 per hectare for their irrigation water.

D. Sharing to Bring Currently Irrigated Areas to Similar Cropping Intensities

The overall average cropping intensity (C.I.) on existing irrigated land in the Komati basin, both sides of the border, is 112.47.[1] Some 43,646 ha are cropped on 38,715 ha irrigated. These figures include cropping on the Komati, the Lomati and the Crocodile, and the area on the Mbuluzi irrigated by Komati water (SIS).

But cropping intensities are very different as between RSA and Swaziland. Excluding the Lomati, Crocodile and Mbuluzi, RSA has 22,789 hectares of cropping on 18,730 ha, an intensity of 121.67 (8,383 ha permanent crops, 10,347 ha summer field crops; 4,059 winter field crops). Without the Mbuluzi watershed, Swaziland has only 2,868 ha cropped on 2,813 ha, an intensity of only 101.96 (2,408 ha permanent; 405 ha summer field; 55 ha winter field). With the 9,492 ha irrigated on the Mbuluzi side with Komati water, the total area rises and the C.I. drops to 100.45 (12,360 ha cropped on 12,305 ha irrigated).

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1 All data used in this section from Table 2.5 of Olivier et.al. Basin Development..., Part II, Volume 1 of 5.

A case might be made therefore, in the interests of equity, to reserve for Swaziland, at a minimum and from the top of the as yet unallocated water, enough new water to at least equalise intensities in time. The difference in hectarage cropped without Mbuluzi is 16,917 ha (18,730 less 2,813); with Mbuluzi included the difference falls to 6,425. Given a difference in intensitites of approximately 20 percent, and assuming an average of some 1,400 M^3/ha we get:

a.	16,917 ha x 1,400 M^3	=	23.684 MCM current use
b.	6,425 ha x 1,400 M^3	=	9.995 MCM current use
c.	20% of line a	=	4.74 MCM
d.	20% of line b	=	1.80 MCM

It is appreciated that the 20 percent figure is terribly crude and that the 1,400 M^3/ha is not exactly correct. The principle has been established, nonetheless, that there is some degree of existing inequity in water use on a per hectare basis. That degree of inequity is on the order 1.8 - 4.7 MCM, depending on how one counts.

E. Summary Conclusions[1]

The overwhelming conclusion from this analysis is that even conservative estimates of population growth for the next 25 years in the Basin carry with then rather staggering implications. The amount of land per family that is irrigable and of Class 1 and 2 quality shrinks to very small farms indeed, even recognizing that not everyone in the Basin will be farming, but also acknowledging that probably a similar proportion of Class 1 and 2 land will be put to non-farming uses.

By implication, therefore, every effort must be made to intensify land use. The Swaziland investment in Stage 1 of E30-60m is a very reasonable price to pay on any basis to enable that essential intensification. By analogy, other major river basins in Swaziland will be experiencing the same problems. This is turn implies immense effort directed towards the education and training of these small farmers. The percentage of new land brought under irrigation command which is farmed by smallholders must rise appreciably so as to accomodate this population growth. But they must be effective and skilled farmers. There will be neither the land nor the water resources to waste. The enhancement of small farmer irrigation research--varieties, cropping patterns, etc. must also be intensified greatly.

Feeding these imperatives back into Table I-A-4 and I-A-5, the three Cases of greatest interest thus should be those which provide the most water. These are V B (171 MCM), III B (141 MCM) and VA (124 MCM). At equity pricing (E0.35i/M^3) these cost, respectively, E million 61,49 and 44. They also feature:

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1 Selected results of this analysis are also integrated with analyses in Chapter VII of the Main Report.

		Case V B	Case III B	Case V B
1.	Dam Cost Share per Capita (year 2010 population--this Consultant)	E304	E244	E219
2.	Dam Cost Share per Hectare of Irrigable Land Potential	E1631	E1310	E1176
3.	Area possibly Irrigable (ha) (@ 1500 M^3/ha)	11400	9400	8267
4.	Dam Cost Share/ha Irrigable (line 3 into Dam Cost)	E5351	E5213	E5322

Analysing these data suggests that line 4 does not really select any one Case above another. Nor does line 1 in effect. Line 3, however, shows that even with optimum water (171 MCM for E61m) only 11,400 ha can be irrigated out of the 37,406 ha which has irrigation potential. With a 2010 population of over 200,000 people, that is 0.06 ha/capita, or 0.48 ha/household of 8 people, not a great deal.

ANNEX 5

Bibliography

Annex 5

Bibliography

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ECONOMIC STUDY OF POSSIBLE USES OF ADDITIONAL WATER ON THE KOMATI RIVER, SWAZILAND

VOLUME II : PRE-FEASIBILITY ANALYSIS OF THE KOMATI RIVER IRRIGATION PROJECT

VOLUME I : THE MAIN REPORT

VOLUME III : MARKETS AND MARKETING

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6150068

August 31, 1985

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ACKNOWLEDGEMENTS

Many people contributed to the successful completion of this report. Particularly concerned and helpful were:

Ministry of Natural Resources, Land Use and Energy

1. Mr. A. Maseko, Under Secretary
2. Mr. J. Vilakati, Land Use Planning Officer and Leader, Government of Swaziland (GOS) Counterpart Team
3. Mr. W. Gibson, Land Use Planning Advisor and Deputy Leader, GOS Counterpart Team
4. Mr. Robert Thabede, Senior Water Engineer
5. Mr. Noah Nkambule, Senior Land Planning Officer
6. Mr. Musa Shongwe, Soil Scientist
7. Mr. Caleb Bhembe, Irrigation Engineer
8. Mr. Stephen Dlamini, Water Control Officer
9. Mr. David Jenkins, Hydrologist, Water Resources Branch

Ministry of Agriculture and Cooperatives

10. Mr. Robert Thwala, Under Secretary
11. Miss Funekile Simelane, Rural Sociologist
12. Miss Nonhlanhla Thwala, Agricultural Economist
13. Mr. Gail Dunn, Irrigation Agronomist (Research)

Economic Planning Office of the Prime Minister

14. Miss Ruth Griswold

USAID

15. Mr. Paul Daly, Agricultural Development Officer
16. Mr. Neil Cohen, Regional Economist
17. Dr.E.V. Richardson, Irrigation Engineer (Consultant)

Other

18. Mr. J.R. Bond, Impompi (Swaziland) Ltd, Irrigation Engineers and Suppliers
19. Mr. Geoff Morling, Chief Civil Eningeer, SIS
20. Mr. Charles Sellick, Engineer, Chunnett, Fourie and Partners.

We are also appreciative of the assistance provided by the numerous officials and representatives in other governmental and private agencies, firms and enterprises, especially those connected with the agricultural sector, e.g. irrigation projects and processing establishments.

LIST OF ACRONYMS AND ABBREVIATIONS

ACP	Africa, Caribbean and Pacific
BLS	Botswana, Lesotho and Swaziland
CAP	Common Agricultural Policy
CDC	Commonwealth Development Corporation
CET	Common External Tariff
CI	Crop Intensity
CIDA	Canadian International Development Agency
CSO	Central Statistical Office
EDB	European Development Bank
EDF	European Development Fund
EEC	European Economic Community
EIRR	Economic Internal Rate of Return
FAO	Food and Agricultural Organisation (of the UNO)
FIRR	Financial Rate of Return
GOS	Government of Swaziland
GM	Gross Margin
GSP	Generalized System of Preferences
GDP	Gross Domestic Product
IBRD	World Bank
IDU	Irrigation Development Unit
IFAD	International Fund for Agricultural Development
IRR	Internal Rate of Return
ITC	International Trade Centre, UNCTAD/GATT
ITF	Individual Tenure Farms
JPTC	Joint Permanent Technical Committee
KOMAPRO	Komati Agricultural Products Marketing Authority
MAR	Mean Annual Runoff
MOAC	Ministry of Agriculture and Co-operatives
MSL	Mean Sea Level
NAMB	National Agricultural Marketing Board
NIDCS	National Industrial Development Corporation of Swaziland
NRLUE	Ministry of Natural Resources, Land Use and Energy
PY	Project Year
RDA	Rural Development Area
RDAP	Rural Development Area Programme
RSA	The Republic of South Africa
SAAGA	South African Avocado Growers Association
SACE	South African Citrus Exchange
SACU	South African Customs Union
SAMB	South African Maize Board
SAMGA	South African Mango Growers Association
SATS	South African Transport Services
SCB	Swaziland Citrus Board (Swaziland Cotton Board)
SI	Shortage Index
SIS	Inyoni Yami Swaziland Irrigation Scheme
SNL	Swazi Nation Land
STABEX	Export Stabilization Fund, EEC
TDF	Title Deed Farm

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TDL	Title Deed Land
TLTS (T AND L)	Tate and Lyle Technical Services
TOR	Terms of Reference
UK	United Kingdom
UNDP	United Nations Development Programme
USAID	United States Agency for International Development
USCOE	United States (Army) Corps of Engineers
VA	Value Added

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CURRENCIES, WEIGHTS AND MEASURES, CONVERSIONS

CURRENCY EQUIVALENTS (END JUNE, 1985)

USA Dollar $1.00 = Emalangeni E1.85
Lilangeni 1 = RSA Rand 1

(Rand is also legal tender in Swaziland)

WEIGHTS AND MEASURES

The international system of units (SI) are used throughout this report. Base units for this system are:

Metre (M)	-	unit of length
Second (s)	-	unit of time
Kilogram (kg)	-	unit of mass/weight
Ampere (a)	-	unit of electric current
Celsius (c)	-	unit of temperature
Litre (ℓ)	-	unit of liquid volume
Hectare (ha)	-	unit of space

SI UNIT PREFIXES USED ARE AS FOLLOWS

Multiples & Submultiples	Prefix	SI Symbol
10^9	Giga	G
10^6	Mega	M
10^3	Kilo	K
10^{-3}	Milli	M

CONVERSIONS

The following conversions are offered:

From old Units	Multiply by (approx.)	To SI Units
Ft^2	0.0929	M^2
Acre	0.4047	ha
$Mile^2$	2.590	Km^2
lb/ft^3	16.018	kg/M^3
Ft^3/s	0.0283	M^3/s
gpm	0.0631	L/s
Mile	1.609	km

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Ft	0.3048	M
in	25.4	mm
Ton(long)	1.016	t,Mg
Ton(short)	0.907	t,Mg
lb	0.4536	kg
hp	0.746	kw
psi	6.895	kPa
Mile/h	1.609	km/h
Yd^3	0.765	M^3
Bushel	35.24	L
Gallon	3.785	L

MOST COMMONLY USED

1 hectare (ha)	=	2.47 acres
100 ha.	=	1 sq. kilometre
1 tonne (t)(MT)	=	1000 kg
1 kg	=	2.2 pounds (lb)
1 km	=	0.62 miles
1 metre (m)	=	3.28 feet (ft)

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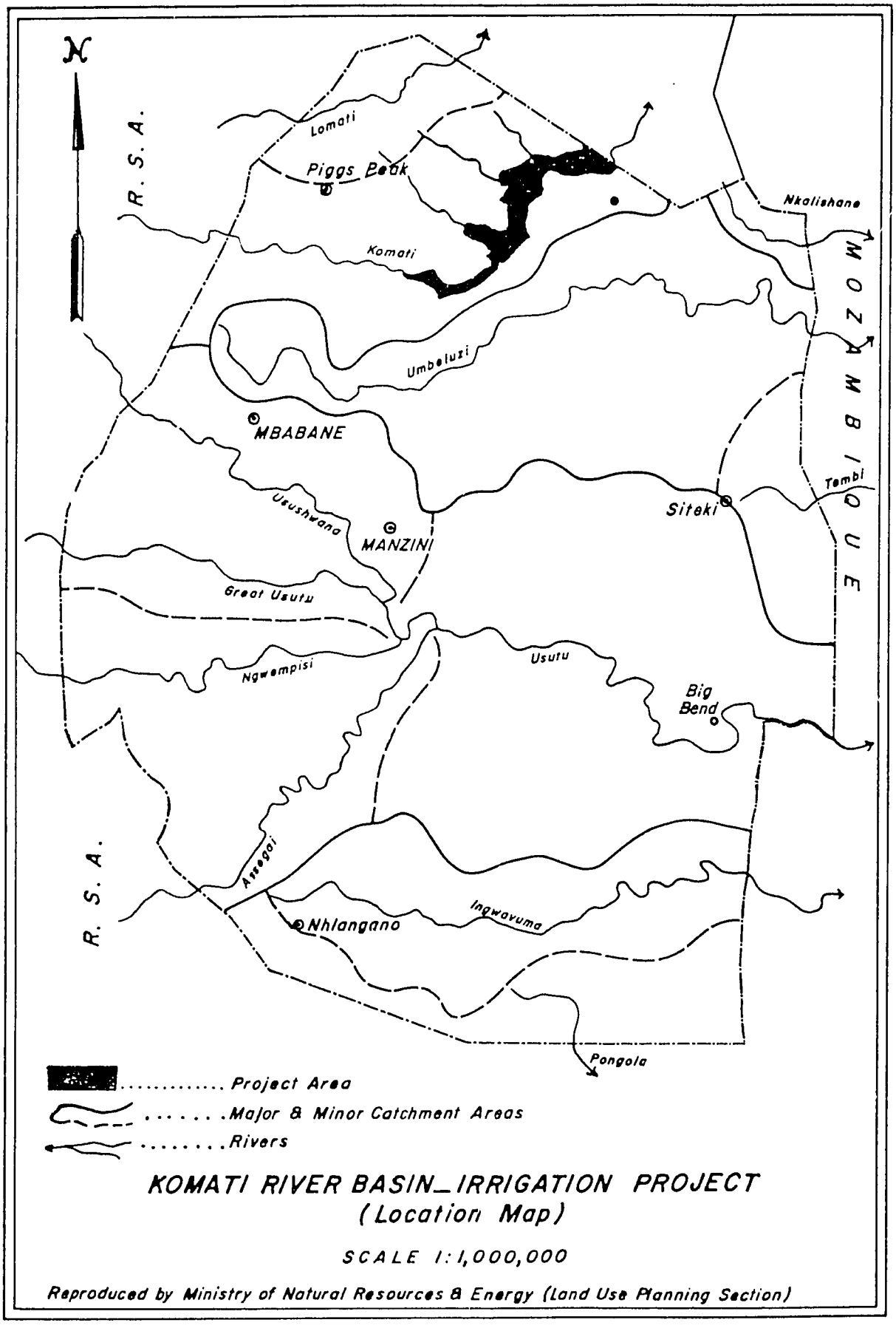

SWAZILAND: ECONOMIC STUDY OF POSSIBLE USES OF
ADDITIONAL WATER ON THE KOMATI RIVER

Figure II-1: Location Map of the Komati River Basin Irrigation Project

I. INTRODUCTION AND BACKGROUND

A. Background and Present Status[1]

1. Background

The current (Fourth) National Development Plan has identified irrigation development as a priority area of national development planning in Swaziland. The Plan calls for the enhancement of the country's irrigation potential to ensure that the maximum economic and social benefits are gained. Under the auspices of the Joint Permanent Technical Committee (JPTC) of the Governments of Swaziland and South Africa, proposals have been made for the long-term development of the water resources of the entire Komati River Basin in those two nations.

The development is planned in two stages. The first stage foresees the construction of two dams (one in each country) to firm up present flows to meet existing needs and to provide for further development. Stage two would involve the construction of irrigation schemes on the land rendered potentially productive with a steady water supply. Preliminary studies have identified some 5,000 ha on the north border of the Komati River that could be irrigated in Swaziland.

Negotiations with South Africa thus far have addressed only the issue of stage one dam construction. To date the planning of the project, downstream from the proposed dams, has not been initiated. To rectify this situation, a feasibility study needs to be conducted to begin stage two in the development of the Komati River basin. The purpose of this feasibility study is to ascertain the viability of further irrigation development there. This must be established before binding decisions regarding the allocation of the dam water and cost can be made. The results from the feasibility study would aid the government of Swaziland in its negotiations with the South Africans by providing information that indicates the economic soundness or otherwise of a large capital investment in a dam and subsequent irrigation activities.

2. Activities to date

a. International water discussions and negotiations

In the mid-1960's concern was expressed regarding the upstream exploitation and development by South Africa of common rivers and the consequent adverse effects these developments were having on cross-border flows into Swaziland. Subsequently, in 1967, Swaziland acceded to the agreement then existing between South Africa and Mocambique which provided for consultations and cooperation towards the joint beneficial use of the common interest rivers. At this time South Africa has exploited only 11 percent of the water resources of its part of the catchment areas. Subsequently, Swaziland made efforts to secure assurances from South Africa that normal dry season flows would be maintained. Since no common basis for apportionment

[1] Taken almost verbatim from the Consultant's Terms of Reference (TCR)

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could be found, however, no agreement has been reached; a detailed memorandu of proposals made by South Africa in 1976 was considered unacceptable. By 197 South African exploitation of the water resource was approaching 30 per cen of its part of catchments.

The continuing problem in these negotiations has been the absence of an agreement concerning equitable apportionment. The South African position i that, without having comprehensive storage facilities in place on their side of the watershed, they are unable to guarantee fully any releases. In the interim, this means that South Africa continues to develop its water storage facilities according to its needs but with inadequate regard for down-stream users. It was on this issue that ministerial negotiations were held with South Africa in 1979, at which time the JPTC was established.

The terms of reference of the JPTC committee were to discuss, plan and recommend to the respective governments optimal water resource apportionments and development projects, while observing the parameters and guidelines of the Helsinki Rules of 1966. Mocambique joined the Committee in 1982, making it a TPTC (Tripartite Permanent Technical Committee).

b. Water resource planning

It has been evident since the 1970 completion of a UNDP water resources survey that further irrigation development would be dependent on cross-border river flow agreements with neighbouring countries and then a planned program of dam construction based on these agreements for each river basin. Schemes proposed in the 1970's were marginal propositions, with the exception of the dam at Mnjoli for Simunye. In the absence of major storage facilities, these proposals were also impractical. As a result of declining cross-border flows from South Africa, however, and the increased domestic demand for water, a reassessment of this resource became a priority during the period of the Third National Development Plan.

In 1979, the United States Corps of Engineers (USCOE) was retained to prepare the terms of reference for the development of a comprehensive water resources and related development framework plan. This was to be used to support negotiations with South Africa on the apportionment of common waters. South Africa had already undertaken a similar study on its side of the common watersheds.

Having subsequently agreed to undertake the study for which they were initially commissioned to formulate the terms of reference, the USCOE related their findings in 1981.[1] This study completed the background to water development by up-dating the national water balance, identifying river basin potentials, (including hydro-water), and singling out two areas for immediate attention. These were the Komati Basin in the north of the country and the Usutu/Ngwavuma Basin in the south.

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1 US Army Corps of Engineers (Omaha District), Swaziland: Water and Related Land Resources-Framework Plan (Mbabane, 1981) (henceforth referred to as USCOE Water Resources).

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c. Komati Basin

The USCOE confirmed that the Komati run-of-river flows were already over-exploited by South Africa and Swaziland and concluded that, if the situation was not to deteriorate further, remedial action was necessary. Consequently, a further study was initiated by both countries through the JPTC, and the consultants Henry Olivier and Associates, in association with Chunnett, Fourie and Partners, (Olivier, et.al., hereafter) were employed for this purpose. The USCOE was retained by Swaziland to monitor study progress. Completed in late 1983/early 1984 the study contains definite proposals for a phased construction programme on the Komati and Lomati rivers which would re-establish the water flow necessary to sustain the existing substantial irrigation developments on these rivers and provide for a modest expansion.[1] The proposals were submitted to Cabinet in April 1984 and were duly approved.

The proposed construction programme calls for two dams, one on the Komati river at Maguga in Swaziland, and one on the Lomati river at Driekoppies in the Republic of South Africa. These two dams are conceived as a single project by the South Africans even though it entails one dam within Swaziland. The Lomati and Komati rivers rise in the Republic, travel through Swaziland and then converge further down-stream once they flow back out of Swaziland. Hence, this proposed project will enable South Africa to irrigate one large basin down-stream from the dams, north of Swaziland. Swaziland, on the other hand, could irrigate two seperate basins within its borders: the Lomati and Komati Basins.

3. Potential uses of the increased water supply

a. New irrigation

In late 1984, the government requested the USCOE to re-examine the feasibility of an irrigation project in the Komati basin. On the basis of their 1981 report and further desk work, a brief document was presented to the government in February, 1985. The project area selected for the analysis was on the (North) (left) bank of the Komati river. This area was selected over the Lomati areas for several reasons including: Availability of class 1 soils (3,600 ha on Komati, compared to 1,200 ha on Lomati); slope gradients (Lomati 3 to 4 times steeper than Komati); number of canal crossings (significantly more on Lomati); and contextual--Maguga Dam would be located on the Komati river about 47 km upstream from the diversion site selected for the irrigation analysis. The identified project could involve a 56 km main canal

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1 Henry Olivier and Associates and Chunnett Fourie and Partners, Komati River Basin Development, Proposals for the Initial Development ... (Mbabane, September, 1983). Document recommending inter-country agreements on water sharing. (Henceforth referred to as Proposals ...) The basic studies were Olivier et. al. Komati River Basin Development (Johannesburg, February, 1984). Volume 1 Development Possibilities. Five supplementary volumes form a second part detailing basic characteristics of the Komati Basin (henceforth referred to as Basin Development ...)

from which it was estimated that an area of approximately 5,000 ha can be reached. A more attractive alternative could be pumping from the Komati at the project site.

b. Firming up existing schemes

Another, more immediate use of the water by Swaziland is to firm up its existing irrigation scheme in the Komati Basin. Swaziland has become aware of late that the effect of increasing Komati river water used by South Africa has been to decrease the normal flows entering Swaziland. This thus presents an ever increasing hazard to irrigators in Swaziland, particularly to the Swaziland Irrigation Scheme (SIS) who rely on run-of-river flows.

The SIS has at present an estimated mean need for 172 MCM per annum. In the drought years 1981, 1982 and 1983 SIS experienced shortages. Although South Africa released some 10 MCM in each of the first two years to assist SIS, in 1983 South Africa required all the available water and therefore could not release any to Swaziland. Thus, the SIS, in a severe drought year, was short of its normal irrigation requirement by an estimated 70 MCM.

It is expected that if action is not taken Swaziland could experience a shortfall in mean need of at least 45 MCM by 1990 and at a frequency of one year in five. The shortage could be much greater in any given year, exceeding 70 MCM. With such declining flows and hazards, it is estimated that the SIS would have to reduce its area under irrigation by at least 3,000 ha or one-fifth of its area. Since the SIS is primarily a sugar producer scheme, this reduction would result in a serious loss of foreign exchange as well as jobs. In 1984 prices, a reduction of 3,000 ha would have meant a revenue loss of E12.7 million and 385 jobs, considerable losses for a country the size of Swaziland.

4. Suggested water and cost apportionment

The 1983 proposal suggested that the water from the dams be distributed as follows:

Total Estimated Yield From Both Dams	560 MCM
Swaziland Share:	
(1) To firm up present needs (SIS)	49 MCM
(2) For new development	40 MCM
TOTAL	89 MCM

South African Share:

(1)	To firm up present needs	395 MCM
(2)	For new development	40 MCM
TOTAL		435 MCM
Surplus - unallocated reserve -		
Still to be negotiated		36 MCM

Between countries the total cost of both dams was estimated in September 1983 at E131.3 million. Since publication of the 1983 report, on-going work has revealed that, first, the estimated cost of the dams at September 1984 is E200 million; and second, the unallocated reserve is now estimated at 46 MCM; the upper net yield is 10 MCM more than originally thought. On the basis of an 80:20 percent division of costs (South Africa : Swaziland), Swaziland's estimated financial input amounts to E40 million and includes payment for 16 MCM of the unallocated reserve. This 16 MCM has been provisionally assigned for working purposes. However, Swaziland could obtain 23 MCM or 50 percent of the reserve if deemed desirable, with a consequent increase in financial input. The 80:20 percent cost shares have been agreed in principle at the JPTC but are not final or binding at this stage in the negotiations.

5. Timing

The South Africans have finalized their own financing plans for the proposed joint dam development and are pressing the Swaziland Government to make a decision. They had wished to sign an agreement in August 1985. Delays in preparation of final cost estimates have postponed this signing until October 1985 and it could be delayed for a few more months, depending on progress. To maintain positive relations with South Africa the government of Swaziland will wish to comply with the desires of the South Africans as much as possible. The pressure from the South Africans is mounting and hence the urgency of this feasibility study. Swaziland cannot make a well informed decision at this point, and they have neither the time nor the resources to obtain the level of accuracy and detail of data they would like on which to base their decision.

For the moment, therefore, the best solution is the pre-feasibility study proposed. It will provide some data, however rough, which the Swaziland Government can use to make the best decision possible under the current constraints.

B. Scope of the Study

Accordingly, this study is concerned with determining alternate possible uses for 40-63 MCM of water expected to become available as a result of the construction of the Maguga Dam on the Komati River in North Central Swaziland.

Volume I of the study considers a variety of alternatives for the beneficial use of the newly available water while the present volume focuses solely on the alternative of using the entire amount on an irrigation project.

The feasibility study considers two cases: one, of an irrigation project of 3,000 ha if only 40 MCM of water were to be used; and the second, a larger one of 5,000 ha if it were possible to use all 63 MCM of water on irrigation. The modelled structure of the irrigation project is based on a 1,000 ha module called an Irrigation Development Unit (IDU). All aspects of design were developed for a 1,000 ha module including infrastructure, water distribution equipment, agronomy, budgeting, etc. The size of the project can be readily adjusted by the addition or subtraction of the 1,000 ha modules as desired. The project was designed to be located on the North or left bank of the Komati River, in the lowveld, just south of the Swaziland/RSA border at Bordergate.

Chapter II provides background information on current macroeconomic conditions in Swaziland, the status of agriculture and livestock development and outlines issues pertaining to land tenure, distribution and utilization. The current physical and socioeconomic characteristics of the project area in the Komati Basin are described in Chapter III. Chapter IV focuses on the proposed irrigation project itself describing its technology and infrastructure, crops and cropping patterns, production levels and net returns. markets and marketing and organisation and management. The economic and financial analyses are also included in this Chapter along with the sensitivity analyses. Finally, chapter V provides recommendations regarding the project.

II. BACKGROUND INFORMATION

A. The Macroeconomic Environment

1. General characteristics

Swaziland's economy consists primarily of two sectors--the traditional and the commerical. The traditional agricultural sector produces goods and services mainly for family subsistence. It indirectly supports almost 70 percent of the population, and is based on cultivation of an average of two or three hectares of land per household. The second, or modern commerical sector, includes agriculture, manufacturing, mining and services. The modern agricultural sector is highly capital intensive and accounts for about 65 percent of sectoral value added and 70 percent of exports, mainly from sugar, citrus and pineapple production, and from advanced forestry.

An important feature of Swaziland's economy is the high dependence upon external trade. Thus, exports of goods such as sugar, wood pulp, citrus and asebstos, and nonfactor services account for over 80 percent of GDP. A related factor is Swaziland's membership in the Rand Monetary Union and the Southern Africa Customs Union (SACU) which means that it lacks autonomy in matters related to international trade, exchange rates, and monetary policy which are essentially determined externally by the Republic of South Africa. A large portion of Swaziland's public revenues derives from SACU receipts, between 55 and 65 percent, representing 12 - 19 percent of GNP is obtained in this way.[1] The amounts represent Swaziland's share in SACU's total imports and excisable production plus a compensation factor for loss of tariff and excise rate autonomy as a result of membership in the Union.

2. Recent developments

a. Production, investment and savings

As shown in Table II-1, agriculture accounts for about one-fourth of value added, followed closely by manufacturing, while government services contribute over 17 percent to GDP and hotels and restaurants about eight percent. As explained in greater detail below, there is a sharp contrast between agricultural production in the commercial and traditonal sub-sectors. Crop production in the modern agricultural sector has experienced a high rate of growth due to rapid expansion in acreage and yields of both sugar and pineapples. Citrus production, on the other hand, has been declining due partly to drought conditions and the 1984 cyclone. Traditional dryland production was also affected adversely by the drought, contributing to an already declining maize production and an increase in imports of that staple. Cotton production also fell between 1980 to 1982 but both maize and cotton production recovered somewhat in 1983/84 with better rains.

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1 International Monetary Fund, Swaziland--Recent Economic Developments (Washington, D.C.: IMF, 1984), p.29.

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Table II-1. Gross Domestic Product by Sector of Origin at Constant 1980 Prices, 1978-83
(Millions of E)

Sector	1978	1979	1980	1981	1982[a]	1983[b]	% Share of GDP 1983	% Share of GDP 1978
Agriculture	81.7	78.6	88.2	98.8	94.2	95.3	24.0	23.1
Forestry	5.2	4.8	5.3	5.7	5.9	6.2	1.6	1.6
Mining	15.4	14.5	14.1	14.6	12.2	10.7	2.7	4.4
Manufacturing	69.8	71.6	79.6	88.4	92.6	94.0	23.7	19.7
Government Services	56.2	57.9	61.1	66.1	71.5	69.8	17.6	15.9
Distribution, hotels and restaurants	32.8	34.4	35.6	35.0	34.8	32.6	8.2	9.3
Transport and Communications	24.4	29.8	20.5	21.4	2.14	22.2	5.6	6.9
Construction	27.9	25.1	16.2	18.7	18.9	17.4	4.3	7.9
Other[c]	40.1	42.6	45.1	47.3	47.8	49.0	12.3	11.3
Total GDP	353.6	354.2	365.9	396.1	399.2	397.2	100.0	100.0
Real annual growth rate (%)		0.2	3.3	8.2	0.8	-0.5		

[a] Provisional
[b] Estimates
[c] Includes banking, insurance, real estate, water and electricity, less imputed back service charge.

Source: Swaziland, Prime Minister's Office, Department of Economic Planning and Statistics, Economic Review 1982-84, February, 1984.

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Forestry accounted for 1.6 percent of GDP at factor cost; its exports comprised 18 percent of the total in 1983. That percentage had increased steadily up to 1981 but declined since then as a result of the worldwide recession. Export prices for wood pulp showed some improvement in 1983 due to decreasing world supplies but the market for sawn timber and logs has not improved.

Manufacturing consists primarily of agro-and forestry-related processing industries, including sugar refining, saw and pulp milling and fruit canning. With an average annaul growth rate of 7.9 percent between 1977 and 1981, manufacturing has been an important source of growth. In 1982, however, the rate of growth slowed; the sector grew only 2 percent between 1982 and 1983. Declining agricultural production affected negatively industries such as cotton ginning and chemicals and fertilisers. Nonetheless, the sector was still 23.7 percent of GDP in 1983, a major rise from the 19.7 percent of 1978.

The contribution of the mining sector is now relatively small and declining, dropping from 4.4-2.7 percent of GDP over 1978-1983. Asbestos and coal are the principal minerals exploited but their production declined between 1977 and 1983. The closure of iron mines as of 1980 dropped the sector's export values by one-fifth. In 1983 however, the sector's contribution to the overall economy increased somewhat with a better export price.

Overall real GDP grew about 5 percent per annum between 1977 and 1982 which was relatively good for those years considering the effects of the worldwide recession and the fact that Swaziland's economy is heavily dependent upon exports. One of the factors that accounted for Swaziland's resilience was the depreciation of the Rand (and hence the Lilangeni) relative to the U.S. dollar between 1980 and 1982. This made Swaziland's exports more competitive and tended to moderate the increase in the current account (discussed below). Real economic growth has slowed in recent years however, becoming negative in 1983 (-0:5 percent). On a per capita basis, with population increasing at 3.4 percent per annum, that negative growth signifies a serious fall in per capita welfare.

Major factors responsible for the slowdown include poor crops resulting from the droughts of 1982 and 1983; depressed world sugar prices; and the standard effects of worldwide recession on export demand and public and private sector investment. Although firm statistics are not yet available, indicators for 1984 suggest that there was only slight growth in overall GDP. While improved rains resulted in marked improvement in agricultural production, manufacturing stagnated and retrenchments and closures were common.[1] An additional setback was caused in 1984 as a result of Cyclone Domoina which did considerable infrastructural damage and left hundreds homeless.

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1 Swaziland, Prime Minister's Office of Economic Planning and Statistics Economic Review, 1982-84. February 1985, p.4.

Gross domestic expenditure consistently exceeded GDP between 1978-82 causing the resource gap to rise in absolute terms, although as a ratio of GDP the gap declined during those years. Gross domestic consumption, both private and government, grew at an average annual rate of 14.4 percent (in market prices) and the domestic savings rate fell from 87 percent in 1977 to 23 percent in 1981. As a result, investment financing is increasingly dependent upon capital inflows. Gross fixed capital formation, which grew at 9 percent since 1978, started declining in 1980 as major public investment projects were completed and fewer new ones were started.

b. Public finance

The public sector consists of the Central Government, the town councils of Mbabane and Manzini, a number of non-financial public enterprises and several public financial institutions. The Central Government, which consists of ministries and departments, is financed by annual budgetary allocations. It plays a dominant role in Swaziland's public sector as it has the exclusive right to impose taxes and local government activities amount to less than one percent of Central Government activities. The Tibiyo Taka Ngwane Fund which is engaged in funding development projects derives revenues from earnings on investments and the Tisuka Fund, from mineral royalties. The national public institutions sector consists of both quasi-government enterprises (posts and telecommunications, and the water and sewerage board, for example) and autonomous enterprises such as the airline.

The main source of Central Government revenue is SACU receipts which provide 55-65 percent of total revenue. All important duties and excise taxes are paid into a common pool administered by South Africa on behalf of the three other member countries (Swaziland, Lesotho, Botswana). Revenues are distributed among members according to a formula in which the value of the country's imports features prominently. Other important sources of revenue in Swaziland are the income tax (25 percent of total revenue), the sugar levy and a sales tax first imposed in 1984 in an attempt to offset historical variability caused by the sugar levy and SACU receipts.

Between 1982 and 1984 Central Government revenues grew moderately, recurrent expenditures more rapidly and capital expenditures more slowly--see Table II-2. The average rate of revenue growth, at 5.6 percent per annum, was moderate compared to the average of 8.8 percent in the previous three year period. Contributing factors include the effects of recession and of lower commodity prices, as well as the declining growth rates of company and income taxes because of a downturn in new investments. Further, receipts from the sugar levy fell to zero in 1983 and 1984. Fortunately, SACU receipts have been a stabilizing factor as they have been growing at a steady rate of 5 percent per annum.

Recurrent expenditures had been growing at the rapid rate of 16.5 percent per annum between 1978/79 to 1981/1982 but slowed to 10 percent between 1982 and 1985 primarily as a result of austerity measures undertaken. Subsidies and transfers continue to be a drain on the recurrent budget, however, as they grew at the rate of 21 percent between 1982-1985. A large

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Table II-2 : Central Government Operations, 1978-85
(Millions of E)

Item	1978/79	1979/80	1980/81	1981/82	1982/83	1983/84	1984/85		Growth Rate (1978/79 -1981/82)	Growth Rate (1982/83 -1984/85)
Total Revenue and Grants	104.3	133.4	163.3	134.2	182.1	187.4	214.3	203.0[a]	8.8	5.6
- Customs Union Receipts	(54.1)	(74.2)	(86.9)	(62.7)	(117.6)	(120.7)	(130.4)	(130.4)	5.0	5.3
- Sugar Export Levy	(6.3)	(7.9)	(13.4)	(12.3)	(1.4)	(-)	(-)	(-)	24.9	-
- Company Tax	(12.7)	(17.8)	(15.7)	(18.0)	(18.4)	(17.6)	(20.7)	(20.7)	12.3	6.1
- Personal Income and Graded Tax	(10.8)	(12.2)	(17.1)	(20.1)	(20.2)	(22.8)	(25.3)	(24.7)	23.0	10.6
- Sales Tax	(-)	(-)	(-)	(-)	(-)	(-)	(10.0)	(5.0)	-	-
Total Recurrent Expenditure	59.2	65.3	84.5	109.1	124.0	136.2	165.5	156.8	22.6	12.5
- Personnel Costs	(32.8)	(34.9)	(45.9)	(95.2)	(66.6)	(75.0)	(84.8)	(81.4)	21.8	10.6
- Goods and Services[b]	(18.2)	(20.2)	(26.9)	(31.5)	(36.2)	(35.8)	(51.6)	(44.5)	20.1	10.9
- Subsidies and Transfers	(6.1)	(6.0)	(7.1)	(12.6)	(13.3)	(16.8)	(19.5)	(19.5)	27.4	21.1
- Public Debt Interest	(2.1)	(4.2)	(4.6)	(5.8)	(7.9)	(8.7)	(9.7)	(11.4)	40.3	20.1
Total Capital Expenditure and Net Lending	84.8	65.9	57.7	73.1	75.4	66.8	97.4[c]	79.8[c]	-4.8	2.9
- Capital Expenditure	53.7	44.7	45.3	61.9	57.7	53.9	74.8	58.7	4.9	0.9
- Net Lending	31.1	21.2	12.4	11.2	17.7	12.9	22.6	-28.9	9.2	
Total Expenditure and Net Lending	144.0	131.2	142.2	182.2	199.4	203.0	262.9	236.6	8.1	8.9
Overall Surplus/Deficit	-39.7	2.2	21.1	-48.0	-17.3	-15.6	-48.6	-33.6	-	-
External Financing (net)	46.0	9.1	6.2	6.3	0.8	4.9	15.6	7.1	-	-
Domestic Financing (net)	-6.3	-11.3	-27.3	-41.7	16.5	10.7	32.7	26.5	-	-

a Forecasts
b Budget Estimates
c Includes an estimated E5m drawdown on Piggs Peak Hotel loan.

Source: Economic Review, 1982-84.

proportion of these expenditures is enhanced deficit financing of public enterprises such as the national airline, the railways, the Royal Swazi Sugar Corporation and the postal and water and sewerage services.

Government capital expenditures at market prices grew slowly between 1983 and 1985 at an average rate of 0.9 percent per annum compared with an average annual rate of almost 5 percent in the 1979-82 period. The slowdown was due to the government's tighter financial position and the lack of funding of major new capital projects. As Table II-2 shows, deficits for the years 1982 and 1983 amounted to E17 million and E16 million respectively. The much larger increase to E34 million in 1984 was caused by expenditures incurred for hurricane rehabilitation and for payment of outstanding accounts. The deficits have been financed by the government's cash reserves and net foreign assets.

c. Prices, inflation, and wages

Price developments in Swaziland are heavily influenced by conditions in the Republic of South Africa because of the high dependence upon imports from there. Consumer price increases in Swaziland have averaged 12 percent per annum between 1979 and 1984 being influenced by trends in South Africa and by a vegetable import ban following an outbreak of cholera in 1980. The effects of the vegetable ban have largely worn away as alternate domestic vegetable supplies have become available, and although the inflation rate fell in 1983, it rose again in 1984.

Price controls exist on a few basic consumer goods such as bread, dairy products, meat, cement and fuel. Periodic adjustments in raw prices made to reflect increased costs of production or importation, however, mean that the prices basically reflect prevailing market conditions, with perhaps a short lag. Though there are no hard data to support the contention it would appear that prices of capital goods and construction materials may have risen more quickly than those of consumer goods.

There is no minimum wage in Swaziland, as such, but floor wages are set by a Wage Council for 12 industries. The rates set represent floor rates for new entrants to the labour market and wage rates for experienced workers are well above minimum levels. Workers in the wholesale and retail trades obtain the highest minimum wage, followed by those in manufacturing, building and construction, and, lastly in the sugar industry. Between 1979 and 1982, real wages increased substantially as minimum wage rates rose much faster than the rate of overall prices. Minimum wages in the wholesale and retail trades increased 75 percent in urban areas, in manufacturing and processing by 30 percent for fruit and vegetable canning workers; and in the sugar industry by 125 percent for some workers and 161 percent for others. Minimum wages for most workers remained unchanged in 1982 and 1983 except in manufacturing and processing, and in the sugar industry, those increasing by 14 percent and 7 percent respectively.

d. Trade, balance, of payments and external debt

Trade is vital to Swaziland's economy as exports provide foreign exchange earnings to finance imports of investment materials and consumer goods and foodstuffs that are not produced locally. The country has a relatively diversified export sector that includes importantly, sugar, which tends to account for above one-third of the country's export values (Table II-3). Sugar price fluctuations render Swaziland's foreign exchange earnings highly vulnerable to external factors. Forestry product exports follow closely, typically averaging 16-17 percent of the total. Other major exports include fertilizers, citrus, canned fruit juices and fruit, electronic equipment, and chrysotile asbestos.

Imports are documented at Table II-4. Machinery and transport equipment dominate merchandise imports (30-32 percent). At about half that share are manufactures (16.4 percent in 1983); minerals, fuels and lubricants (14.3 percent); and chemicals and chemical products (11.7 percent). The food and live animal group of imports represent 9.9 percent of the total of which cereals and cereal flours comprise almost 4 percent. Unmilled maize imports continued to climb in 1984 and 1985.

The trade account deficit increased steadily since 1978 reaching a peak negative value in 1983 as the value of exports declined for the first time in recent years (see Table II-5). Factors contributing to the trade deficit were rising capital and consumer goods imports and sharp increases in petroleum prices. Increases in food imports, which in 1983 amounted to some 10 percent of the total, have become a cause for policy concern. Deterioration in Swaziland's terms of trade by 25 percent between 1980 and 1982 have also played a role in the balance of payments deficits. The trade imbalance has been accompanied by deficits in the services account resulting primariy from profit remittances and investment income. The services account showed some improvement in 1983 because of a decline in outflows of dividend payments due to decreasing company profitability and increases in income from services and tourist receipts.

Until 1981 the current account deficit was financed by large inflows of private and public investment capital for financing new projects. Since then, however, the deficits have been financed by drawing down (and hence reducing) the level of foreign reserves. There were modest improvements in the foreign reserves position in 1983; in general, however, there has been a declining trend since 1977. This points to a need for restraint in public spending, diversification of exports and increased emphasis on export promotion and import substitution activities.[1]

In the four-year period 1979/80 to 1983/84 Swaziland's external public debt has grown at about a 16 percent rate per annum; in 1983 the debt stood at E211 million or about 34 percent of GDP. Although debt service obligations have not been a serious problem to date, there has been an upward trend in debt service requirements. Thus, the ratio of interest payments to government revenues increased from 3.1 percent in 1979/80 to 5.5 percent in 1983/84.

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1 Economic Review, p.14.

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Table II-3: Principal Merchandise Exports (f.o.b.), 1978-82
(Millions of E)

	1978	1979	1980	1981	1982	1983	Percent 1983
Sugar	59.6	71.0	128.4	125.8	105.2	122.8	36.2
Wood pulp	27.1	28.2	36.9	46.4	46.5	44.8	13.2
Wood products	8.6	10.8	13.1	15.9	11.4	11.4	3.4
Chemical fertilizers	6.8	10.0	23.7	36.6	55.2	42.7	12.6
Asbestos	18.2	17.6	15.6	17.8	16.5	19.5	5.8
Citrus	7.2	9.4	7.6	9.2	15.2	14.9	4.4
Canned fruits	8.2	9.2	9.4	12.7	18.0	22.5	6.6
Electronic equipment	3.2	4.7	8.2	11.6	14.5	5.0[b]	1.5
Other manufacturing	4.0	6.9	13.0	14.8	18.5	7.0[b]	2.1
Other domestic exports	27.7	28.8	23.3	27.4	28.6	33.1	9.8
Total domestic exports	170.6	196.6	279.2	318.2	329.5	323.7	95.5
Re-exports[a]	2.2	6.8	7.7	22.1	19.9	15.2	4.5
Total exports	172.8	203.4	286.9	340.3	349.4	338.9	100.0

[a] Includes transit trade.
[b] Mission estimates.

Source: The World Bank, Economic Memorandum on Swaziland, (Washington D.C.: The World Bank, 1984). Data for 1983 from Annual Statistical Bulletin, 1983. (Mbabane: Central Statistical Office).

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Table II-4 : Principal Merchandise Imports (c.i.f.), 1978-83
(Millions of E)

	1978	1979	1980	1981	1982	1983	Percent 1983
Total Imports	271	366	469	520	563	609	100.0
of which:							
Machinery & transport equipment	69	61	77	114	123	190	31.2
Chemicals & chemical products	24	43	50	43	86	71	11.7
Minerals, fuels, lubricants	26	48	78	74	83	87	14.3
Manufactures - classified by material	28	68	80	60	49	63	10.3
- misc	20	56	69	63	59	37	6.1
- Total	48	124	149	123	108	100	16.4
Food and live animals[a]	19	20	37	42	53	60	9.9
of which: Unmilled maize	1	1	1	1	4	7	3.8
Wheat flour/meal	-	-	5	4	3	7	
Other cereal meals & flours	-	-	5	6	7	6	
Cereal preperations	-	-	2	1	2	3	

[a] 1978 and 1979 - date for calendar year from Annual Statistical Bulletin for 1982, Table G5. Series not continued. Years 1980 - 1983 from Table G7 of 1983 Statistical Bulletin, and for years 1980/81 etc. Data similar but not identical.

Source: Annual Statistical Bulletins 1982 and 1983.

Table II-5: Balance of Payments, 1979-83
(Millions of E at Current Prices)

	1979	1980	1981	1982	1983
Exports (f.o.b.)	201.9	286.8	340.3	368.5	351.0
Imports (f.o.b.)	271.8	405.7	448.0	476.1	497.3
Trade Balance	-69.9	-118.9	-107.7	-107.6	-146.3
Services: credit	28.2	61.0	91.5	91.2	109.5
Services: debit	103.6	92.4	126.6	133.5	113.9
Goods and Services Balance	-145.3	-150.3	-142.8	-149.9	-150.7
Transfers	35.5	49.4	43.8	67.1	66.0
Current Account Balance	-109.8	-100.0	-99.0	-82.8	-84.7
Direct Investment	60.6	13.6	30.7	31.0	2.7
Long Term Capital to Government	17.5	15.8	10.5	20.7	41.0
Balance on Capital Account	-31.7	-71.5	-57.8	-31.1	-40.9
Other Short Term Capital	-12.9	14.1	-13.1	12.5	38.5
Net Errors and Omissions	34.4	77.5	46.6	13.0	20.4
Other	4.7	2.6	-2.4	1.1	4.6
Overall Balance	-5.5	22.7	-26.7	-4.5	22.6
Change in Reserves[a]	5.5	-22.7	26.7	4.5	-22.6

[a] Minus sign = increase in assets

Source: Economic Review, 1982-84.

Recent changes in debt structure have occurred as a result of increases in public sector borrowing and the less concessionary terms available from international organisations whose share of the debt increased from 26 percent in 1979/80 to 56 percent in 1983/84. Loans provided by international organisations are concessionary in terms of repayment periods but generally are extended only at commercial interest rates.

Population, growth and employment

Swaziland's 1985 population is about 625,900 and is estimated to be growing at an average annual rate of 3.4 percent. This is expected to accelerate to 3.6 percent in the early 1990's before stabilizing again at the current rate. The labour force, which is defined to consist of people in the 15-64 years age group, has been growing at the much faster rate of 7.4 percent. Although only two-thirds of that age group is regarded as comprising the active labour force, employment generation is clearly a major developmental challenge. The World Bank estimates that the number of new labour force entrants will double between 1980 and 2000.[1]

Currently, Swaziland's formal economic sector is able to provide employment for only 2,400 out of 7,000 primary school leavers every year; some 4,600 must look for employment either in the urban informal sector or in rural areas, or remain unemployed. Data limitations preclude an accurate assessment of the extent of unemployment and underemployment but employment in the formal sector has grown more slowly than labour force size. Between 1979 and 1982 employment in the formal sector grew at an average annual rate of only 3 percent. Simultaneously, the decline in alternate migrant opportunities in the Republic of South Africa and the marked slowdown in economic growth in both the modern and traditional sectors in Swaziland have had their impact on slower employment growth.

Future increases in employment potential are constrained by the continuing effects of recession in the private sector and budgetary tightness in the public sector. The capacity of traditional agriculture to support an expanding rural population is also very limited under present conditions which are described at greater length in Section B of this Chapter. The continuing South African recession and the preference to hire workers who are nationals implies reduced opportunities for alternative employment outside Swaziland. Consequently, new sources of growth are needed to absorb the expanding labour force. Improvement in traditional agriculture and the introduction of newer agricultural technologies are particularly necessary to provide productive employment to the growing rural labour force.

Future prospects

The current recession in Swaziland's modern export-oriented sector which has resulted from depressed demand and falling commodity prices is not expected to change rapidly. Expansion is particularly unlikely in sugar, wood pulp and fertilizer exports. Sugar production, for example, cannot be expanded

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1 The World Bank, Economic Memorandum on Swaziland (Washington, D.C.: The World Bank, 1984), p.12.

as current production is almost entirely sold under preferential quota agreements in international markets. The quotas are not likely to be raised and alternate markets do not exist currently to absorb any potential surplus production. There are some opportunities for the development of coal mining for thermal power generation, for irrigated agriculture, and for forestry development on SNL, but these possibilities cannot impact growth in the current and medium terms.

Thus, the Department of Economic Planning medium-term economic forecasts up to 1990 indicate slow economic growth--less than 1 percent per annum--with declining real per capita incomes and hence slow growth in real government revenues as well.[1] Earlier World Bank forecasts up to 1987 generally agree with these projections of slower economic growth although the actual numbers differ from those of Swaziland's Department of Economic Planning. Both sets of forecasts also predict slower growth in exports, some increases in imports and thus a growing trade deficit. Slower revenue growth is anticipated primarily because company and individual taxes are expected to grow slowly while the sugar levy is not expected to generate increased revenues.

Based on these rather gloomy forecasts, the Department of Economic Planning's strategy for future development is focused on the need for improved economic growth, for the expansion of employment opportunities, and the maintenance of current real income levels. The recommended strategies include:

- Improved efficiency in the management of public funds by the central government and parastatals;
- Encouragement of private sector investment;
- Employment creation through vocational training; and
- Development of further productive employment opportunities in the rural areas.

The latter is of particular relevance to this Komati River Basin feasibility study whose main aim is the development of irrigated agriculture. Development of improved smallholder agriculture and employment creation on a nucleus farm form an integral part of the project's basic design.

B. Agriculture in Swaziland

Swaziland's agricultural sector is important for several reasons, not the least of which is that over 80 percent of the population resides in the rural areas, 65 percent of people living on Swazi Nation Land (SNL) and close to 20 percent on Title Deed Land (TDL).[2] About one fourth of Swaziland's GDP

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1 Economic Review, p.39-45.

2 Swazi Nation Land comprises 56 percent of the total land area of Swaziland where traditional law defines solely usufruct rights over this land. On Title Deed Land individual ownership of land is recognized. Land tenure rights are more fully discussed in Section C.

in produced directly in agriculture and about 50 percent of manufacturing value added is contributed by agro-industries. In the formal sector, agriculture employed about one third of the 80,000 paid employees registered in June 1983. In the informal sector, agriculture is a major source of self-employment, whether for subsistence, production of market crops, or cattle raising. It is estimated that 190,000 paid and unpaid family workers are employed in traditional agriculture. Some hired labour is also used in the traditional sector.

1. Size and distribution of landholdings and current land use

As Table II-6 shows, just over 8 percent of the total land area in Swaziland is used for crop production and over 66 percent for grazing livestock. The SNL area is divided into Rural Development Areas (RDA) which accounts for 51 percent of the total area while the non-RDA comprises 30 percent. The rest is trust land held by the Tibiyo Taka Ngwane Fund, National Trust land and other Government controlled land. The Table indicates that farms occupy just under 90,000 ha on SNL whereas the rest (almost 90 percent) is communal grazing land. In 1982 it was estimated that there were about 57,000 homesteads on SNL each with an average plot size of 2.57 ha.

Virtually all of the TDL is in commercial farming or forestry. In 1982/83, there were 48,000 ha of TDL land under cultivation as compared with 73,000 ha on SNL. There were 320 ITF (Individual Tenure Farms) farms in use with 23 large farms that occupied 58 percent of the land area while farms of less than 500 ha accounted for more than one half of the remaining number.

2. The Rural Development Areas Programme

The Rural Development Areas Programme (RDAP) was firt instituted in 1970 with the aid of the United Kingdom Government. The Programme's main objectives were to increase crop and livestock production and to raise rural living standards. In its first phase (1970-76) the RDAP focused on four maximum-input RDAs established on seven percent of SNL. The RDAP provided improved extension and credit services, farm inputs, social infrastructure and technical assistance. During the second phase from 1977-84, the Programme was expanded to cover 51 percent of SNL with six maximum-input and eight minimum-input RDAs funded by a combination of bilateral and multilateral agencies and the Government of Swaziland. The minimum input RDAs received only strengthened extension and credit services.

The RDAP introduced hybrid high-yielding maize varieties with the idea that the land and labour savings resulting from increased staple food production would be applied to increased cash crop production. Results have, however, been contrary to expectation as maize yields have increased but total output has been declining simultaneously as less land is devoted to maize cultivation.

3. Crop production

a. Swazi National Land

Smallholder family farmers predominate on SNL producing mainly subsistence food crops, primarily maize. In addition, some dryland cash crops such as cotton, tobacco, groundnuts, beans and sweet potatoes are grown as well as small quantities of sugarcane and pineapples. Maize production has exhibited a declining trend since 1980/81 and most homesteads typically produce just enough for their own use. In recent yrears, drought conditions were primarily repsonsible for lower yields while reduced acreage can be attributed to low producer returns from maize when compared with alternative earnings potential in urban wage employment. Smallholder production of other food crops has also been constrained by factors such as high risk, high production costs and stagnant prices.

b. Title Deed Land

By contrast, production on TDL farms has been growing, having increased 11 percent between 1978/79 and 1982/83. TDL farms produce primarily cash crops for export. The main crops are sugarcane, citrus fruits, pineapples and cotton.

Much of the growth in this sector was led by sugarcane which is grown under irrigation on large commercial estates in the lowveld. Over 95 percent of the sugar is exported and rising export prices through 1982 resulted in steadily increasing area under sugarcane between 1978/79 and 1981/82. However, since 1983, declining prices and the effects of the drought have negatively effected output, yields and financial returns from sugar production. Moreover, further expansion in sugarcane is restricted by international sugar quotas and additional output cannot be sold in a slutted open market. Therefore, the government's policy is to diversify crop production and reduce excessive reliance on a single crop such as sugar. New projects such as the Komati Basin irrigation project can be designed to assist with that diversification.

The second most important commercially produced crop is citrus. Three-fourths of the citrus produced is exported under the aegis of the Swaziland Citrus Board, and the rest is processed at a local canning factory. Although the drought caused setbacks in citrus production, increases in unit value since 1982/83 have been beneficial.

Cotton is a cash crop grown by both commercial and SNL farmers. It is produced primarily for domestic consumption. Production peaked at almost 11,000 MT in 1980/81 as a result of favourable prices and the Swaziland Cotton Cooperatives' promotional efforts to encourage farmers to grow more cotton. Since then, however, production has declined sharply, with only 3,800 MT produced in 1982/83. Factors responsible for the decline were the drought, falling prices and reduced credit for smallholders.

Table II-6: Land Use in Swaziland 1982/83

Land Use Category	SNL (000s ha)	% of Total	ITF[a] (000s ha)[b]	% of Total	All of Swaziland[c] (000s ha)	%
Cropland						
Crops	73.0	7.6	48.1	6.3	121.1	7.0
Fallow	15.4	1.6	4.2	0.6	19.6	1.2
Subtotal	88.4	9.2	52.3	6.9	140.7	8.2
Grazing Land[d]						
National	864.3	89.6	184.8	24.3	1049.1	60.8
Improved	-		98.3	12.9	98.3	5.7
Subtotal	864.3	89.6	283.0	37.2	1147.4	66.5
Commercial Forests			101.0	13.3	101.0	5.9
Other Farm Land[e]	12.4	1.3	74.8	9.8	87.2	5.1
All other Land[f]			249.0[g]	32.8	249.0	14.4
Total Land	965.1	100.0	760.0	100.0	1725.1	100.0

[a] ITF = Individual Tenure Farms held on TDL
[b] Including Sihoya Swazi Nation Land Sugar Project
[c] Excludes urban areas of approximately 11,360 hectares
[d] Includes all unallocated communial grazing land and mountains and hills on Swazi Nation Land
[e] Includes areas of farms, buildings, services and unused land
[f] Land unused or used only for traditional Swazi agriculture
[g] Includes Purchase-Land for RDAs and other SNL resettlment schemes

Source: Annual Statistical Bulletin, 1983.

4. Livestock production

Livestock accounts for about 40 percent of total agricultural production, 12 percent of GDP and 4 percent of exports. The principal livestock holding is of cattle which is raised on both SNL and TDL. The current cattle population is estimated at 636,000 head and is growing at an annual average rate of about 1.9 percent. About 80 percent of Swaziland's cattle are raised on SNL communal grazing land and the rest on TDL ranches. Large stock holdings and low productivity are characteristic of SNL livestock raising patterns. Cattle offtake on SNL is very low of the order of 6 percent per annum because cattle are regarded as a store of wealth.[1] Offtake is much higher (14 percent) on TDL. Total offtake peaked at 42,000 head in 1979 but declined since then to 25,000 head in 1982 because of drought conditions and low prices. Although production has recovered somewhat since 1982, Swaziland is generally unable to fulfill its beef export quota of 3,300 MT to the EEC.

Other livestock holdings include goats which number about 300,000, almost all being held on SNL. The number of poultry has risen from 300,000 to over 700,000 over the last twenty years. Sheep and pigs are also raised.

There is also a small dairying industry, and the Government's stated objective is to encourage self-sufficiency in dairy production. As a result of improvements in the dairy industry, milk consumption rose from 4.4 million litres in 1978 to 7.2 million litres in 1982 while imports of fresh milk dropped from 2.7 million litres in 1978 to none in 1982.[2]

5. Trade in agricultural commodities

Agricultural commodities grown primarily on TDL are important earners of foreign exchange--sugar alone accounts for 40 percent of total export earnings while other agricultural products constitute a further 40 percent. The value of agricultural commodity exports, as well as the proportion of export earnings contributed by agricultural commodities, have both increased since independence. In addition to sugar, the other main groups of agricultural exports are citrus fruits and canned fruits. Meat and meat products represent less than 5 percent of total exports and their share is declining.

Swaziland's agricultural imports have also been growing and in 1981/82 the value of imports exceeded E500 million or almost three times the value (in nominal terms) of the value imported in 1977. Average food imports for 1981 and 1982 were double the annual average for 1977-79. Estimates for 1983 place growth of food imports at 24 percent over 1982 but this may be temporary and caused by the drought which affected all of Southern Africa. Maize imports have been rising despite the effort to raise domestic production and totalled

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1 The social/institutional dimensions of livestock holding are discussed at greater length in Section C of this Chapter.

2 It should be clarified that 60 percent of the milk consumed in 1982 represented reconstituted milk powder from the EEC and the World Food Program.

45,000 MT, 32,000 MT and 51,000 MT in 1978, 1980 and 1981, respectively, against a total requirement of 120,000 - 140,000 MT annually. Net imports of vegetables (prior to a recent import ban on vegetables from RSA) were about 5,000 MT per annum as compared with an estimated domestic requirement of 19,000 MT. It is not surprising, therefore, that the Government regards the achievement of self-sufficiency in maize as a priority objective of national policy.

6. Employment objectives and agriculture

An important governmental policy objective in agriculture pertains to national employment goals. As stated above, traditional agriculture, with 190,000 self-employed workers, is a major source of employment with paid employment in modern agriculture, the public sector, trade, manufacturing and construction accounting for just 74,000 workers. With a rapidly growing population, 48 percent of which is below 15 years of age, the size of the labour force is expected to grow rapidly until the end of the century. Meanwhile, off-farm employment opportunities have slowed, particularly in the RSA mines which are the third largest employer of Swazi labour. Under these circumstances, an important national policy objective is to retain labour in the rural areas. In order to provide employment for the additional labour improvements in traditional agriculture are necessary.

The Komati Basin Irrigation Project can assist in the attempts to achieve the important national policy objective of improving traditional agriculture in order to provide expanded employment opportunities and self-sufficiency in maize production.

C. Social and Institutional Factors

1. Land tenure issues

a. The land tenure system

Land tenure rights in Swaziland are determined by two systems--the traditional system that governs rights on Swazi National Land (SNL); and a system of freehold or concession leases granted for individual tenure farmland holdings. Under the former the Monarch holds the land in trust for the people. Individual homesteads are allocated land for agricultural production by the Chiefs under authority delegated to them by the King. Further subdivision of land allocation authority gives responsibility to Indunas who are responsible for smaller areas under the Chiefs.

The Chief allocates residential sites and arable land to each household head who gives allegiance to him. Household heads in turn are responsible for land allocations to members of their families and land also may be inherited. In addition, homestead heads are granted communal grazing rights for their livestock. Solely usufruct rights are granted to farmers on SNL. This means that the farmer has no absolute claims to the land and may not sell or otherwise dispote of it. Once a person has been granted land he enjoys a measure of security of tenure although the Chief can always reallocate the land. Eviction of households is also possible but is quite rare.

Title Deed Land (TDL), by contrast, confers on title deed holders statutory rights over land. Deed holders are essentially owners of the land and are free to administer it as they wish and to sell or morgage it. Most commercial agricultural production occurs on TDL. Mineral rights do not accompany surface rights except where the concession was originally granted as a mineral concession. Similarly, water rights do not accompany the concessions but have to be applied for separately to a Water Apportionment Board. A project authority on the Komati, using SNL land, would be required to do this.

The title deed system originated in the early part of this century when the traditional authorities granted land concessions for foreign interests. Eventually about two-thirds of the land in the country was transferred to foreign concessions and private land owners. Through a process of repurchases, however, some of this land has been bought back. SNL now comprises, therefore, over 56 percent of Swaziland's total land area.

b. Land tenure and irrigation project development

The project area in the Komati basin is located entirely on SNL where previous studies have shown that difficulties are likely to arise with regard to irrigation development because of the prevailing system of land tenure. Magagula, for example, has pointed out that although the traditional land tenure system represents a serious constraint to the full development of agriculture on SNL, the issue is not generally examined carefully because of its highly political and emotional nature.[1]

Yet there are specific problems arising out of the land tenure system. These include the inability to use land as collateral for institutional credit and the insecurity of land tenure which may act as a disincentive to farmers. The more serious problems are those associated with the conflict of authority between traditional authorities and irrigation management over resource use and management and leasehold rights.

Heilbronn points out that traditional rights over SNL confer both economic and political power on traditional authorities.[2] Thus, economically, the Chiefs may use land for direct investment and demand tribute labour while, politically, the power to allocate land creates a system of allegiance and dependence which ensures a relatively stable social system. On the other hand, the system may stifle initiative as progressive successful farmers are likely to provoke criticism from their neighbours who are not so successful. Traditional authorities tend to view these developments as foreshadowing the emergence of inequality as wealtheir farmers monopolise a communal resource. But they also respresent a challenge to traditional authority as they affect the Chief's ability to reallocate land. Further, granting of leasehold rights to irrigators, by excluding the majority, is likely to create pressure on the traditional socio-political system in the long run, especially if it was successful.

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1 Glenn T. Magagula, "Land Tenure and Agricultural Production in Swaziland" (University College of Swaziland, Mimeo, 1982).

2 S.G. Heilbronn, "Swazi Nation Land Irrigation Development" Mimeo.

Tate and Lyle also accept the position that a large infrastructural development project such as an irrigation scheme is likely to strain the traditional land tenure system and therefore some modification of it would be necessary for the successful establishment of an irrigation project. This is to some degree borne out by the conflicts arising over leasehold agreements at Vuvulane Irrigated Farms, although it should be noted that there are some differences, as the project is on ITL land and not on SNL. Still, conflicts have arisen with traditional authorities as the written leases held by settlers grant greater rights than are customarily allowed.

Given the critical and fundamental nature of this issue, in relation to the Komati Basin project it would be necessary to examine very carefully the experience of other irrigation projects in order to identify the specific problems likely to arise and to assess their potential impact upon project implementation and, finally, to recommend workable solutions. This is recommended as an important area of investigation during the design stage of the Komati Basin project (see Volume I Annex 3).

2. Livestock issues

Aside from its importance in agriculture, cattle ownership is an integral part of Swaziland's social life. Thus, while cattle are economically important as a source of meat, milk and manure and provide drought power for ploughing and transportation, their traditional value lies in their function as a store of wealth. Neither is cattle ownership simply a matter of prestige but it involves an intricate web of economic, social and cultural factors that include marriage customs. It is, therefore, important to understand the role of livestock in Swazi society and to apply this knowledge in the design of any project concerned with bringing about changes in farming patterns and practises on SNL.

Livestock ownership patterns are very complex and the right to dispose of all cattle in a herd is seldom vested solely in the head of a homestead. The relationship between herd size and ownership is further complicated by the sisa system, under which cattle are looked after by a friend or relative, in return for the right to the milk and the use of the cattle for draught power.

Cattle on SNL is held in small herds with an average size of 17 head per homestead. The herds are grazed on communal lands on the basis of grazing rights accorded by the chiefs. The communal grazing system has been blamed for contributing to the problem of overgrazing in Swaziland. A significant factor is a high overall stocking rate of 34 head/km^2 or 1.9 ha/livestock unit, which is the highest in Africa. The problem is compounded by the existence of a large goat population with a stocking density of 15/km^2. The result is serious overstocking which has already caused overgrazing and soil erosion in certain areas.

A general awareness of the problem exists in the country, and a series of measures have been implemented to induce Swazi herd owners to destock; for instance, the introduction of sisa and fattening ranches by the Government. However, offtake levels are still low. Neither has the RDAP policy of resettling people and allocating certain parts of SNL for grazing purposes

helped. Part of the problem was that the policy was not reinforced with support policies to limit herd size or to establish payment for grazing rights.

Given the social reality of the importance of catle ownership, it cannot be assumed that the resettlement required by the Komati Basin Irrigation Project will cause residents to sisa their livestock to neighbours or relatives or sent them to sisa or fattening ranches. Few rural homesteads will sisa all their livestock, particularly if they continue to live on SNL. Therefore, alternate means must be sought to accomodate the problem and to minimize this social cost of resettlement.

In this regard, it is helpful to note that the people in the Komati Basin project area have become accustomed to grazing their livestock in allocated and fenced grazing areas as a result of the RDAP's efforts. The RDAP provides fencing material and the community is expected to contribute money and labour. The people are satisfied with the new system as it renders herding unnecessary. The young boys who generally function as herders are freed to go to school and this is preferred.

III. THE PROJECT AREA

This section describes the physical and socioeconomic characteristics of the Komati Basin Irrigation Project area. Section A provides information on project area location and topography, geology, climate, soils and hydrology. Section B focuses on the demography and features of the rural homestead--income and living conditions. While adequate data were available on the physical characteristics of the region, incomes, employment and other economic data specific to the area were limited. Therefore, discussion of some of the socioeconomic issues was based on nationwide aggregates for which there was more complete information. Site specific demographic data were obtained from the 1984 Agricultural Census and the existing sociological information was supplemented by on-site interviews with a half-dozen families.

A. Physical Characteristics

1. Location of the project area

The project area is in the North East of the Hhohho District, in the lowveld ecological zone. It encompasses roughly the Eastern part of the Mayiwane Herefords RDA, and all of the Madlangampisi RDA. The area of particular interest is the Northern bank of the Komati River with the Tunzini Citrus fruit estate and the Tjaneni Sugar estate to the East. Geographically, the project area lies approximately between the 31'30' and 31'45' longitude east and the 25'54' and 25'05' latitude south. Administratively, the area falls under the Mayiwane Sub-region of the Hhohho Region. It is also wholly located within the Mayiwane Sub-area of the KaHhohho Rural Development Area as proposed for Phase III of the RDA programme. Locally, the project area is known as Mpofu in the western sector and Mhlangatane in the east.

For economic analysis purposes, the selected project area was confined to the more productive alluvial soils along the northern bank of the Komati River and lying between the confluence of the Komati and its tributary, the Mzimnene River, and the RSA border. The 335 meter (1,100 foot) contour was taken as representing the upper reaches of the alluvial deposits and thus forms the northern and western boundaries with the RSA and on the south, the border is the Komati channel. Within the boundaries of this area are approximately 8,000 ha of arable land.

2. Topography

Swaziland's Komati River Basin contains three different topographic regions, the Highveld, Middleveld and Lowveld, distinguishable by elevation and relief.[1] The Highveld usually is considered to be the area with land surface gradients greater than 18 percent with elevations 900 m above mean sea level (MSL) including all of the highest mountains in Swaziland.

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1 G. Murdoch, Soils and Land Capability in Swaziland (Mbabane: Ministry of Agriculture, 1970).

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Swaziland's high point (1,862 metres) is within the Komati River Basin, in the mountainous area along the western border near where the Komati River enters Swaziland from the RSA. At this point, the river's elevation is about 700 m.

The Middleveld generally has a mean elevation of about 600m and a median land surface gradient of about 12 percent. The site of the proposed Maguga Dam in the Middleveld.

The Lowveld includes all area with a mean elevation below 400 m MSL. The Lowveld land surface is gently undulating with a mean gradient of about 3 percent. Isolated Lowveld hills rise above 400 m. The Komati River elevation where it departs Swaziland is about 261 metres. The area to be irrigated as part of the proposed development is located in the Lowveld. The Komati River catchment area in Swaziland is about 1,940 km^2 ; the area upstream of Swaziland is about 7,400 km^2 . The highest point in the basin is near Belfast, RSA, where the elevation is about 1,937 metres.

The lowveld region of the Komati Basin is characterized by flat to undulating topography. It has the most gentle relief of Swaziland's four regions with three percent median gradient. Even in the region, however, the land tends to be undulating rather than flat.

3. Climate and rainfall

The climate of the Komati Basin is relatively mild, but seasonally variable and strongly influenced by topography. Most of the precipitation occurs during the warm summer months of November to January, when regional weather patterns are dominated by the southern trade winds from the Indian Ocean. Swaziland's border mountains are effective orographic wind barriers, causing nearly all annual precipitation. Convective storms also occur, accompanied by severe lightning.

A high pressure ridge typically dominates winter weather patterns during the months of May to July. Winter days are dry and clear, with large diurnal temperature changes. Snow occurs but rarely in the highest parts of the basin only, and frost occurs only rarely in the lowest parts of the basin. Polar air masses sometimes mix with warm tropical air during spring and autumn, causing occassional precipitation during these normally dry seasons.

Average annual rainfall in the Komati Basin in the vicinity of the proposed development ranges from about 700 mm near Mhlume and Tshaneni (elevation 300 m) to about 1,230 mm in the highveld near Piggs Peak (elevation 1,000 m).[1] Monthly rainfall distribution is shown in Table II-7. The weather stations at Mhlume and Tshaneni are near the area proposed for irrigation under this project. Data from these stations are therefore directly relevant.

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1 T. Yates, Water Resources for Mhlume Water, Consultant Report (London: Binnie & Partners, 1984).

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Table II-7: Summary of Climate from Stations in the Komati Basin, Swaziland

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP:	ANNUAL
PRECIPITATION (monthly averages in mm)													
Piggs Peak	101	159	178	209	207	161	73	32	17	17	23	51:	1228
% of annual total	8	13	14	17	17	13	6	3	1	1	2	4:	100
Homestead[a]	51	92	94	118	110	83	39	20	11	13	10	29:	670
% of annual total	8	14	14	18	16	12	6	3	2	2	1	4:	100
Mananga[a]	64	98	115	131	122	71	47	24	11	12	10	32:	735
% of annual total	9	13	16	18	17	10	6	3	1	2	1	4:	100
Vuvulane[a]	71	101	117	130	118	82	63	31	13	13	16	40:	799
% of annual total	9	13	15	16	15	10	8	4	2	2	2	5:	100
Average of Homestead, Mananga and Vuvulane	62	97	108	127	117	78	49	25	13	13	12	33:	735
% of annual total	8	13	15	17	16	11	7	3	2	2	2	4:	100
TEMPERATURE (°C)													
Piggs Peak max	24	24	25	26	25	24	23	21	20	20	21	23:	23
min	12	13	15	15	15	15	12	9	6	6	8	10:	11
mean	18	19	20	21	20	20	18	15	13	13	15	17:	
								MEAN ANNUAL TEMPERATURE					17
Mananga max	27	29	30	31	30	29	28	26	24	25	26	28:	28
min	17	18	20	21	21	19	17	13	10	10	13	15:	16
mean	22	24	25	26	26	24	23	20	17	18	20	22:	
								MEAN ANNUAL TEMPERATURE					22
EVAPORATION (average monthly pan evaporation in mm)													
Mananga[a] (Class A pan)	199	214	230	218	187	185	143	134	120	141	177	206:	2154
% of annual total	9	10	11	10	9	9	7	6	6	7	8	10:	

[a] T. Yates, Water Resources for Mhlume Water, Consultant Report (London: Binnie and Partners, 1984).

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Table II-7: Summary of Climate from Stations in the Komati Basin, Swaziland (continued)

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP:	ANNUAL
Estimated lowveld[b]													
(Class A pan)	216	176	178	200	202	203	134	123	94	111	137	176:	1949
(Symons pan)	160	140	145	155	160	155	105	95	75	85	105	135:	1515
% of annual total	11	1	10	10	11	10	7	6	5	6	7	9:	
Estimated highveld[b]													
(Class A pan)	189	170	166	181	170	177	122	110	94	111	130	163:	1781
(Symons pan)	140	135	135	140	135	135	95	85	75	85	100	125:	1435
% of annual total	10	9	9	10	9	9	7	6	5	6	7	9:	

[b] Data estimated from: W.V. Pitman, B.J. Middleton & D.C. Midgley, Surface Water Resources of South Africa. Hydrological Research Unit Report, University Witwatersrand, Johhanesburg, september 1981, Figure 3.66 and A155-A166.

Source: Water Resources Branch, Ministry of Natural Resources, Land Use and Energy (MNRLUE)

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Basin average annual temperatures range from 22 degrees C near Tshaneni to 17°C at Piggs Peak. The lowest and highest temperatures reported at Tshaneni are 3.0°C and 42.6°C. June typically is the coldest month. Minimum and maximum temperatures reported at Piggs Peak are -0.8°C and 35.5°C. Monthly temperatures distributions are also shown on Table II-7.

Average annual Class A pan evaporation in the Basin ranges from about 2,120 mm at Mhlume and 1,950 mm at Tshaneni to 1,780 mm at Piggs Peak. Monthly evaporation rates are also shown on Table II-7.

There are no wind condition recording stations in the Basin.

4. Geology

The Komati River Basin is underlain primarily by three distinctly different types of rocks. From west to east (highveld to lowveld), these rocks can be grouped as the metamorphic rocks of the Swaziland Super Group, the Lochiel Granite, and the interbedded sediments and volcanic rocks of the Karroo Super Group. The first group has no direct relevance to this project. Most of the Komati Basin in Swaziland, including the Maguga Dam site and all of the area proposed for irrigation by this project, is underlain by the Lochiel Granite. It is believed to be at least two km thick. Generally not mineralized, this granite has some late phase pegmatites which contain tin-bearing minerals which are mined in small quantities. Though Swaziland's groundwater resources have not been explored properly, the rocks in the Komati River Basin project area could supply adequate amounts of water to wells for household and livestock use. These rock structures are not porous and well yields are barely two ℓ/sec.

The study area predominantly consists of three lithological types. Lochiel granite which is less acid constitutes a greater part of the area in question, followed by gabro and dolerite which form dyke swarms and thick sills.

The lochiel granite is characterized as being coarse to fine-grained; multiple hood-like batholith fed from below by dykes and sheets, feldspar megacrysts developed at edges of greenstone belt, in tin-belt and in gneisses below batholith; marginally foliated varieties cut by late stocks; pegmatite with cassiterite, columbotantalite etc. This is estimated to be at least 2 km thick.

The material of the terraces is alluvium and the upper terraces consists predominantly of late Quaternary alluvium that has undergone intensive pedogenic processes. The lower terraces also consists of late Quaternary alluvium with a predominance of quartz, micas and other minerals. These river terraces were superimposed over the major lithological types.

5. Soils and land classification

a. Soils

The project site comprises a variety of soils. These range from juvenile soils on river terraces (entisols) to well developed soils of the old landscape. The old landscape consists of Fersiallitic soils, Lithosols, Solonetz-like soils, Soil lessives or Two-deck soils and Lithomorphic Vertisols. Generally, these soils form from alluvium, gabro, dolerite and lochiel granite parent materials.

In this project context, project site soils are classified in nine "Sets" found in the area describing their major attributes. A brief description of these "Sets" follows:

- B-Set: These soils are deep, pale yellowish brown to brown in colour, light or occasionally medium in texture and low in humus content. Horizon differentiation is apparent due to the depositional history rather than the pedological development. In terms of structure, these soils have very weak or single grain structures. When dry, they are friable to loose and are high in weatherable minerals such as muscovite. The base exchange capacity is moderate. The available water holding capacity of some of the constituent soil series of this "Set" is too low for irrigated annual crops, but is considered to be satisfactory for fruit-tree crops. Where irrigation water is available, however, annual crops can be produced provided appropriate irrigation techniques are introduced and implemented. Paddy rice is not recommended on those soils. Flooding, in rare cases, can be a problem;

- W-Set: The soils represent an intergrade between Alluvium and Fersialitic Sandy parent material. They are primarily upper terrace late of Quaternary alluvium. They are more than 200 cm deep, brown to yellowish red and fine sandy loam to sandy clay loam. They possess moderate to weak structures with slightly hard dry consistencies. Although fairly high in weatherable minerals, these soils tend to be low in humus content. They have good drainage and infiltration capacity and are not prone to flooding. The slope ranges between 0-5 percent. They also have good available water holding capacity;

- L-Set (Fersialitic Soil): The soils are deep, red in colour and sandy clay loam in texture with moderate structure. They have a fairly hard, dry consistency. They are excellent in drainage, fertility status and infiltration rates. They also have satisfactory available moisture holding capacity for most irrigated crops. They have slopes ranging between 0-2 percent;

- Cl-Set: The soils represent an intergrade between brown calcareous soil and vertisols derived from basic rocks. They are clay soils with dark brown colour and 35-100 cm deep. They have strong blocky structures and hard, dry consistencies. Rich in weatherable

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minerals, they may have free lime deposits in the profiles. Slightly imperfectly drained but the available water holding capacity and fertility are high;

- H-Set: Commonly known as duplex soils, the soils comprise two distinct profiles with a 15-60 cm deep loamy sand to sandy loam light coloured top layer overlaying a mottled grey, yellowish or brown sandy clay. The change from the top to the bottom layer is somewhat abrupt. The clay layer has strong blocky to medium prismatic structures and a dry hard consistency. The clay pan contains small amounts of free lime. The presence of a sandy clay layer in the soil profile limits the sub-surface permeability and drainage. This problem, however, is not considered serious. Undulating topography creates surface ponding of water and a salinity hazard;

- K-Set (Lithomorphic Vertisol): The soils are characterized by black or very dark grey, cracking blocky clay often with a surface of granular structure and calcareous sub-soil. Soil depth ranges between 35 and 125 cm. Very poor drainage is characterisic of these soils and there is an added danger of salinity. Some soil series belonging to this set are already known to have high sodium contents, often exceeding 30 percent of the total exchangeable cations. Slopes vary between 0-6 percent;

- Z1-Set: This is a marked duplex soil with a light grey loamy sand to sandy clay loam top layer with an abrupt transition to an underlying dark greyish brown calcareous sandy clay with strong prismatic structure and hard dry consistency. Finally, the horizon merges into an olive brown highly calcareous friable silty clay. Although soils belonging to this set have high fertility and satisfactory available water holding capacity they are hard to work mechanically when wet as it has a tendency to swell resulting in the closure of the cracks. Both infiltration and surface drainage are poor. Salinity is another problem. Slopes range from 0-2 percent;

- O-Set (Lithosol): These are light coloured and light textured soils with depths less than 40 cm. Textures vary from coarse sand to fine sandy loam. They are handicapped by their shallowness and their light texture renders them unsuitable for irrigated crop production. Slopes range from 2 - 5 percent; and

- S1-Set (Lithosol on basic rocks): These are shallow soils less than 35 cm deep to the weathering rocks. They are dark red to brown or black clay loam, often stoney or gravelly with moderate fine to medium sabangular blocky structures and slightly hard dry consistency. One good point, however, is that the weathering rock is often soft and can thus be penetrated by roots. In spite of the presence of the underlying soft weathering rock, these soils have restricted rooting soil volume and available water holding capacity. Slopes vary from 1 - 3 percent.

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b. Land classification of the project area

Initially three contiguous sites, each measuring approximately 1,000 ha have been suggested for the development of the irrigation project. Based upon the data available on the morphological characteristics of the different soils found in these sites, it was noticed that about 44 percent of the area would present serious problems when brought under cultivation. If used for intensive agricultural production, they might need sub-surface drainage and other corrective measures in conjunction with specialised crop production techniques.

There are, however, additional good agricultural soils adjacent to the three proposed sites. It is recommended that a detailed study be conducted to determine the feasibility of substituting the area containing the problem soils by the adjacent land area containing the good quality soils. This would alleviate the nascent problems of salinity, lower rooting soil volumes and restricted sub-surface drainage. Such selection would need to keep in mind the problem of pumping lifts. It is also likely that many settlers will have cattle and will thus need grazing land. Marginal land or land unsuitable for irrigated crop production in the vicinity of the irrigation project should be used for growing pasture and fodder crops. The management and administration of the pastures will, of course, need very careful attention to maintain their productivity and also to avoid pasture overgrazing and degradation. Such a step would provide good quality cattle feed and result in improved settler incomes. It will also control soil and water erosion resulting in the reduction and/or elimination of land degradation.

6. Vegetation and range

Swaziland's vegetation has been divided into eleven distinct veld types, two of which occur within the project area. As a general rule, the boundaries will coincide closely with the divisions between the country's four main physiographic regions. Grass species in Swaziland may be described as being either "sweet" or "sour" and a direct relationship exists between elevation, rainfall and soil pH in determining the degree of sweetness or sourness a grass cover may be in a particular location.

In the highlands, rainfall is heavier and the soils are more acid; it is referred to as the "Sour Veld". Grass species become unpalatable and low in nutritive value during the autumn and winter and provide, on the average, only between five to six months of good grazing. On "Sweet Veld" in the lowlands, the palatability and nutritive value of the grasses remain moderately high throughout the year.

The Lower Komati Basin, in which the project area is located, lies within the Lowveld. However, moving from east to west, there is a gradual rise in elevation, an increase in annual rainfall, and a noticeable rise in soil acidity. These factors have a recognizable effect upon the vegetation and the value of the range.

months of October through March, irrigators may divert their September apportionment times by specified monthly factors when flows are greater than 390 cusecs. Flows greater than 470 cusecs may be apportioned at the discretion of the Water Apportionment Board.

From Legal Notice 51, the apportionment to Swazi Areas 763 and 790 in Zones 34 and 35 are given as 0.826 percent (about 3.0 cusecs) and 0.61 percent (about 2.2 cusecs) respectively. The sum of these, less a portion for existing development, is about 3.5 cusecs or about one percent of the normal September flow at SIS. This 3.5 cusecs is the basis for calculating the water availability for the proposed pre-dam development, but it would have to be approved by the Water Apportionment Board.

It appears, however, that the normal September flow in Notice 51 (362 cusecs) probably is the mean annual runoff (MAR) and not the normal September flow. Swaziland's portion of the MAR at the SIS weir is about 372 cusecs, calculated from Pitman, Middleton and Midgley[1]. The apportionments seem to have been based on the demand for water at the time of control and are expressed as a percentage of the MAR.

Using synthesized naturalized runoffs at the SIS weir from Yates the normal September flow is apportioned to SNL (0.826 percent plus 0.61 percent) is 2.34 cusecs.[2] Approximately one-third of the apportionment has been committed to existing development. The unused apportionment to SNL which may be available for the proposed development, if a proper application to the Water Apportionment Board is made, is about 1.57 cusecs.

Table II-8 shows the amount of land which could be irrigated by the apportionment to SNL in a typical year, when flows are greater than normal September flows. It also shows the normal September flows calculated from the naturalized flows, and an estimate of the amount of land which might be irrigated with that flow. Four years out of five, a minimum of 162 ha can be cultivated. More realistically, a nursery could be started, and fruit tree planting cut, plus 250-330 ha of field crops in the April-July period.

c. Present water use in the project area

The 1972 apportionment of Komati River water for irrigation is shown in detail at Legal Notice 51, 1981.

The main crops grown in these irrigation projects are sugarcane and citrus for export. Other crops grown on a smaller scale, mainly by smallholders are cotton, green maize and vegetables. It would appear that at time of no water shortages, small farmers seem to be happy with their present allocations. Observation would suggest there is some water unuse in the form of waste since water availability to the farmers is no constraint.

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1 Pitman, Middleton and Midgley, Surface Water Resources.

2 Yates, Water Resources

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The natural vegetation of the eastern portion of the project area, which is the lowest in elevation and the driest, is described as being "Sweet Veld Acacia Savanna". This is a tree and shrub savanna varying from open parkland to dense bush. The grasses are sweet and, consequently, this is good cattle ranching country. Overgrazing rapidly damages the native cover, however, and causes bush encroachment and should be guarded against.

Common grasses in the eastern section are mostly perennials. Much of the natural ecology has been replaced by thorn bushes and wattle due to overgrazing, annual burning and land clearing for homesteads and farming.

In the extreme western section of the project area (around Mphofu), a "Broadleaved Tree Savanna" has evolved and the veld is slightly sour. It is a more open savanna and is composed primirily of scattered broadleaved trees with tall perennial grasses.

In general, on lands that have not been cleared for cultivation and have not been overgrazed, most of the natural vegetation throughout the project area remains. Bush encroachment is a widespread threat nonetheless. In terms of range resources, the pasture condition can be classed as being fair to poor in most localities. In its present condition, the estimated carrying capacity of the range varies from five to six hectares per large stock unit. When in good condition, the recommended grazing capacity for this ecological zone drops to four hectares per animal unit.

7. Hydrology and water use

a. Pre-Maguga dam development

The use of Komati River Water, as with other water in the country, is governed by the Water Act, 1967 (Act No. 25 of 1967). Komati water has been apportioned to various smaller users on private estates, two large estate users (SIS/CDC, and Mhlume Co.), and the Swazi nation for use on Swazi Nation Land. As indicated below, however, where the phasing of new project development is discussed, it is anticipated that a pre-dam phase could see the use of run-of-river water to at least begin production on the project site prior to having Maguga Reservoir water available. The pre-dam development phase is envisioned to minimize the lead-time required to begin generating project revenue. It involves acquiring an adequate water supply to begin planting revenue-producing tree crops such as fruit or citrus trees, and selected annual crops such as maize, cotton and vegetables.

b. Legal water apportionments

The size of the pre-dam phase is limited by the avaiable water supply. Water in the Komati Basin in Swaziland is known to be over-appropriated. Therefore, an assessment of water availability to Swazi Nation Land (SNL) was made. First, the legally defined apportionment of water to SNL, defined in Legal Notice 51 of 1981, Part C, was examined. Apportionment is calculated "... as a percentage of normal September mean low flow which will not produce a shortage more often than one year in five". Notice 51 states that normal September flow is approximately 362 cusecs (10.25 M^3/sec). In the

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Table II-8: Estimate of Pre-Dam Water Requirements and Water Availability for Pre-Production Agriculture at the First Irrigation Development Unit (IDU)

Month	Application rate[a] (ℓ/sec/ha)	(cusecs/ha)	Monthly Factor for Flows >390[c] (cusecs)	Naturalized Komati Runoff at SIS[d] (MCM)	(cusecs)	Maximum Diversion[b] (cusecs)	Potential Area[e] (ha)
Oct	0.57	0.020	1.08	30.8	406	3.90	194
Nov	0.63	0.022	1.12	69.6	949	3.90	175
Dec	0.77	0.027	1.30	118.0	1555	4.53	166
Jan	0.79	0.028	1.30	168.7	2224	4.53	162
Feb	0.65	0.023	1.15	176.3	2574	4.01	174
Mar	0.54	0.019	1.10	132.1	1742	3.83	201
Apr	0.48	0.017	1.00	83.0	1131	3.48	205
May	0.41	0.014	1.00	53.7	707	3.48	240
Jun	0.32	0.011	1.00	38.1	519	3.48	308
Jul	0.32	0.011	1.00	30.1	396	3.81	337
Aug	0.39	0.014	1.00	25.4	335	3.22	234
Sep	0.46	0.016	1.00	23.2	316	3.04	187
Total				948.2		Maximum:	337
Average	0.53				1071.2	Average:	215
						Minimum:	162

a Application rates are generalized, but sufficient for most crops.

b Water apportionment for monthly flows and maximum diversion is defined in Legal Notice 51 of 1981, of the Water Act of 1967 as apportionment to "Swazi Area" 763 and 790. Apportionment is 1.436 percent of flow less 1/3 for existing development.

c Appropriate monthly factor when flow is between 390 & 470 cusecs. Flow 470 may be apportioned by Water Apportionment Board.

d Runoff is, synthesized naturalized runoff from Yates, 1984, Table C.4. Diversions above SIS are considered in apportioning flow. Therefore these fate approximate mean flow which will be available for proposed development prior to completion of dam.

e Potential area = Maximum diversion/Application rate (cusec/ha)

Source: Water Resource Branch, MNRLUE

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d. Water laws, rights and administration

Water use requires a permit from the Water Apportionment Board. Some critical studies have been made on this Water Act recently, pointing out shortcomings as they pertain to "private water" use and Swazi Nation Land water use.

The monitoring of water use and abstractions is done directly from the Water Resources Branch. However, for a large project like the proposed Komati Irrigation project, it is possible and advisable to form an irrigation board for the project. It will monitor and administer the use of water on the project on behalf of the Water Resources Branch. The board would need to employ technical staff to monitor daily water use operations including irrigation work, maintenance, and pollution control. The new Water Board would comprise members from the water users (both big and small), the Ministry of Natural Resources, the Ministry of Agriculture, and the JPTC.

8. Overall lowveld conditions and irrigation project potential

a. General

The lowveld, 40 percent of Swaziland's total area, lies in a north-south strip east of the middleveld. Topography is gently undulating within altitude limits of 60-375 m above sea level.

The western lowveld is characterized by heavy clay pan soils or light textured materials overlying sandstones and shales. Topography, poor drainage and a tendency to sodicity in the subsoil restrict their use for irrigated cropping and the low moisture retention in the topsoils reduces rainfed crop yields.

The eastern lowveld is underlain by basalt which gives rise to red, brown and black clay associations ranging from shallow (20-40 cm) to deep (exceed of 1 m). Although poor drainage is a problem on the black clays and some of the soil series are two decked with sodic subsoils, general soil fertility is excellent and topography is suitable for a combination of overhead and furrow irrigation.

The lowveld climate is almost tropical and subhumid. Rainfall is low and distribution erratic--the annual mean varies from 500 to 900 mm. Temperature ranges from 14°-29°C with an annual mean of about 22°C; frosts occur frequently in drainage lines during winter (June to August). Rainfed cropping is risky and yields are generally low.

With irrigation, the lowveld has excellent potential for a wide range of crops. Large scale sugarcane and citrus are already developed and two crops of maize and other field crops can be grown annually. Other suitable summer crops include beans, groundnuts, soya bean and sunflower with winter crops including wheat, beans and vegetables. Cotton also yields well.

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b. Irrigation development in the lowveld

There are opportunities to develop irrigation in all the main regions of Swaziland but water resources are limited in relation to land and the most productive use should be made of the water available. Twenty-eight percent of Swaziland's total land area is highveld which receives good rainfall. Thus, little irrigation is required here. In any case only 10 percent of the highveld is classified as potential arable land.

There is a high proportion of good arable land on the middleveld and the area is densely settled. With the introduction of irrigation, considerable social problems would be involved with resettlement, and pressure on land availability would be high. Rainfall is usually adequate for reasonable crops of maize and nearly half of Swaziland's smallholder maize area is planted in the middleveld. The benefits from irrigation in the rainy season would therefore be relatively low. There are several small irrigation schemes in the middleveld, mainly concentrating on dry season vegetable production. One of the largest areas with a topography suitable for irrigation is the Malkerns Valley, already extensively planted with rainfed pineapple on private land.

With an annual rainfall of from 50-900 mm, the lowveld covers 40 percent of Swaziland. Outside the existing major irrigated cane schemes the region is relatively sparsely settled, especially in the lowerlying, drier areas where rainfall is insufficient for reliable cropping. Rainfed maize does not grow well, and cotton, which is grown in the wetter foothill area, suffers from a serious drought risk. The western lowveld has an adequate rainfall for cotton in four years in ten and the eastern lowveld, the project area, in only two years in ten. Existing schemes have shown, however, that the agricultural potential is high for a wide range of crops given adequate water supply.

B. Socioeconomic Characteristics

This section describes briefly the main socioeconomic features of the Komati Basin Irrigation Project area. This is, of course, a rural area and the resident population is primarily engaged in agricultural production while non-resident members of homesteads and commuters are in wage employment.

1. Size and distribution of landholdings

A "holding" as used in this report is defined as an area of land operated by the residents of a single homestead and held as one technical unit. It possesses some means of agricultural production, such as a labour force, equipment and draft animals. The homestead members grow a variety of crops such as maize, pumpkins, beans and cotton; keep livestock and/or poultry and perhaps also produce wood and wattle. Aerial photographic interpretation (using 1984 photography) showed that the average land holding within the project area was approximately 3.0 ha which is the most common size of holding in the lowveld as revealed by recent census studies. The actual sizes of individual holdings range from less than one hectare in areas of dense population to more than five hectares in more isolated locations.

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2. Population size and distribution

Table II-9 shows the population in each of the Enumeration Area (EA) that together comprise the project area. Data from the lates Agricultural Census in 1984 indicate that there are 9,179 residents in th region. By the year 2,000, the population will be 15,670 if current tren rates of growth persist. Current average population density in the region i 54 people/km², and it ranges from a high of 143 people/km² in the EA closes to Bordergate to a low of 28 people/km² in EA 1107. Based on 1976 Census dat for the whole country, population density in the project area is relativel high compared to the average for the lowveld rural areas which was 22.9 ir 1976.

In 1984, there were 1,176 homesteads in the area and average family size is about 8 people. The economic analysis has assumed that at least 900 of these families will be resettled. As elsewhere in Swaziland, there is considerable variation in family size from a low of 6.54 to a high of 10.4 people. Average family size in the proposed project areas is identical to that found by deVletter for the country as a whole.[1] This survey showed a sample resident population of about 8 people per homestead with about a fifth of the population absent and engaged in wage employment. A quck survey of half a dozen families in the project areas confirmed the census data on family size and composition and the fact that at least one member of each household was engaged in off-farm wage employment.

2. Employment and homestead incomes

According to RDAP reports, 23 percent of the population in the area is actively involved in agriculture, i.e., those cultivating their own piece on SNL, while 18 percent is reported to be absentee homestead members, most of whom are in off-farm wage employment. The average number of absentees is 2.16 per some homestead. This figure is in line with the national average. Absentees are generally employed for a wage by any of the four major centres of employment found around this area--Tjaneni Sugar Estate, Tunzini Citrus Estate, Bulembu Asbestos Mine and Peak Timbers. No data were available on the patterns of employment, i.e., employment by sex, age, education, etc. or on the duration of employment. But indications are that most of the women in wage employment work on the citrus and sugar estate whereas, more of the men are employed by Peak Timbers and Bulembu Asbestos Mine.

Determining the attractiveness of the Komati Basin irrigation project to farmers requires information on current household incomes. Only if participation in the scheme provides household earnings at least equivalent to income and income security from alternative sources for the same amount of family labour inputs invested will there be adequate incentives for farmers to join. Since rural income data specific to the project area were unavailable, it was necessary to extrapolate estimates from more generalised surveys.

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1 Fion deVletter, The Swazi Rural Homestead (University of Swaziland, SSRU, July 1983), p.17.

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Table II-9: Population Size and Distribution in the Project Area

Enumeration Area	Population 1984	Population Projected in 2000	Number of Homesteads 1984	Population/ km² 1984	Population/ Homestead
1101	1486	2540	216	143	6.88
1102	494	840	58	42	8.52
1103	1110	1895	135	42	8.22
1104	968	1655	112	50	8.64
1105	984	1680	100	63	9.84
1106	346	590	50	47	6.72
1107	412	705	63	28	6.54
1108	542	925	66	44	8.21
1109	798	1360	88	72	9.07
1110	571	975	79	50	7.23
1111	798	1360	113	77	7.06
1112	260	445	25	33	10.40
1113	410	700	71	54	5.77
TOTAL	9179	15670	1176	54	7.81

Source: Swaziland Agricultural Census Data, 1984.

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At this stage, it is important to clarify that income estimation from survey data is always a difficult task and particularly so when households obtain income from a variety of sources including resident and non-resident family and non-family members.[1] Further, data available from different sources do not agree on the estimates of rural household income. Therefore, alternate estimates of current rural household income are provided below along with a brief discussion of their method of derivation.

The Swazi Rural Homestead Survey (SRHS), in 1979, estimated average annual subsistence and cash income to be E1,915 per homestead. Resident and non-resident wage earners contributed 56 percent of reported earnings or E782. Crop and livestock sales accounted for 15 percent of total income or E160. Homestead non-agricultural activities (handicrafts, beer brewing, etc.) brought in an additional E133. Accounting for self-consumed production raised agricultural income to E376. Alternate estimates of homestead agricultural production (sales and self-consumption) amounted to E309 per household based on an ILO survey in 1978.

In 1982 Tate and Lyle estimated household income by combining their own estimates of the value of agricultural production on SNL with the SRHS estimates of off-farm cash earnings adjusted for inflation. The value of crop and livestock production by averaging total production per hectare per homestead on SNL. In 1981/82 prices total SNL production was valued at E32.5 million which amounted to E28 million net of the cost of inputs and mechanical services applied. Thus, income per head was E73 and using an average household size of 8.03 residents yielded a mean household agricultural income of E586. Adding to this adjusted off-farm cash income gave a total income of E1,866.[1] This is somewhat lower than the total income estimated by the SRHS and the discrepancy becomes even greater if the effects of inflation are considered.

Estimating 1984 household income directly from the SRHS estimate of total income adjusted for inflation results in a figure of E3,831, whereas using the alternate method of combining the inflation-adjusted average value of production on SNL with the adjusted SRHS estimate of non-agricultural cash income yields an average household income of E3,158.

4. Living standards and levels

As reported above, specific data on incomes and employment in the project area were not available. Random interviews with a few families revealed that income levels were generally low as were consumption and living standards except for a few families engaged in commercial agricultural production. Most families are employed in subsistence agriculture though a few reported sales of surplus produce when they had some. A few families are

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1 See Margo Russell, "Beyond Remittances: the Redistribution of Cash in Swazi Society," The Journal of Modern African Studies, XXII: 4 (1984), p.595-615.

1 Tate and Lyle, Reconnaissance Study, Volume 5, p.15.

engaged in production of cash crops such as cotton, fruits and vegetables. Fruit and vegetable production is generally sold in the local area to friends and neighbours and marketing crops at longer distances is relatively uncommon.

The primary source of homestead cash income as elsewhere in Swaziland is from remittances sent by family members engaged in off-farm wage employment. Every one of the families interviewed reported that one or more family members were away working in wage employment. Consequently, most area residents were either women, children or older men. Children's education is a major financial investment for most homesteads and, despite the limited number of schools in the area and their distance, all homesteads reported that children at school-going age were at school. The women reported being primarily responsible for agricultural production.

Most houses are mud huts, many of which do not appear to be well maintained. Public utilities such as water and electricity are not available for homestead consumption. Water must be fetched from the Komati River and this is a major daily undertaking as is the collection of firewood collected from the neighbouring veld. The diet of area residents consists primarily of mealie-meal porridge and wild weeds cooked on three-legged pots over wood fires. Some families could not even afford this simple daily meal. Members of one of the homesteads visited during a site visit reported in the late afternoon that they had not eaten all day.

Grocery shops are few and sparsely distributed and generally poorly stocked. It is not uncommon to find a shop with several empty shelves. Goods generally found in the shops are mealie meal, sweets and instant soup powders. Prices tend to be higher than in the supermarkets in town. Consumer items not available locally must be purchased in Piggs Peak which is the nearest town. A visit to Piggs Peak is a major undertaking that takes all day as transportation is severely limited.

5. Infrastructure and public services

The project area has access to major population centres via several well-maintained major roads. MR 6 begins at the tarred MR 1 approximately 6 km southwest of the border post at Jeppes Reef, passes Herefords and bisects the entire Mayiwane Sub-region before it crosses the Komati River near Bulandzeni and terminates at Balegane on the southern bank of the river. MR 2 starts from MR 6 near the Bulandzeni crossing and runs westward to Piggs Peak and MR 1. MR 5 begins at Balegane and winds southward to Manzini via the crossing of the Black Mbuluzi at Croydon, passing through the centres of Mliba, and Luve.

Internal access is less developed. District road, D35, connects MR 6 with the Mhlangatane Clinic and continues eastward roughly paralleling the northern bank of the Komati to the Mananga border post. There are numerous smaller tracks leading towards the river from MR 6 and D 35 but these are not maintained by either the Roads Branch or by Mayiwane RDA equipment.

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At present, the only crossing of the Komati giving access to the eastern Lowveld developments and the proposed railroad station at Tshaneni is the crossing of MR 6 between Bulandzeni and Balegane.

Within the project area, public services are poorly developed although there are several schools and clinics adjacent to the proposed boundaries. Public health services are available at the Mhlangatane Clinic. Some parts of the project will also have access to clinic facilities at Mayiwane, Bulandzeni and Mayiwane. There are three primary and one secondary and high school within the boundaries, but numerous other schools are located along MR 6 and MR 2. The nearest hospital is located at Piggs Peak.

Police, postal and telephone services are available at Balegane. Electricity is supplied along MR 6 for schools, clinics and TDL farms in the area, but is not available for domestic consumption in the homesteads.

IV. THE IRRIGATION PROJECT

A. Project Description

1. Size and location

a. Background

This study develops a nucleus estate-smallholder irrigated farming project in the north-east corner of the Komati River Basin in north-central Swaziland. It is of two sizes, depending upon assumptions made regarding water availability. The first size, the "base" project, uses some 40 MCM and is 3,000 ha. The second case consumes some 63 MCM and is for 5,000 ha. In both, 40 percent of the irrigated area is devoted to smallholders and 60 percent to nucleus estates. The analytical technique has concentrated on creating one Irrigation Development Unit (IDU) of 1,000 ha and then adding equivalent modules consecutively over time to reach the "base" project of three IDUs; and then the larger project of five IDUs.

The analysis of the irrigation project is one of the several key elements in support of the Government of Swaziland's position when negotiating with neighbouring states with respect to the future development of common water resources. Studies have shown that virtually all of Swaziland's run-of-river water resources are fully utilized or nearly so. While additional upstream releases from the RSA could provide modest increases in Swaziland's water supplies on occasion, any substantial enhancement must come from the increased storage provided by dams and reservoirs. This pre-feasibility analysis concentrates on one use of a possible increase in Komati River supply, an irrigation scheme utilizing water provided by the proposed Maguga Dam.

It is important to note in this connection, however, that even if negotiations with the RSA (funding/costing decisions, design studies, tendering processes, dam construction, etc.) were expedited fully as of mid-1985, it would still be nearly a decade, before agricultural and other benefits could materialise on any scale. Therefore, it is important to think about costs, prices, crop/product suitabilities, market windows, as indicative and to maintain flexibility in making appropriate choices based on conditions prevailing when the project is actually implemented.

The consulting team, perforce, thus concentrated in this study on establishing a well documented process and its framework, indicating methodologies and analytical steps in detail. This will permit subsequent and more timely analyses to be effected in due course with some ease; it will be a matter of updating, not one of starting all over again.

b. Description

The base 3,000 ha project consists of the phased installation of three IDUs each containing a total of 1,000 ha. Each IDU is divided into a nucleus farm and individual smallholder farms. A water

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allocation is to be provided from the construction of the Maguga Dam on the Komati River. The project is located along the North Bank of the Komati River immediately to the west of Bordergate and across the river from the SIS estates.[1]

Each IDU is a self-contained farming enterprise consisting of the following features:

- Net cropped area is 600 ha to the nucleus farm and 400 ha to the smallholder;
- Establishment of 200 smallholder farms of 2 ha each;
- Construction of pumping stations on the Komati River to supply flows to the units;
- Installation of buried permanent mainlines with balancing reservoir to provide irrigation water on demand to the infield portable overhead irrigation systems;
- Establishment of a 130 unit village to house the permanent labour staff with required utilities and social amenities;
- Establishment of a management housing compound consisting of 20 units with required utilities;
- Establishment of the necessary shop, warehouse, office, and crop processing facilities;
- Provision for extension counselling, input supply, and other basic services to smallholders;
- Establishment of cropping systems, emphasising tree crops;
- Establishment of a nursery to supply both the smallholders and the nucleus estate with fruit tree planting material and to conduct research in due course; and
- Establishment of an effective management and organisational structure.

The sequencing of IDUs is designed to optimise contractor and management rsources. Some production and nursery establishments on the first IDU can occur prior to dam water becoming available by modest run-of-river pumping. Full output levels on the nucleus estate of the first IDU are reached at project year (PY) 9; for three or five IDUs at PY 12. By the time three or four IDUs are established it is entirely likely that an umbrella project management structure will be required.

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1 Inyoni Yami Swaziland Irrigation Scheme; usually referred to as SIS.

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2. Proposed works, measures and policies

a. Water abstraction and conveyance

(1) Criteria for selection

Two basic options are available for the abstraction and conveyance of water to the individual IDUs. The first is a gravity system consisting of a diversion works in the river followed by a long canal (56 km) carrying water to the top of the project and several balancing reservoirs as required to effectively manage the supply flows. Factors to consider relative to this option are:

- Initial costs tend to be very large but operating energy costs a low;
- A combination of relift stations and inverted siphons may be required to minimize construction costs in rugged terrain;
- Long canals can be expensive to maintain and supervise;
- Efficiencies of conveyance can be relatively low with losses estimated at 10 to 15 percent;
- Useful life is long (estimated at over 40 years);
- Open water in canals and reservoirs raises health concerns for the spread of diseases such as malaria and bilharzia;
- During the initial installation phase (up to several years) no flows are available until the system is complete; and
- Catastrophic failure cuts off all flows to the project.

The second option involves the use of pumping installations immediately adjacent to the IDU and abstracting water directly from the river. Factors to consider relative to this option are:

- Capital costs are relatively low but operating energy costs are substantially higher than gravity systems;
- Wide seasonal variations in river stage can create problems in design, construction, and operation;
- The system is easier to manage as wide ranges in demand are more efficiently accomodated;
- Capital expenditure can be phased to match development schedules thus permitting earlier project cropping; and

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- Accessibility for maintenance and security purposes is improved.

For initial design purposes, a cost analysis of the two options was made with the results shown in Table II-10.

Given the current design for three IDUs and interest rates approaching 18 percent, the pumping option was selected and used throughout the analysis. However, a final selection for the project should have the benefit of a more detailed cost analysis. Major factors affecting the final decision should include a firming up of canal construction costs, a verification of the canal conveyance efficiency with an estimated value of the net water loss and a projection of future energy cost escalations and off-peak pumping economies.

(2) Construction of the pumping stations

The general layout of the on-farm irrigation system is shown in Figure II-2. The basic pumping units are capable of supplying the required gross flow rates to the balancing reservoir at the top of the project through buried steel mainlines. A total of three pumping facilities per IDU will be located on the north bank of the Komati River. The combined power requirements is 2.8MW. Estimated total dynamic head is approximately 200 m at a combined flow rate of 0.94 M^3/sec (per IDU of 1,000 ha). Estimated annual operating pumping period is 4,200 hours.

Because of the varying stage and concern about flood protection, the basic units are located back from the river bank and pumped from a small surge reservoir which is in turn supplied by high capacity sump pumps suspended in the river. A concrete retaining wall would be required to stabilize the river banks in the vicinity of the sump pumps.

Each IDU requires six identical horizontal split case centrifugal pumps. Use of the multi-pumping unit facilitates efficient matching of supply flows to demands. This particular pump is noted for its longevity and ease of maintenance. The prime movers are electric motors. Adequate safety controls are provided to ensure against damaging flow conditions.

(3) Installation of buried steel and plastic (PVC) mainlines, sub-mains, and manifolds

Because of the inherently high static pressure (to 2,000 kPa), adequately rated steel pipe and automatically operating pressure reducing valves were selected for the mainlines connecting the pumps to the balancing reservoir. The entire system is capable of delivering the net capacity of 5.00 mm/day with an efficiency of 75 percent to the nucleus farm, and 60 percent to the smallholders. The details of these layouts are shown in Figures II-3, II-4 and II-5. The steel pipelines are fitted with flanged ends for ease of field assembly and buried below plough depth.

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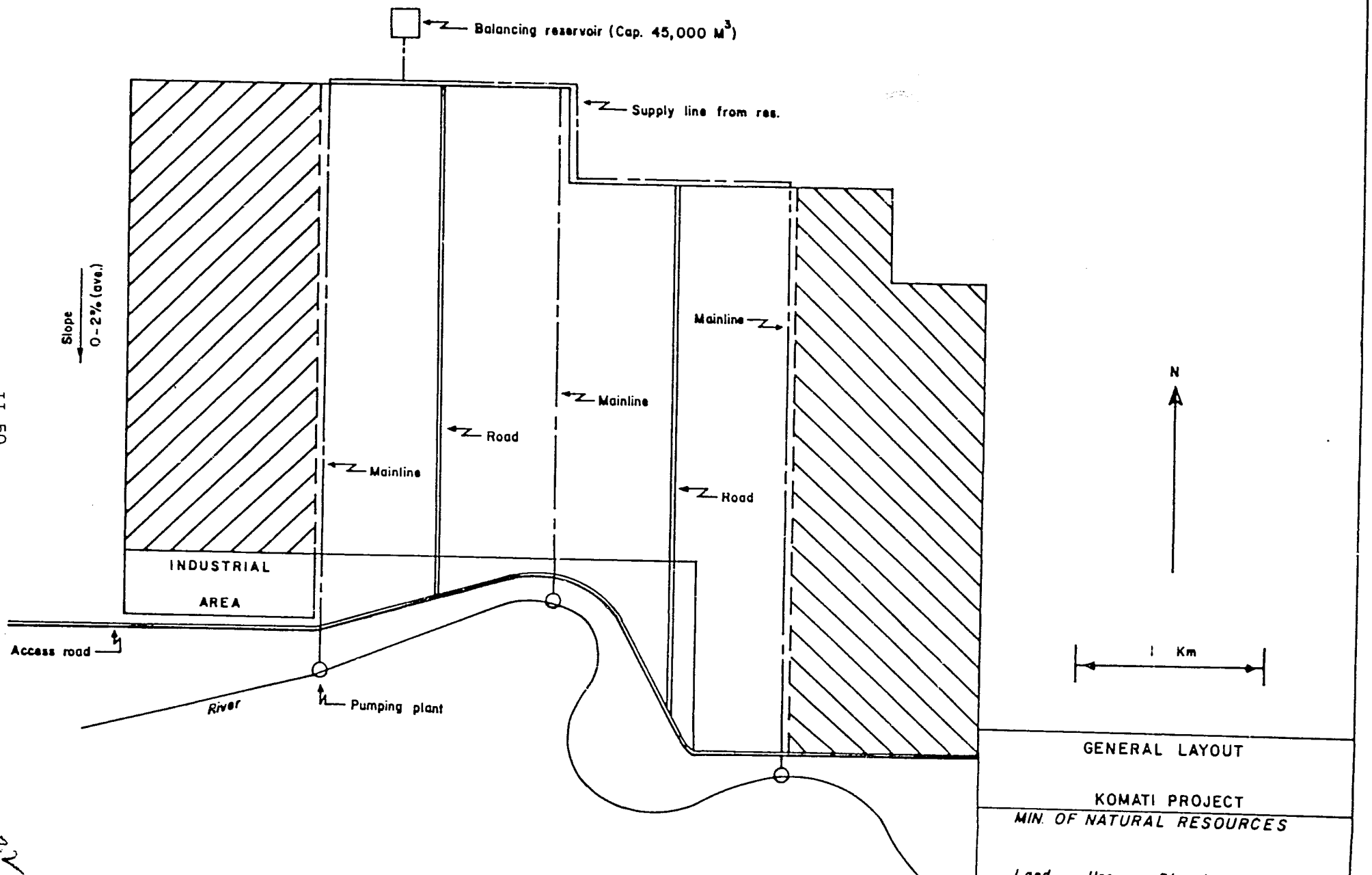
SWAZILAND: ECONOMIC STUDY OF POSSIBLE USES OF ADDITIONAL WATER ON THE KOMATI RIVER

Table II-10: Comparison of Gravity vs. Pumped Extraction

Area Served (ha)	Option	Capital Cost (E/ha)	Annual Operating Cost (E/ha)	Total Annual Owning Cost[d] and Operating Cost at Interest Rates of 6% (E/ha)	12% (E/ha)	18% (E/ha)
3,000 (3 IDU)	Canal (gravity)	6,700[a]	120	545	925	1,326
	Pump	500[b]	685[c]	730	760	790
5,000 (5 IDU)	Canal (gravity)	4,600[a]	75	365	365	905
	Pump	550[b]	685[c]	735	760	790

[a] Costs per Tate & Lyle Report No. 10 up-dated to 1985
[b] Costs per Bond correspondence dated June 20, 1985
[c] Power costs per Swaziland Electricity Board tariff dated January 1, 1985
[d] Assumed useful life: canal 40 years, pump 20 years

Source: Devres Staff Estimates, August 1985


Balancing reservoir (Cap. 45,000 M³)
Supply line from res.
Slope
0-2% (ave.)
Mainline
Road
Mainline
Mainline
Road
INDUSTRIAL
AREA
Access road
River
Pumping plant
N
1 Km
GENERAL LAYOUT
KOMATI PROJECT
MIN. OF NATURAL RESOURCES
Land Use Planning Section

The sub-mains and manifolds are specified as Poly-Vinyl-Chloride (PVC) for ease of field assembly and readily available hydrants and valves. Adequate operating pressure (approximately 450 kPa) is provided to allow for the operation of either an above ground portable aluminium pipe system or gravity surface systems at the option of the smallholder. A bill of materials covering pipe for a single IDU is shown in Table II-11.

(4) Construction of a balancing reservoir

The balancing reservoir assists in meeting peak demands on the system as smallholders, in particular, irrigate to suit their labour requirements. The reservoir capacity is fixed at 45,000 M^3 as adequate to store the full pumping plant capabilities for 12 hours. The reservoir will also be especially helpful in avoiding peaking period electrical rates during reduced crop water demand periods. The reservoir would be equipped with appropriate valving and overflow facilities. The wide range of stages should discourage bilharzia host snail propogation.

b. Land clearing and development

(1) Clearing, ploughing and smoothing

The entire area of 1,000 ha per IDU will be cleared of natural vegetation which will be bulldozed into piles and burned. Because irrigation is planned using overhead systems, extensive shaping is not required. Bulldozers will be used to level steep knolls and fill major depressions. Waterways will be shaped to control storm flows. The entire area will be ploughed ready for final cultivation and planting.

(2) Construction of secondary and in-field road networks

Approximately 32 km of secondary and and in-field roads will be installed to facilitate access to the fields for irrigation, cultivation, fertilizing and harvesting equipment. Installation includes culvert and drainage concerns as may be required to avoid storm damage.

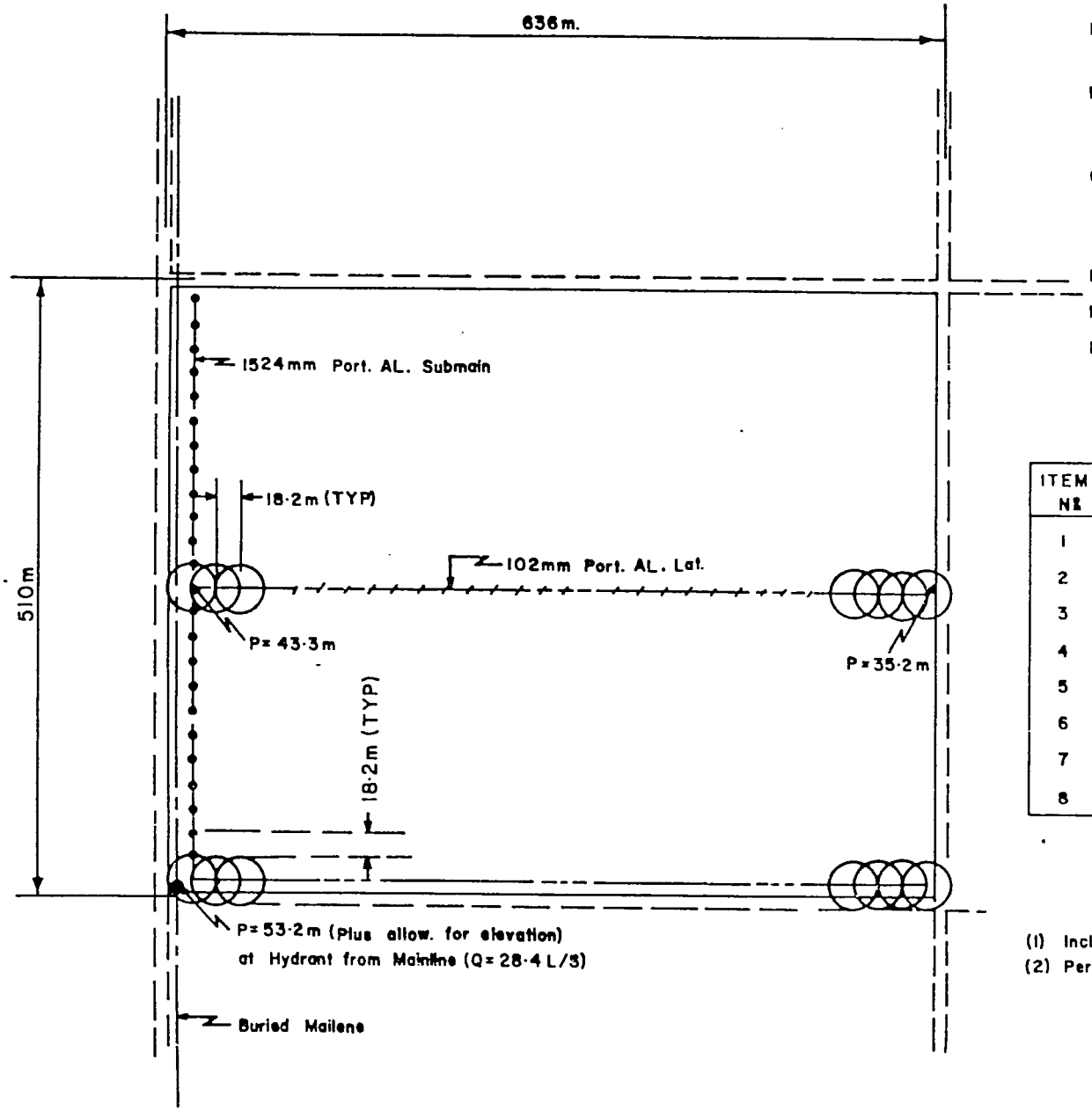
(3) Installation of sub-surface drainage system

A preliminary field survey indicates that about 50 percent of the area is the "duplex" soils that require drainage if salinity and sodic problems are to be avoided. Tentative design parameters provide for a capacity of a 4mm/day using perforated plastic pipes spaced 20 to 40m. The pipes are connected to a downfield main drainline that delivers the flow to a surface collector ditch.

Table II-11: Bill of Pipe Materials for One IDU

Pipe Material	Size (mm)	Quantity (m)
Steel	457	4,800
Steel	356	7,700
PVC	162	6,200
PVC	102	10,500
Total		29,200

Source: Devres Staff Estimates, August 1985



SPECIFICATIONS

Design Cap., ... 5·0 mm/Day "Net"
6·7 mm Day "Gross"

Lat. Op. Press., ... 35·2m End
43·3 m Supply

Sprinkler. ..... 0·43 L/S

Operating sequence ..... 11 Hr Set
1 Hr Move

Application, ... 51 mm Effective
64 mm "Gross"

Minimum Interval, ... 7 Days

Lateral flow rate, ... 14·2 L/S

Block flow rate, 28·4 L/S

BOM
Portable system

ITEM Nº	DESCRIPTION	QUANTITY PER BLK(1)	EXTENDED (2)
1	Sprinkler (Rb 14070)	72	1368
2	Riser (254mm x 1·0m)	72	1368
3	Lateral (102mm x 9·1m)	144	2736
4	Hydrants (102 x 152·4)	30	570
5	Submain (152·4mm x 9·1m)	60	1140
6	End plugs /102mm	3	57
7	" " /152·4mm	2	38
8	Valve openers (102mm)	30	570

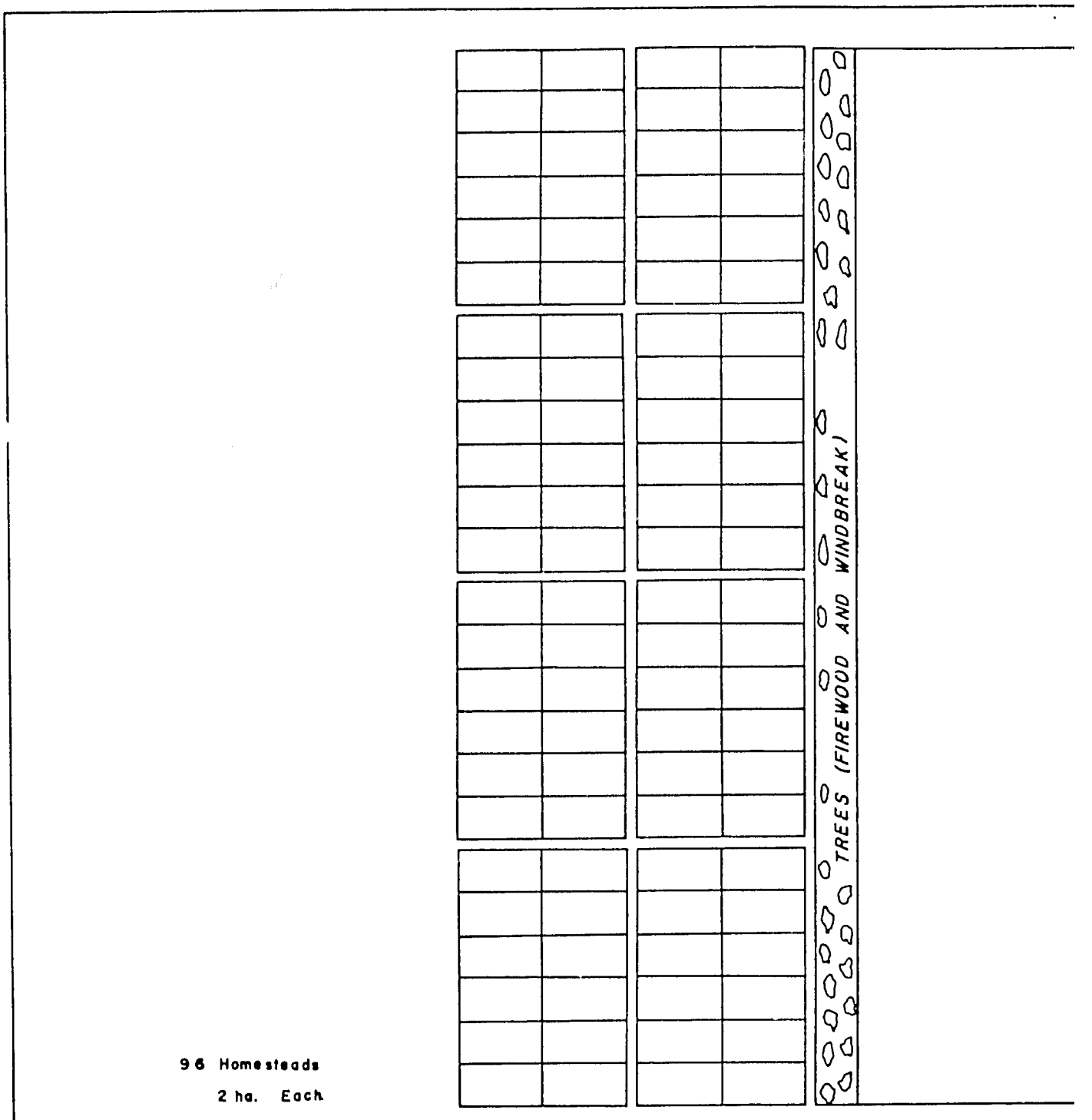
(1) Includes 10% allowance for parts
(2) Per 19 blks or 613·4 ha IDU

NUCLEUS FARM IRRIGATION
SYSTEM LAYOUT (TYP)
KOMATI PROJECT

MINISTRY OF NATURAL RESOURCES

Land Use Planning Section

Designed by Norum *Date* 2/8/85	*Checked by* *Date*
Drawn by C.J. Zini	*Approve by*



KOMATI PROJECT

SMALLHOLDER FIELD LAYOUT (West Side)

MINISTRY OF NATURAL RESOURCES & ENERGY

Land Use Planning Section

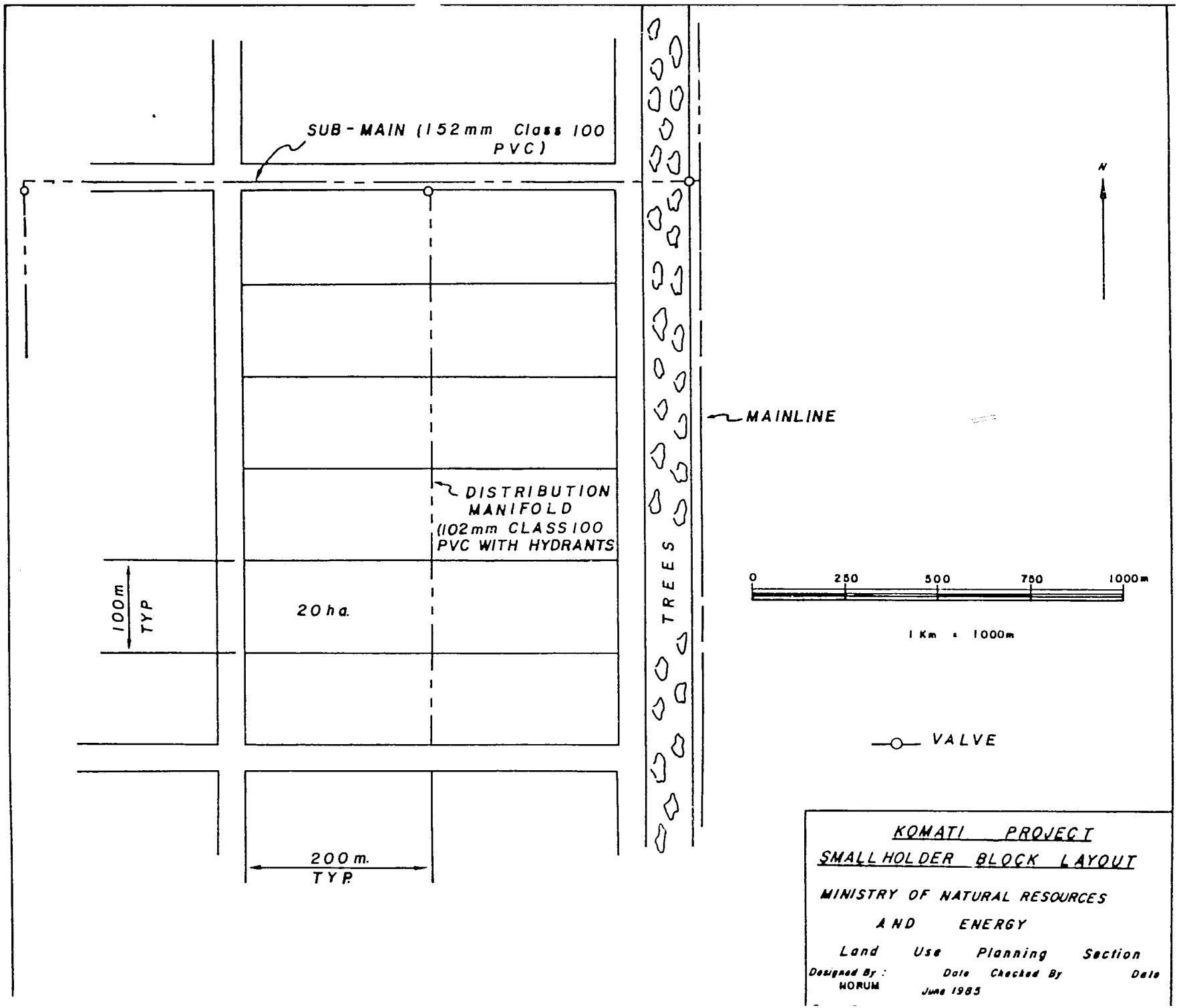
Designed By: NORUM Date: July 1985 Checked By: Date:

Drawn By: C. Mavuso Approved By:

0 250 500 750 1000m

1 Km = 1000 m

SWAZILAND: ECONOMIC STUDY OF POSSIBLE USES OF ADDITIONAL WATER ON THE KOMATI RIVER



SWAZILAND: ECONOMIC STUDY OF POSSIBLE USES OF ADDITIONAL WATER ON THE KOMATI RIVER

Figure II-5: Smallholder Farm Block Layout

c. In-field irrigation system

(1) Specifications

A handmove fully portable overhead irrigation system was selected for the nucleus farm, and available at option to the smallholder. Summary specifications for the system are as follows:

- Design Capacity: 5.0 mm/day (net) or 6.7 mm/day (gross);
- Lateral Length: 600 m;
- Sprinkler Spacing: 18.2 m by 18.2 m;
- Sprinkler Capacity: 0.43 L/s at 340 KPa;
- Minimum Interval: 7 days (winter) and 21 days (summer);
- Estimated Set Time: 11 hours; and
- Estimated Application: 55 mm (effective) and 64 mm (gross).

The system design for the smallholder areas is similar except that a small capacity sprinkler is specified at a reduced spacing of 9.1 m by 18.2 m.

(2) Assembly of sprinkler laterals

All 102 mm portable aluminium pipe laterals will be ordered as components for final assembly and distribution on site. Two laterals will be provided for each 31-ha field on the nucleus farm. (Each smallholder will be provided with a single 77 mm lateral). A proposed bill of materials for the laterals on the nucleus and smallholder farms is shown in Table II-12.

(3) Assembly of portable sub-mains and control valves

Each 31-ha field within the nucleus farm will be fitted with a 500 m fully portable aluminium sub-main that can be moved out of the field to facilitate cultivation or harvesting operations. A partial bill of materials for the sub-main is as follows:

- Aluminium pipes with couplers, 9 m of size 152 mm; required quantity 1,140; and
- Inline valves of size 152 mm; required quantity 570.

d. General infrastructure

(1) Electrical service to pumps, housing, central administration and shops

Electrical service is provided for the management housing (5 units), supervisory housing (15 units), and the industrial complex consisting of the office, warehouse, shops (3 units) and crop processing facility. Each of the three major pumping facilities were also provided electrical service. Electrical service is available from the south side of the river requiring approximately a 3 km extension of powerlines to service the IDU.

(2) Telephone service

Telephone service is provided to all management housing, administrative units, shops and the warehouse.

(3) Primary access roadway

Approximately 6 km of primary access roadway is provided across the lower edge of the project in order to link the IDU to other units and provide a connection to major access roads out of the area. The basic road construction is total width of 8 m, running width of 6 m, with a 150 mm gravel surface. This should provide all-weather access to the unit and allow transportation of produce.

(4) Office, warehouse, and shops

An office building is provided that includes five individual offices for the management group, a main office with a desk for each of the fifteen supervisors, and an accounting and general office. Total area for this unit is 390 m^2. An allowance was made in the budget for furniture. A warehouse is provided with a floor area of 300 m^2. A budget allowance was made for interior shelving and security fencing for outdoor storage. Shops were constructed for automotive repair (150 m^2), electrical repair (100 m^2) and general maintenance (100 m^2). An allowance was also made in the budget for hand and shop tools.

(5) Crop processing facility

Provision was made for a grading and packing shed (300 m^2) and a single grading and packing line. In addition, a chiller unit and storage facility (200 m^2) were provided. This is in anticipation of on-farm processing of papaya, avocado, citrus, etc.

Table II-12: Bill of Materials for Laterals for In-field Irrigation

Description	Size (mm)	Quantity
Nucleus Farm		
Sprinklers (Rainbird 14070)		1,370
Aluminium Pipes with couplers, 9 m	102	2,740
Valve Openers	102	570
Risers 1 m long	25	1,370
Smallholder Farms		
Sprinklers (Rainbird 20)		4,900
Risers 1 m long	15	4,900
Aluminium Pipes with couplers, 9 m	76	4,900
Valve Openers	102	220

Source : Devres Staff Estimates, August 1985

(6) Nursery facility

The nursery facility is included in response to anticipated orchard establishment as a way of accelerating the growth process. The facility covers 30 ha and includes required land grading, water supply, irrigation equipment, security fencing and guard housing.

e. Domestic water supply, reticulation and sanitation

Facilities for water treatment, reticulation and disposal of water borne sanitary wastes were provided for in the management and supervisory housing and the office complex. The basic source of water will be from the river as pressurized by the main irrigation pumps.

f. Housing

(1) Management and supervisory personnel

In general, this is estate-type housing as required to attract and hold qualified staff. Construction is to high standards by reputable contractors. The manager's unit has a floor area of 220 m^2, the senior staff of 125 m^2 and the supervisory staff of 90 m^2.

(2) Permanent skilled and unskilled labour

In order to retain skilled and qualified labour, permanent housing is required. A total of 130 separate units are provided including 65 for married labourers (40 m^2) and 65 for bachelor block (14 m^2). A medium quality contractor was allowed for. The units were provided water, power and sanitary sewer services.

3. Crops, and cropping patterns

a. Bases for crop selection

Crop plants are biological organisms whose performance is dependent upon their genetic constitution and interaction between the genetic make-up and their growing environment. Modern agricultural technology relies upon the manipulation of the plant's inherent characteristics in conjunction with its environmental and adopted management factors to improve performance. Cropping patterns take into account a variety of considerations. These include the nature and properties of the soils selected for production of given crops and climatic factors such as intensity, duration and distribution of rainfall, soil and air temperatures, occurrence of frost, etc. Other considerations, primarily economic and market-related, are also important. After all, farmers cannot benefit economically unless they are able to dispose of their surpluses at favourable prices.

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(1) Agronomic considerations

The Western parts of the lowveld form parts of the Karoo Systems sediments in conjunction with dolerite intrusions while the Eastern parts of the lowveld are basaltic in nature. The dominant soils of the eastern half of the lowveld are characterized by reddish brown, heavy textured, structured, fersialistic and black vertisols. These were described in some detail at Chapter III Section A.5 above.

In general, the lowveld soils are known to be the most fertile in Swaziland. However, some soils suffer from a lack of sub-surface drainage. Almost all are deficient in phosphate. These soils can support production of a variety of crops provided supplemental irrigation is available during the growing season at critical growth stages of the crop plants. Other agronomic characteristics influencing crop growth are temperatures, diurnal ranges, and rainfall.

(2) Economic and social considerations

Economic and soil factors were also considered in crop selection. National policy objectives for agricultural development guided the selection. The following are the main factors that were considered:

- Self-sufficiency in maize and vegetables;
- Income generation for smallholders;
- Creation of employment;
- Generation of foreign exchange; and
- Crop marketability.

b. Selection of crops

Prior to the selection of the project's recommended crop mix a wide variety of crops was examined. Using the above criteria, the final list was narrowed down to the following:

- Perennials : Citrus, Mango, Papaya, Avocado;
- Summer Annuals: Maize, Cotton; and
- Winter Annuals: Cabbage, Tomato, Potato.

Final crop selection criteria also took into account the adaptation characteristics of the selected plants and growers' familiarity with them. Another important consideration in not choosing too many crops in initial stages of the project was the level of management expertise required to

produce economic yields in an unproven area. This irrigated agriculture is both labour and capital intensive as the cropping intensity is equivalent to nearly 200.[1]

Adaptation characteristics of each of the selected crops and other important considerations are described in the following sections.

(1) Maize

Maize self-sufficiency is a high priority of the Swaziland Government, since this is the nations's most important food crop and currently the country is a net importer of maize. Maize is grown on a commercial scale on TDL under completely or partially mechanized conditions with average yields of 4-5 t/ha. On SNL maize is grown on small plots of land near homesteads and yields are extremely low. In the lowveld region if maize is grown under irrigation, with high yielding disease resistant and improved varieties and in conjunction with improved production technology yield can be increased substantially.

(a) Nucleus farm

Maize production on the nucleus farm is important for several reasons including the fact that improved production technology (cultivars, tillage practices, fertilizer use and application, weed control, insect pests and disease control, etc.) could be used for demonstration purposes to assist smallholders to improve yields. Production from the nucleus farm would contribute towards achieving the goal of self-sufficiency.

Maize also generates cash income during the establishment years of the fruit-trees planted on the nucleus farm. It is compatible with cotton in the crop rotation and yields can be increased substantially under irrigation and thus would generate high income per unit area of cultivated land (and hence of investment cost).

(b) Smallholders

Part of the smallholder's maize production can be used for family consumption, thus helping with self-sufficiency. As well, part of the production would be available for sale to generate grower cash income. Growers would be able to use the improved technology practiced on the nucleus farm to increase their per hectare yields and income, and the use of irrigation water should produce higher yields. It is a convenient crop for crop rotation and farmers are familiar with the crop.

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1 A very long list of crops/products was examined, based upon earlier studies. Most were rejected for climatic or technical reasons. Details in Annex 1.

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(2) Cotton

Cotton is well adapted to the lowveld region and is the most important cash crop on SNL. The industry is well established. High yielding disease resistant varieties are necessary for good yields. In conjunction with irrigation, cotton requires good field production practices and efficient management techniques.

(a) Nucleus farm

Cotton production on the nucleus farm could be used for demonstration purposes for the smallholders. Project farmers and others could be trained in the improved production and management aspects of the crop. Under irrigation, cotton produces higher yields and higher incomes per hectare and would generate more revenues. Cotton is also an important cash crop and the country has an estiblished processing industry. It is a good summer annual and would create meaningful employment opportunities during the growing season. It fits well in the rotation with maize and other crops.

(b) Smallholders

Most smallholder farmers are already familiar with producing cotton. It is an important cash crop and market access is good. Farmers can use the improved technology practised on the nucleus farm to increase both yield and quality. Cotton cultivation would provide efficient use of family labour and would also be a source of additional employment during the peak growing season.

(3) Potatoes

Potatoes are produced under irrigation in the lowveld during the winter months. Local production during the August-November period is in excess of local demand; the balance (50 percent) is exported to Durban and other RSA markets. Potatoes are Swaziland's biggest vegetable export by volume.

(a) Nucleus farm

Potatoes are an important winter vegetable crop in the lowveld and are well-adapted. Production on the nucleus farm would provide the opportunity to demonstrate improved production and management practices to the smallholders. Yields can be increased substantially under irrigation. Larger production would also create employment opportunities for smallholders and it fits well in the crop rotation.

(b) Smallholders

Some farmers are already familiar with the production of potatoes and it can be grown easily in the project area with guidance and advice from the nucleus farm. Part of the smallholder production

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would be used by the farmers and the surplus could be sold for cash. Smallholders can indeed generate higher incomes due to the higher yields obtainable under irrigation.

(4) Tomatoes

Tomatoes are well-adapted to the lowveld region and can be grown under irrigation during the winter period. They are also one of the most profitable crops. In 1982 tomatoes accounted for almost one-third of all vegetables produced in Swaziland. It is popular and has good export access to the RSA markets.

(a) Nucleus farm

Tomatoes are well-adapted to the project area and yields will be substantially higher under irrigation. Output can be sold in the domestic as well as the RSA markets. Yields can be increased substantially under irrigation and tomatoes fields on the nucleus farm can be used for demonstration purposes to improve production practices on smallholders' farms. Tomatoes are a labour-intensive crop and create meaningful employment.

(b) Smallholders

Farmers are already familiar with tomato production and they can improve crop yields and quality by incorporating improved production techniques learned from the nucleus farm. As well, farmers can improve their diets and earn extra income by selling the surplus. Tomatoes provide an efficient use of labour during the winter months, as well as higher farmer incomes due to increased yields under irrigation.

(5) Cabbage

Cabbage is well-liked by the population and it has a thriving domestic market. It is a suitable winter crop in the lowveld with very high yields when grown under irrigation. The reasons cited for selecting potatoes and tomatoes in the cropping patterns for the nucleus and smallholders' farms apply equally to cabbage.

(6) Fruit-tree crops

Fruit-tree crops are specialty crops and for optimum production they require specialized technical and managerial knowledge. They are both capital- and labour-intensive and require a heavy initial capital expenditure. Labour costs may amount to a third of the total field production costs. Most fruit trees are exacting in their demand in relation to soil characteristics, water use, fertilizer application and the control of insect pests and diseases. Ideal fruit-tree soils are deep and well-drained, with good water-holding capacities. Shallower soils with hard pans causing infiltration and drainage problems should be avoided or would need special

management practices such as shortened irrigation cycles, changes in irrigation cycles, changes in irrigation systems and the installation of sub-surface drainage,

To establish a reliable and profitable fertilization programme for fruit-trees, leaf and soil analyses are extremely important. It is also important to maintain accurate orchard records in terms of production, previous fertilization details, fruit size and results of past leaf and soil analyses. A good fertilization programme should take into account nitrogen, phosphorus, potassium, calcium, magnesium and micro element requirements.

(a) Citrus

Swaziland's first citrus planting was in the early 1950's. Most of the current citrus plantations are grown as estate crops under irrigation in the lowveld. Production is mostly exported overseas, but some is processed for local markets. It is also consumed as fresh fruit. Citrus production requires a high level of management expertise. The primary problem affecting this crop is the occurrence of root and other diseases and insect pests requiring high levels of disease and insect pest control measures and efficient water use techniques.

(b) Mango

One of the most important tropical and sub-tropical fruit-tree crops, mango is well-adapted to the lowveld. It is, however, extremely sensitive to climatic conditions. It is a high value export crop. Significant progress has been made in developing varieties suitable for the southern African production conditions. The harvesting period lasts only six to eight weeks.

(c) Avocado

Although very sensitive to climatic requirements, it is considered to be a suitable crop for the lowveld. It also is a high value export crop. In avocado production, the occurrence of root rot disease (Phytophthora cinnomomi) is a major limiting factor. A new technique has been developed to address this important problem, and moisture stress must be avoided. Supplementary irrigation is essential for the crop. Soils should be deep, well-drained and free of root rot-causing organisms.

(d) Papaya (Pawpaw)

Papaya is known to have originated in tropical Central America and is widely adapted to the world's tropical and sub-tropical regions. It is suitable for the lowveld region as the climate is almost sub-tropical. It does well when it is grown on deep, well-drained soils free from root rot-causing organisms. It is a valuable export crop and its overseas market acceptability is largely dependent upon fruit size, uniformity and colour.

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(e) Nucleus farm and smallholders

The selection of fruit-tree crops is based upon the following considerations:

- All the fruit-tree selected for growing in the project area are high value export crops and would thus assure the economic viability of the project. They would contribute to Swaziland's foreign exchange earnings and would reduce the foreign trade deficit. As well, since Swaziland has trade preference in the EEC market, it would be competitive with other exporting countries;

- All the selected tree crops are well-adapted to the lowveld region and they could provide impetus to further development of such projects in other suitable areas of the country. Farmer-settlers and others would benefit from the nucleus farm in the production and management of these trees on their farms. Fruit trees also create conditions for a more profitable use of irrigation water in terms of returns per unit of irrigation water used. As well, there is a better distribution and use of labour throughout the year as the harvesting period varies for the different tree species; and

- Tree crops also improve the health of the people and diet nutritional quality. If production is substantial, agro-industries might be established in future for processing. Such activities in turn will create additional employment opportunities and higher incomes.

c. Crop rotations

Crop rotation is a long-established tradition in crop culture. The primary objectives are to maintain and/or enhance soil fertility and productivity, create crop and product diversification, ensure efficient use of soil moisture, plant nutrients and labour and control soil and plant-borne disease. It also aids in combating soil and water erosion. Usually, crop rotation increases total farm income.

The suggested crop rotation for the recommended summer and winter annual crops are spelled out in detail in Annex 1. Since some 470 ha of the nucleus estate are devoted to tree crops, rotations are really relevant to only a small share of the total. Maize follows cotton as summer crops, with cabbage, potato and tomato following one another in the winter. Similar rotations apply to smallholers, but a lower share of land is devoted to field cropping.

It is important to emphasise that the suggested cropping pattern is based upon current economic and marketing considerations; it thus should be regarded as essentially indicative. It is quite likely that both the economic and marketing factors might be different by the time the project is initiated in a few years' time. This would necessitate a change in the cropping pattern to suit the prevailing conditions.

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Also if the first IDU of the project is successfully implemented on schedule, attention should then be given to reviewing the cropping pattern for possible modification and/or alteration in subsequent IDUs.

The nucleus farm and smallholders crop budgets and basic crop production economics data are presented in Annex 1.

d. Production areas and yields on the project

(1) Crop areas

Agricultural production is the core of the irrigation programme. Crop selection for production on both the nucleus farm and the smallholder area was based on a variety of factors in terms of their overall suitability for the project, their adaptation to the soils and climate of the area and the social and economic factors considered important for project viability.

Perennial crops--citrus, mango, avocado and papaya--are the important crops as they occupy approximately two-thirds of the nucleus farm total area. The economic viability of the project hinges on these crops as they are the highest income generators on a sustained basis. Annual crops included in the cropping pattern are maize, cotton, cabbages, tomatoes and potatoes. Of these, maize and cotton are the summer annuals while cabbage, tomatoes and potatoes are winter crops. Maize is Swaziland's most important food crop while cotton is the most important cash crop on SNL. Cabbages, tomatoes and potatoes are important vegetables grown in the country and have ready domestic and RSA markets. Some of the country's farmers are already familiar with these crops. The planted areas on an individual crop basis are shown in Table II-13.

(2) Crop yields

Anticipated crop yields on the nucleus and smallholders farms are shown in Table II-14. On the nucleus farm, during the first IDU, production would reach its peak during the 9th year of the project, while production on the smallholders' area would peak in PY 11. Anticipated cropping intensity is nearly 200 percent on the nucleus farm and some 175 for smallholders. As the yield figures indicate, it is assumed that the yields of the perennial crops will be the same under the nucleus and the smallholders' conditions. By and large, management and production practices will be the same in both cases. It is expected that the smallholders' practices will be closely monitored by the staff of the nucleus farm, however.

In the case of annual summer and vegetable crops, the smallholders are assumed to be much more independent in adopting modern farm production techniques. Thus it is assumed that smallholder per hectare yields for annual crops would be lower than those obtained on the nucleus farm. However, it is essential to point out that efforts should be mounted to raise the annual crop yields from the smallholders farm to the yield levels of the nucleus farm. A

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Table II-13: Areas Planted to Crops on Nucleus and Smallholder Farms

Crop	Nucleus Farm Summer (ha)	Nucleus Farm Winter (ha)	Smallholders Summer (ha)	Smallholders Winter (ha)
Maize	60	--	100	--
Cotton	60	--	100	--
Cabbage	--	40	--	50
Tomatoes	--	40	--	50
Potatoes	--	40	--	100
	All Year Round		All Year Round	
Mango	100		50	
Citrus	150		50	
Avocado	100		50	
Papaya	100		50	

Source: Devres Staff Estimates, August 1985.

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Table II-14: Anticipated Crop Yields on the Nucleus and Smallholder Farms

Crop	Nucleus Farm (t/ha)	Smallholders' Area (t/ha)
Mango	9	9
Citrus	25	25
Avocado	40	40
Papaya	25	25
Maize	7	3.5
Cotton	2.5	3.5
Cabbage	55	40
Tomatoes	30	20
Potatoes	35	28

Source: Devres Staff Estimates, August 1985

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SWAZILAND: ECONOMIC STUDY OF POSSIBLE USES OF ADDITIONAL WATER ON THE KOMATI RIVER

Table II-15: Smallholder Farm Budgets, PY 4 - 10, First IDU Development

CROP	Est. Yield (T/ha)	Est. Price (E/T)	Cost/ha (E)	Year 4 Total area(ha)	Year 4 Total Direct Cost (E)	Year 4 Total Return (E)	Year 4 Gross Margin (E)	Year 5 Total area(ha)	Year 5 Total Direct Cost (E)	Year 5 Total Return (E)	Year 5 Gross Margin (E)
Summer											
Maize	3.5	313	870	25.0	21750	27388	5638	50.0	43500	54775	11275
Cotton	2.0	820	1422	25.0	35550	41000	5450	50.0	71100	82000	10900
Papaya	25.0	400	3553								
Mango	9.0	642	4493								
Avocado	40.0	176	4668								
Citrus	25.0	271	3804								
Subtotal Summer				50.0	57300	68388	11088	100.0	114600	136775	22175
Winter											
Cabbage	40.0	100	3266	12.5	40825	50000	9175	25.0	81650	100000	18350
Tomatoes	20.0	347	4896	12.5	61200	86750	25550	25.0	122400	173500	51100
Potatoes	28.0	200	4520	25.0	113000	140000	27000	50.0	226000	280000	54000
Subtotal Winter				50.0	215025	276750	61725	100.0	430050	553500	123450
TOTAL IDU1				100.0	272325	345138	72813	200.0	544650	690275	145625

Source: Devres Staff Estimates, August 1985

SWAZILAND: ECONOMIC STUDY OF POSSIBLE USES OF
ADDITIONAL WATER ON THE KOMATI RIVER

Table II-15: Smallholder Farm Budgets, PY 4 - 10, First IDU Development (Continued)

SMALLHOLDER FARM CROP BUDGETS

BUDGET FOR IDU1

CROP	Est. Yield (T/ha)	Est. Price (E/T)	Cost/ha (E)	Year 6 Total area(ha)	Year 6 Total Direct Cost (E)	Year 6 Total Return (E)	Year 6 Gross Margin (E)	Year 7 Total area(ha)	Year 7 Total Direct Cost (E)	Year 7 Total Return (E)	Year 7 Gross Margin (E)	Year 8 Total area(ha)	Year 8 Total Direct Cost (E)	Year 8 Total Return (E)	Year 8 Gross Margin (E)	Year 9 Total area(ha)	Year 9 Total Direct Cost (E)	Year 9 Total Return (E)	Year 9 Gross Margin (E)	Year 10 Total area(ha)	Year 10 Total Direct Cost (E)	Year 10 Total Return (E)	Year 10 Gross Margin (E)
Summer																							
Maize	3.5	313	870	75.0	65250	82163	16913	100.0	87000	109550	22550	75.0	65250	82163	16913	100.0	87000	109550	22550	100.0	87000	109550	22550
Cotton	2.0	620	1422	75.0	106650	123000	16350	100.0	142200	164000	21800	75.0	106650	123000	16350	100.0	142200	164000	21800	100.0	142200	164000	21800
Papaya	25.0	400	3553	12.5	44413	125000	80588	25.0	88825	250000	161175	37.5	133238	375000	241763	50.0	177650	500000	322350	50.0	177650	500000	322350
Mango	9.0	642	4493									12.5	56163	72225	16063	25.0	112325	144450	32125	37.5	168488	216675	48188
Avocado	40.0	176	4668									12.5	58350	88000	29650	25.0	116700	176000	59300	37.5	175050	264000	88950
Citrus	25.0	271	3804									12.5	47550	84687.5	37138	25.0	95100	169375	74275	37.5	142650	254063	111412.5
Subtotal Summer				162.5	216313	330163	113850	225.0	318025	523550	205525	225.0	467200	825075	357875	325.0	730975	1263375	532400	362.5	893038	1508288	615250
Winter																							
Cabbage	40.0	100	3266	37.5	122475	150000	27525	50.0	163300	200000	36700	50.0	163300	200000	36700	50.0	163300	200000	36700	50.0	163300	200000	36700
Tomatoes	20.0	347	4696	37.5	183600	260250	76650	50.0	244800	347000	102200	50.0	244800	347000	102200	50.0	244800	347000	102200	50.0	244800	347000	102200
Potatoes	28.0	200	4520	75.0	339000	420000	81000	100.0	452000	560000	108000	100.0	452000	560000	108000	100.0	452000	560000	108000	100.0	452000	560000	108000
Subtotal Winter				150.0	645075	830250	185175	200.0	860100	1107000	246900	200.0	860100	1107000	246900	200.0	860100	1107000	246900	200.0	860100	1107000	246900
TOTAL IDU1				312.5	861388	1160413	299025	425.0	1178125	1630550	452425	425.0	1327300	1932075	604775	525.0	1591075	2370375	779300	562.5	1753138	2615288	862150

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Table II-16: Nucleus Estate Farm Budget, PY 2 - 8, First IDU Development

CROP	Est. Yield (T/ha)	Est. Return (E/T)	Year 1 Total area(ha)	Year 1 Cost/ha (E)	Year 1 Total Direct Cost (E)	Year 1 Total Return (E)	Year 1 Gross Margin (E)	Year 2 Total area(ha)	Year 2 Cost/ha (E)	Year 2 Total Direct Cost (E)	Year 2 Total Return (E)	Year 2 Gross Margin (E)	Year 3 Total area(ha)	Year 3 Cost/ha (E)	Year 3 Total Direct Cost (E)	Year 3 Total Return (E)	Year 3 Gross Margin (E)	Year 4 Total area(ha)	Year 4 Cost/ha (E)	Year 4 Total Direct Cost (E)	Year 4 Total Return (E)	Year 4 Gross Margin (E)
Summer																						
Maize	7	313																				
Cotton	2.5	820						60	1454	87240	131460	44220	135	1454	196290	295785	99495	135	1454	196290	295785	99495
Papaya	25	400						60	1886	113160	123000	9840	135	1886	254610	276750	22140	135	1886	254610	276750	22140
Mango	9	642																				
Avocado	40	176																				
Citrus	25	271																				
Subtotal Summer								120		200400	254460	54060	270		450900	572535	121635	270		450900	572535	121635
Winter																						
[illegible]	[illegible]	[illegible]																				
Tomatoes	30	347						40	4373	174920	220000	45080	90	4373	393570	495000	101430	90	4373	393570	495000	101430
Potatoes	35	200						40	7258	290320	416400	126080	90	7258	653220	936900	283680	90	7258	653220	936900	283680
								40	5171	206840	280000	73160	90	5171	465390	630000	164610	90	5171	465390	630000	164610
Subtotal Winter								120		672080	916400	244320	270		1512180	2061900	549720	270		1512180	2061900	549720
TOTAL IDU1								240		872480	1170860	298380	540		1963080	2634435	671355	540		1963080	2634435	671355

Source: Devres Staff Estimates, August 1985

SWAZILAND: ECONOMIC STUDY OF POSSIBLE USES OF
ADDITIONAL WATER ON THE KOMATI RIVER

Table II-16: Nucleus Estate Farm Budget, PY 2 - 8, First IDU Development (Continued)

CROP	Est. Yield (T/ha)	Est. Return (E/T)	Year 5 Total area(ha)	Year 5 Cost/ha (E)	Year 5 Total Direct Cost (E)	Year 5 Total Return (E)	Year 5 Gross Margin (E)	Year 6 Total area(ha)	Year 6 Cost/ha (E)	Year 6 Total Direct Cost (E)	Year 6 Total Return (E)	Year 6 Gross Margin (E)	Year 7 Total area(ha)	Year 7 Cost/ha (E)	Year 7 Total Direct Cost (E)	Year 7 Total Return (E)	Year 7 Gross Margin (E)	Year 8 Total area(ha)	Year 8 Cost/ha (E)	Year 8 Total Direct Cost (E)	Year 8 Total Return (E)	Year 8 Gross Margin (E)
Summer																						
Maize	7	313	135	1454	196290	295785	99495	60	1454	87240	131460	44220	60	1454	87240	131460	44220	60	1454	87240	131460	44220
Cotton	2.5	820	135	1886	254610	276750	22140	60	1886	113160	123000	9840	60	1886	113160	123000	9840	60	1886	113160	123000	9840
Papaya	25	400	33	3553	117249	330000	212751	66	3553	234498	660000	425502	100	3553	355300	1000000	644700	100	3553	355300	1000000	644700
Mango	9	642											33	4493	148269	190674	42405	66	4493	296538	381348	84810
Avocado	40	176											33	4668	154044	232320	78276	66	4668	308088	464640	156552
Citrus	25	271											30	3804	114120	203250	89130	60	3804	228240	406500	178260
Subtotal Summer			303		568149	902535	334386	186		434898	914460	479562	316		972133	1889704	908571	412		1388566	2506948	1118382
Winter																						
Cabbage	55	100	40	4373	174920	220000	45080	40	4373	174920	220000	45080	40	4373	174920	220000	45080	40	4373	174920	220000	45080
Tomatoes	30	347	40	7258	290320	416400	126080	40	7258	290320	416400	126080	40	7258	290320	416400	126080	40	7258	290320	416400	126080
Potatoes	35	200	40	5171	206840	280000	73160	40	5171	206840	280000	73160	40	5171	206840	280000	73160	40	5171	206840	280000	73160
Subtotal Winter			120		672080	916400	244320	120		672080	916400	244320	120		672080	916400	244320	120		672080	916400	244320
TOTAL IDU1			423		1240229	1818935	578706	306		1106978	1830860	723882	436		1644213	2797104	1152891	532		2060646	3422348	1362702

Table II-17: Summary of Nucleus Farm and Smallholder Net Returns from Base Project of 3,000 Ha (Three IDUs)

NUCLEUS FARM NET RETURNS SUMMARY
(Wage of E 3.50/day)

CROPS	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Summer															
Maize		43800	91800	91800	159800	168800	176800	176800	176800	176800	176800	176800	176800	176800	176800
Cotton		18500	37125	37125	64625	44000	71500	71500	71500	71500	71500	71500	71500	71500	71500
Papaya					226710	453420	899970	1133550	1477050	1477050	1477050	1477050	1477050	1477050	1477050
Mango							47130	94260	187720	231660	386100	457600	457600	457600	457600
Avocado							76890	153780	305220	384450	500950	500950	500950	500950	500950
Citrus							88350	176700	589000	736250	1178000	1472500	1472500	1472500	1472500
Subtotal Summer		57300	128925	128925	451135	606220	1360700	1806710	2836910	~~3077710~~ 3770400	4156400	4156400	4156400	4156400	4156400
Winter															
Cabbage		48200	108450	108450	120500	120500	192800	192800	192800	192800	192800	192800	192800	192800	192800
Tomatoes		130600	293850	293850	359150	359150	587700	587700	587700	587700	587700	587700	587700	587700	587700
Potatoes		71000	159750	159750	195250	195250	319500	319500	319500	319500	319500	319500	319500	319500	319500
Subtotal Winter		249800	562050	562050	674900	674900	1100000	1100000	1100000	1100000	1100000	1100000	1100000	1100000	1100000
TOTAL 3 IDUS		307100	690975	690975	1126035	1281120	2460700	2906710	3906910	4177710	4890400	5256400	5256400	5256400	5256400

SMALLHOLDER FARM NET RETURNS

CROPS	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Summer															
Maize				6063	12125	24250	42438	48500	66688	72750	72750	72750	72750	72750	72750
Cotton				5250	10500	21000	36750	42000	57750	63000	63000	63000	63000	63000	63000
Papaya						85875	171750	343500	601125	772875	944625	1030500	1030500	1030500	1030500
Mango								17875	35750	71500	125125	160875	196625	214500	214500
Avocado								29125	58250	116500	203875	262125	320375	349500	349500
Citrus					95500			36813	73625	147250	257688	331313	404938	441750	441750
Subtotal Summer				11313	22625	131125	250938	517813	893188	1243875	1667063	1920563	2088188	2172000	2172000
Winter					72300										
Cabbage					226550										
Tomatoes				9375	18750	37500	65625	84375	103125	112500	112500	112500	112500	112500	112500
Potatoes				35688	71375	142750	249813	321188	392563	428250	428250	428250	428250	428250	428250
				25625	51250	102500	179375	230625	281875	307500	307500	307500	307500	307500	307500
Subtotal Winter				70688	141375	282750	494813	636188	777563	848250	848250	848250	848250	848250	848250
TOTAL 3 IDUS				82000	164000	413875	745750	1154000	1670750	2092125	2515313	2768813	2936438	3020250	3020250
GRAND TOTAL		307100	690975	772975	1290035	1694995	3206450	4060710	5577660	6269835	7405713	8025213	8192838	8276650 [a]	8276650

[a] Maintained at this level in subsequent years

Source: Devres Staff Estimates, August 1985

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well-planned, well-organized and well-executed extension service will be able to accomplish this goal at some time in the future.[1]

(3) Total production levels and margins

Four summary tables are presented to depict cropping build-up and margins on the first IDU; they are similar, though slightly accelerated, on subsequent IDUs. Table II-15 presents smallholder farm budgets from when they start being settled (PY4) to maximum development (PY10). Table II-16 does the same for the nucleus estate. Table II-17 provides a summary of project-level returns for the first 15 years on 3,000 ha of development. returns stabilize at the 15 year level.

4. Implementation and phasing

Implementation and phasing of the project is conditioned by the following considerations:

- A cropping pattern that includes orchards with their inherently long establishment periods;
- The availability of a small water allocation to "Swazi area" from the existing run-of-river flows;
- The decision, based on economic analysis, to pump directly from the river as compared to the 56 km gravity canal option;
- A requirement to frame the project economic returns as favourably as possible as a means of justifying the large expenditure for the dam; and
- A need to expand food production to meet the needs of a rapidly expanding population and to assist with a balance of payment problem.

In combination, these factors suggest overlapping the dam construction with the establishment of the first IDU as per the generalised schedule given in Table II-18.

The objective of this type of phasing is to arrive at full planting of orchard areas at the time when full irrigation flows are available from the dam. This requires the availability of small flows as required for nursery operations and field irrigation of small transplanted trees. The information presented in Table II-8 above suggests that this water is available. From the Table it can be concluded that with careful management, water is available for

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1 An assessment of research available may be found in Devres, Inc., Agriculture Research Resource Assessment in the SADCC Countries. Volume II. Country Report: Swaziland (Washington, D.C., November, 1984)

Table II-18: Project Establishment Phasing, First Three Irrigation Development Units

Project Year	Dam[a] and Canal	IDU No. 1			IDU No. 2			IDU No. 3		
		On Site Works	Estate[4]	S.H	On Site Works	Estate	S.H	On Site Works	Estate	S.H
1.	Design									
2.	Construction		Nursery							
3.	Construction	Water delivery and Civil Works	Plant	25%						
4.	Construction		Plant	25%						
5.	Complete		Plant	25%	Water delivery and Site Works	Plant	$33^1/_3$%			
6.			Plant	25%		Plant	$33^1/_3$%			
7.						Plant	$33^1/_3$%	Water delivery and Site Works	Plant	$33^1/_3$%
8.									Plant	$33^1/_3$%
9.									Plant	$33^1/_3$%

Source: Devres Staff Estimates, August 1985

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Table II-19: Estimated Nuclues and Smallholder Farms and Cumulative Planting and Settlement for Three IDUs

Project Year	Estate Planting (ha)				Smallholder Planting (ha)				Smallholders Settled (no)				
	IDU 1	IDU 2	IDU 3	Cum Total	IDU 1	IDU 2	IDU 3	Cum Total	IDU 1	IDU 2	IDU 3	Total	Cum Total
		(ha)				(ha)			(Number of families)				
1.													
2.													
3.	150			150	100			100	50			50	50
4.	150			300	100			200	50			50	50
5.	150	200		650	100	112		432	50	66		116	216
6.	150	200		1,000	100	113		666	50	67		117	333
7.		200	200	1,400		115	112	934		68	66	134	467
8.			200	1,600			113	1,068			67	67	534
9.			200	1,800			115	1,200			66	66	600

Source: Devres Staff Estimates, August 1985

use in establishing nurseries and for another field cropping during specific months. This is, of course, contingent on receiving the right to use the apportionment. As well, some water will no doubt become available while the dam is under construction.

Table II-19 demonstrates the cropping and related build up of smallholder and nucleus estate development. These are supplemented in more detail in Annex 4 to this Volume II. Cropping patterns and yield build-up are naturally related to these schedules. Given the lead-times needed for the crops to reach full yield, peak revenues are reached at PY 11, 15 and 19 for the first three IDUs.

5. Markets and marketing

a. Crop selection and market potential

A wide variety of prospective crops had already been examined and evaluated in a recent study commissioned by USAID. From this list, nine were selected as suitable for cultivation in the lowveld project area, and having export and domestic market potential--citrus, mango, papaya, cotton, maize, cabbage, tomato and potato.

Those tree crops are currently in demand in overseas markets between November and April, during the off-season in the Northern hemisphere. Cabbage, tomatoes and potatoes have established markets in Swaziland and neighbouring African countries. Maize is the most important ingredient in the African national diet, and a high priority item for import substitution. Cotton is in increasing demand by the RSA cotton spinning and textile industry.

Overseas export markets in which Komati project produce should be able to generate significant foreign exchange earnings are identified in Western Europe, the Middle East and Japan. In Western Europe, particularly attractive opportunities should exist in France, the U.K., German Federal Republic and Scandanavia. The Middle East is Swaziland's most important customer for citrus, and this provides a valuable bridgehead into the Gulf States. Japan is already an important market for Swaziland grapefruit, and could become a regular importer of papaya (Solo or Pepio varieties only) throughout the year, and of mangoes and avocados during the off-season when high wholesale prices could cover the costs of air transport. Access to the Japan's market would be subject to export produce satisfying the rigid plant production laws, and the availability of direct transport. Since this presents no problem for grapefruit exports, the prospects for other produce would appear favourable.

Supply projections for fresh produce, prepared by IFAD in 1980, forecast 38,000 MT would be required by 1994, when the Komati Irrigation Project's first IDU is scheduled to commence its first year of vegetable harvest. Actual supply in 1982 was less than half IFAD had forecast for that year. Corrected projections from the 1982 data base indicate a shortfall of 13,000 MT on original estimates. Calculations by Ronco Consulting Corporation in 1983 pointed to a projected shortfall of 9,400 MT by 1990, requiring 670 ha additional irrigated land, equating to 926 ha by 1994 which conforms closely

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with the 1,100 ha of vegetables proposed by this project at full development of three IDUs. In the absence of alternative irrigated land, the Project would be well placed to make good the projected shortfall.

The recent establishment of the National Agricultural Marketing Board (NAMB) by the Government of Swaziland (Bill No. 5 of 1985) is a major step towards producing a steady market for smallholders on SNL. The existence of such an organisation, appropriately staffed and equipped, will be an indispensable channel for the distribution of produce from the project area to the national markets. Moreover, the construction of the proposed new wholesale market at Mahlanya would provide ready access to the main markets of Matsapha and Mbabane in the contract area.

Cabbage is selected for its important role in the national diet, its profitability in Swaziland between January and July, and for its competitive advantage in the RSA market between August and September. Tomatoes, too, are able to trade in the domestic and RSA markets according to comparative price advantage and use. The proximity of the tomato canning plant at Malelane provides an outlet for up to 3,000 MT of the Roma variety when RSA supplies cease during October and November. During this period, the Durban fresh produce market is undersupplied from RSA sources, and up to 1,000 MT is regularly sought by itinerant trucking companies. Potatoes have been Swaziland's principle vegetable export for many years. In 1982 2,000 MT, or 64 percent of potato production, was exported to RSA. During the period 1975 to 1981, RSA production consistently failed to satisfy market requirements. It is estimated that RSA processors would have no difficulty in absorbing 2,000 MT potatoes annually.

Exports of fresh vegetables to Europe, the Middle East and Japan are not economic as these countries are fairly well supplied throughout the year and market prices do not cover the cost of freight from Swaziland to the market place.

The RDA programme is directed towards increasing maize production in rainfed areas. USAID is concentrating on research and extension. IFAD is expected to fund a credit/marketing project within the structure of the newly established NAMB. Notwithstanding these programmes, actual and proposed, it is estimated that maize imports of around 50,000 MT annually will continue for several years. Each project IDU provides for an average of 200 ha under irrigated maize cultivation throughout the life of the project with an annual output of 700 MT valued at E215,000 per annum. Three IDUs would triple those values.

The crops selected are limited to those for which a ready demand has been identified. However, opportunities are known to already exist or to be rapidly developing for many other fruits and vegetables including green beans, lychees, passion fruit (granadilla), guavas, macadamia nuts, green nuts, groundnuts, oil seeds and pineapple. These items will be cultivated in the project nursery to test their suitability for cultivation in the project area and later to test market potential in the domestic and export markets.

b. Domestic and export sales and sales margins

(1) Background

The market sales/margins analysis builds upwards and outwards from the project farmgate values used in the project's financial and economic analysis. The analysis delineated market percentage shares for each crop--domestic, RSA, and external. These, of course, varied for each crop and, in some cases, between smallholder and nucleus estate. Market prices (E, R, $) were multiplied by these net production to calculate revenues or net sales (NS) and thence gross margins (GM) by subtracting farmgate values. Those amounts to cover all marketing costs in-project. GM values are then expressed as percentages of NS values.

(2) Selected findings

The field crops have the lowest GM/NS rations, generally negative in the case of smallholders since a 30 percent share has been assumed to be consumed on-farm. Exported tree crops, however, usually have very high ratios, ranging from a low of 33 percent for citrus (shipped by sea) up to 90-93 percent for avocado (shipped by sea)--ratios are slightly lower if the produce is shipped by air, since transport costs per tonne are higher.

A further set of assumptions was made to delineate foreign exchange earnings. For smallholders, it was assumed that 70 percent of the tree crops marketed in the Northern Hemisphere were sent by sea, and 30 percent by air. It was then assumed that 1/3 (33.3 percent) was lost due to spoilage, waste, etc. That dropped the $ figure to $7.5 million. The equivalent for the nucleus estate on one IDU was $23.7 million, a total of some $31.2 million annually as full development; the base project of 3,000 ha would naturally triple that figure in due course (nearing PY 28-30).

c. Transport and packaging

(1) Export by air cargo

Jan Smuts Airport, Johannesburg, is the main air cargo port for South Africa with regular daily flights to the markets of Western Europe. As a member of the SACU, Swaziland has access to this facility, Swazi produce is shipped by road transport to Jan Smuts Airport, a distance of 450 km taking seven hours, using South African Transport Service vehicles which also handle similar produce from Nelspruit and the RSA lowveld. Costs are E8.03/kg by SATS, and E7.08/kg by fruit growers; small loads are E10.08/kg.

The commodity rate, as of July 1985, from Jan Smuts Airport to principal Western Europe air terminals is R0.99/kg (April - September) and R1.05/kg (October - November).

Air cargo to the Gulf States is R6.05/kg at straight freight costs. Commodity rates are not known but are normally around 25 percent = estimated R1.50 (at 40 percent straight rate = R2.42).

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Air cargo to Tokyo is R10.35/kg at straight rates and could be expected to be a minimum R2.58 and a maximum R4.1/kg. However, direct flights are not scheduled and would not provide a basis for on-going exports to these markets.

Air charter services do not operate out of Johannesburg. Air Gambia operates a direct cargo service to Stockholm (Sweden) from Harare (Zimbabwe) at US$2/kg. Air Gambia also has flights from Harare to the Gulf States. Trade Winds, a leading British air cargo operator, quoted E1.04/kg in 1984 for direct cargo flights from Matsapha Airport using the extended runway to take Boeing 707s on a twice weekly service to Europe (lifting 25t of horticultural produce per aircraft). A decision has yet to be taken on this matter.

Until recently, wholesale prices in export markets, during the northern hemisphere off-season period, were high enough to absorb air cargo costs from RSA to Europe. However, with sea freight costs being around 88 percent less than air cargo, the prospect of increasing competition implies that products dependent upon air freight may need to make greater use of alternative carriers to compete effectively. Avocados, for example, are currently traded in Western Europe wholesale markets at $1.6/kg. Continuing pressure could erode margins to a point where profitability will depend on containerized shipments by sea transport. By contrast, the greater margins resulting from sea transport will ensure that the Komati project product is able to defend its position, at least on a price basis. To this end, it is recommended that Komati exporters should collaborate closely with RSA exporters to secure the most economic rates from the shipping conference lines.

(2) Export by sea

Fruit and vegetable exporters consider Cape Town more suitable, more economical and faster than Durban and Maputo for perishable cargo destined for Europe.

Fruit cargoes are sent by road transport from Swaziland direct to Cape Town at E0.16/kg. For large consignments, cool box containers are used as an alternative to normal containers. Cool boxes are fitted with a portable electric cooling unit which circulates cool air continuously through an elevated floor. Boxes (6m x 2.5m x 2.5m) are transferred to container vessels and connected to the ship's cooling system. Containerized transport would be essential for produce from the Komati project area.

The composition of costs between farmgate and arrival at export destination are complex and vary according to each type of produce. The figures quoted in Volume III have been obtained from farmers, fruit exporters in RSA, and shipping agents and may be taken as a reliable calculation base as of July 1985.

Sea freight costs from Cape Town to Europe, including port handling, documentation, wharfage, insurance and freight to European ports are as follows:

- Mangoes: E0.13/kg
- Avocados: E0.12/kg
- Papaya: E0.12/kg

(3) Packaging for export

Swaziland is fortunate to have its own paper pulp industry and cardboard cartons for two-colour printing. Four and five kilogram fruit boxes at E0.50 per unit are available at 18 percent below Kenya prices. However, competitors' prices from RSA should also be sought in view of economies of scale through over-run of similar containers. Vegetable boxes of three and five kilograms are E0.25 and E0.45 respectively.

d. Recommendations

The basic recommendation must be to begin work with all deliberate speed on the institutional structure required for the marketing process in this irrigation project. Annex 2 to Volume II contains numerous recommendations as to initial staffing, training, and relationships to the new NAMB. The Terms of Reference for the next (design stage) study recommend strongly that an equivalent study to Volume III of this study be conducted when the full feasibility study is underway. It should begin 12-15 months before that final analysis is completed so as to provide the required inputs.

B. Project Organisation and Management

1. General introduction

Any discrete project needs an institutional home, a nest in which to sit. That nest provides the institutional framework by which the project survives. Technical, financial, administrative, servicing, marketing and other umbilical cords provide inputs, accept outputs, and otherwise sustain the project's life. Thus a description of management structure and process within the project must be accompanied by an estimation of those structures and processes without, or outside of, the project.

Failure to provide a suitable decision-making process brings agricultural development projects by the score, to their knees. There are numerous reasons for this. Among the more common, singly or in combination, are:

- Failure to divorce the project from the typical governmental and bureaucratic systems which are not made for commercial/financial management decisions regarding financial viability; many of the new people on such projects can be transfers from government and naturally bring that mental set with them;

- Failure to come to grips with the "people" aspects of such projects. Not accomodating properly to peoples' felt needs has ruined far more projects than faulty agronomy or water distribution. Examples might include festering resettlement issues; non-accomodation for livestock; and tenure and jurisdiction system; small farmer representation in management decisions affecting them; and, in some areas, representation in management by local traditional authorities;

- Failure to provide continuous up-grading of services to improve efficiencies;

- Relatively, failure to provide dynamic marketing services and all that attends such failures; and

- Failure to stay on top of engineering and agronomic issues which, progressively, can affect yields and production, e.g. vesting of pests and diseases in soils, and matters of soil fertility such as drainage and salinization.

As a matter of common sense, then, the Komati Irrigation Project's management structure and processes should be devised so as to negate or at least minimize these known illnesses and sicknesses. Bad management means other resources, cumulatively scarce in poorer nations such as Swaziland, are also wasted e.g. land and water. That being said, it is of course a bit unreal attempting to think out a structure and set of processes for an organization which, at the earliest, will not be in operation for 8-12 years!

A general overview of water management organization in Swaziland was provided in the Tate and Lyle report (Main Report, Chapter 7); there is no need to repeat that here in all detail. They discussed the rather limited institutional capability at the national level with respect to overall and multi- basin water management, and the absence of organized research. They made the point, ascribed to fully here, that the absence of experience with 3,000 - 5,000 ha projects such as this, especially including smallholders, means, per se, the lack of precedents on which to rely for the design of specific projects, of basin-level plans, and of national-level water plans. They also emphasised that projects which would be considered highly modest in scoope and claim on national resources in many other nations nonetheless loom very large relative to Swaziland's resources.

Subsequent discussion will, first, touch on the matter of the management system and organization <u>above</u> the project. The problem of an inadequate "nest" into which a given project may sit can be added to the earlier list of "failure to" matters. It is important to point out, with emphasis, that because of the lack of appropriate financial, administrative, technical and other "umbilical cords" a project can fail quite miserably, regardless of how well it is designed internally.

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Section 3 then provides more details on those internal project workings and investigates the primary management functions and their relationships to one another. There are any number of "ifs", "maybe's" and "buts" given all the unknowable at this point in time so that detail beyond that provided is not considered realistic.

A project authority must perform a range of distinct functions. Though intimately related in a sequence of events over a cropping and calendar year, and over longer periods of time for some functions, each distinct operational area can be discussed in its own right. These include:-

- Land management for the overall project;
- Development and maintenance of water supply and distribution systems;
- Installation and maintenance of all other structures and civil works;
- Establishment, operation and maintenance of all rolling stock, machinery and equipment;
- Continuous development of agricultural production systems and pursuit and maintenance of optimal yields over time;
- Establishment, operation and ongoing maintenance of on-projects, transport, handling, storing, packing, etc. services;
- Initial and continuous screening of smallholder candidates, their establishment on their plots, and the ensuring of their adherance to settlement contractual obligations, e.g. yields to <u>not</u> drop below certain levels;
- Continuous provision of services to the nucleus estate and smallholders:

  - extension, including crop and water use;
  - machinery services;
  - credit services;
  - input supply;
  - marketing services;
  - transportation services off-project; and

- Continuous effort to ensure payments for water, services, etc so that the project's financial base remains sound; necessary to work off heavy investment in water delivery systems.

Section 4 presents a further dimension. The management organization and progress may require modification and enlargement over time as the second, then the third IDUs are put in place--there may be thresholds at which points new management elements will be required, certainly if the project moves up to

five IDUs (63 MCM). Section 5 reiterates a number of elements which must receive continuing management attention if the Komati Irrigation Project is to maintain is financial and economic buoyancy over time.

2. Possible management systems above the Komati Irrigation Project

This section's purpose is to suggest in an highly skeletal fashion a possible management structure for planning and running the Komati Basin system. Figure II-6 shows the proposed organisational structure for a Komati Basin Authority. As indicated in numerous connections elsewhere in this pre-feasibility analysis, a new-born baby dies when it is thrown out in the bush; it needs connecting system.

If not at the present time, then in due course the entire Komati River Basin must come under one integrated operating and planning management. It could become the prototype for other larger basins which concern both Swaziland and one or more other countries. In the Komati case the RSA are dominant in water use. They therefo e will want a strong hand in planning overall Basin use and in operating Maguga and any future reservoirs--there could be a good number.

The governing Board of such an authority would no doubt need joint Chairman from both nations (possibly Mocambique in due course), or alternating Chairman. These would be responsible to both governments, possibly through JPTC.

The more technical wing of the Board would be composed of relevant professionals from both nations, including those who administer Maguga and any other dams. Agricultural officials are necessary since there can be a tendency for such Boards to be water distribution systems rather than systems responding to the needs and demands of cultivators and of other users. The other half of the Board should comprise representatives of the main public and private uders in the several countries. In the Komati case, these would be mainly from the RSA. To assist the executive chairman with the overall Basin planning task, a small group of technical experts and resource planning experts could be assembled. Budget could also be provided for consultants as as needed.

3. Management at the IDU level

a. Introduction

An irrigation project such as the one proposed requires management skills of particular kinds. The first requirement is to recognize that the project will have cost the GOS a great deal of money; rapid cost recovery and financial viability as quickly as possible are mandatory.[1]

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1 As will be shown in Section II.C. below, the project's financial structure has been designed to permit liquidity and viability with all deliberate speed.

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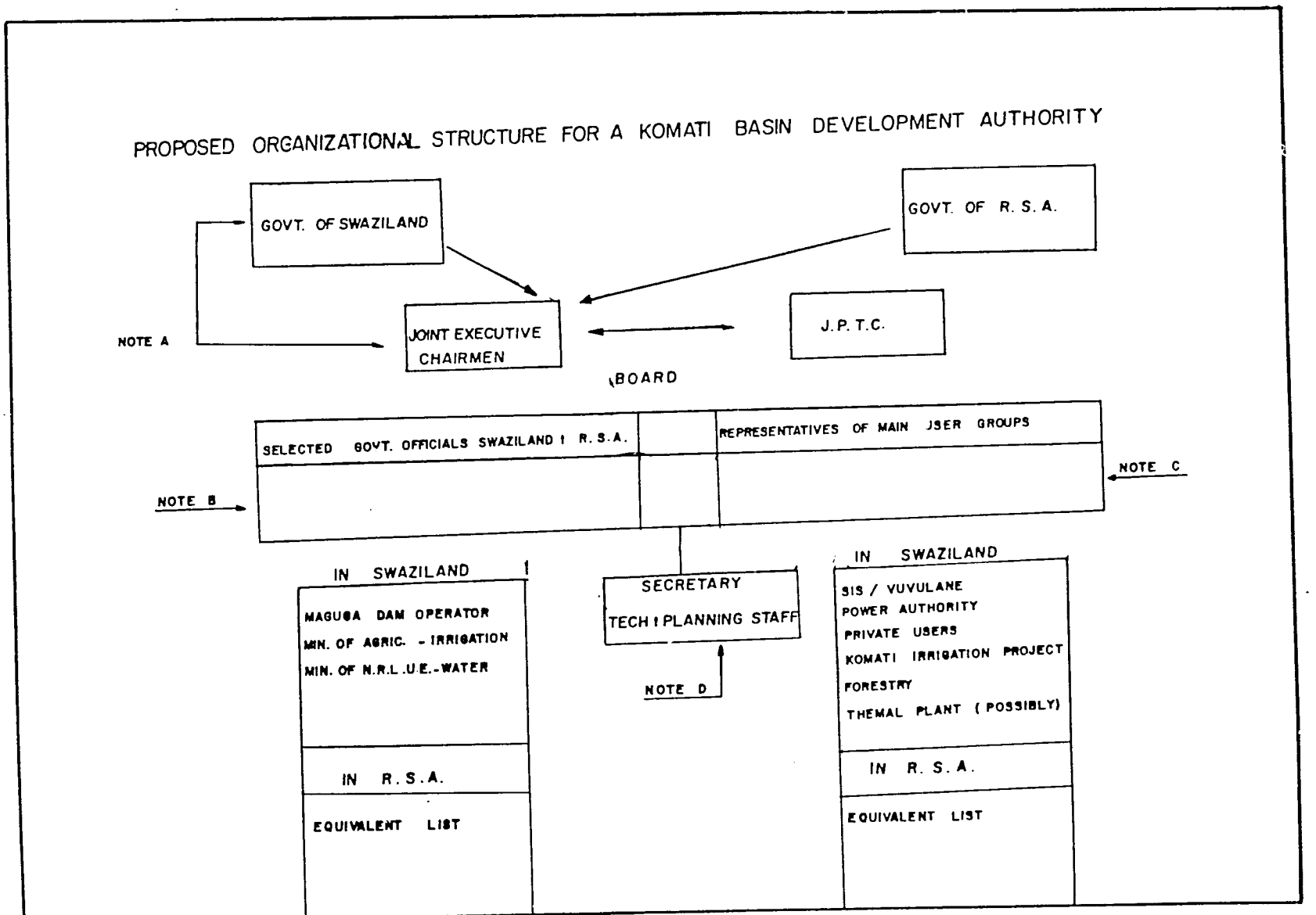

SWAZILAND: ECONOMIC STUDY OF POSSIBLE USES OF ADDITIONAL WATER ON THE KOMATI RIVER

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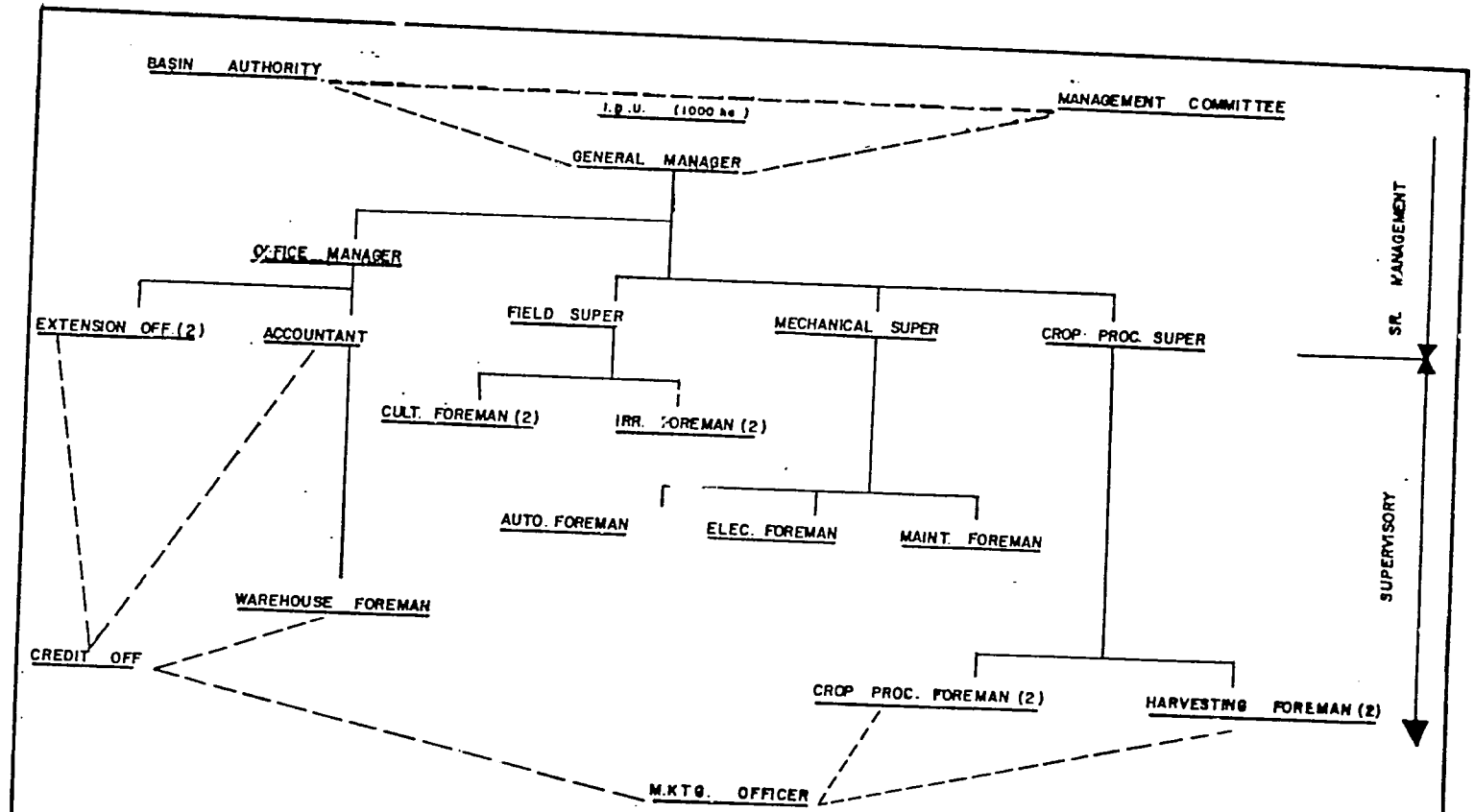

FIG POSSIBLE MANAGEMENT ORGANISATION FOR TYPICAL I.D.U.

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Secondly must be the continuous application of skills to the harmonization of smallholder production with production and other processes on the nucleus estate. While it is recognised that the nucleus estate itself probably will become more viable more quickly, a failure to service smallholders properly, raising their production and incomes quickly, will cause a continuing drag on overall project viability. It will also provide serious disincentives if smallholder income is not realised with all deliberate speed.

b. Senior management

(1) General Manager

The first requirement is an operationally experienced general manager (G.M.) He should have basic training in agricultural production and experience in business. Depending upon circumstances and timing several other senior management devices may be employed. As shown at Figure 1 -7, the project requires links of a very definite variety to higher government levels, a Basin Authority, or whatever (discussed in more detail at Section 2 above).

(2) Management Committee

As well, however, it is useful to conceptualize some form of Management Committee (MC). Its role is to provide policy and proceedural direction to the GM, and guidance respecting project development matters and their timing. Representation could be, for example:

Chairman: Director of Agriculture

Members: Representatives of/from
- -Ministry of NRLUE and JPTC
- -Managing agents/consultant contractors
- -Chiefs/headmen of the area; elected or appointed officials/representatives
- -Project smallholders
- -Project permanent workers
- -Possibly a Basin Development Board

Clearly which government agency provides the Chairman is a policy decision. It must be recognized, however, that this is an agricultural project, not a water supply project, not a land project, not a power project, or whatever--its justification is agricultural; its objectives are those for the agricultural sector; its impacts are economic and social. It could be, however, that such an MC would be more appropriate at the "full" project level--three or four IDUs and is therefore mentioned again at Section 4 below.

(3) Senior Managers

Senior management then also includes four others, an office manager, and superintendents of field operations, of mechanical operations and of crop processing. The office manager would generally deputize

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for the GM. Under his jurisdiction would be all accounting staff, and the warehouse and its records. The warehouse, in turn, would not only support the nucleus estate with its requirements, but would also carry the inputs needed by the project's smallholders. Thus, there are links between the credit officer, the extension officers, and, as appropriate, the marketing officer. The extension officer, working almost exclusively with the smallholder, could be directly under the GM if desired. There are arguments for keeping them administratively associated with the credit and marketing officers as well.

The credit officer would be responsible for the entire credit fabric for the project's smallholders. This includes, most importantly, credit for input supply. It could encompass, however, marketing credit, including transport credit.[1] The crop processing operation and the marketing officer (or marketing unit) would often be involved in this process, depending on the crop. The marketing officer would be responsible for selling the project's output. He would be experienced in international marketing, would be connected to brokers, shippers and wholesalers in the relevant overseas markets (tree crops), and would work closely with the crop processing operations to ensure that market requirements (size, quality, packing, etc.) were being met. There are strong arguments for the marketing function to be contracted to a private firm.[2]

The field superintendent would be responsible for all production operations on the estate including cultivation, irrigation, fertilization and the nursery. He and his foremen would also work with the extension officers in providing production advice to smallholders. His foremen would specialize in both crop cultivation and irrigation. He would also make basic decisions regarding advice on varieties, weed control, pest management and the like.

The irrigation staff functions under the field superintendent. Two irrigation foremen share the responsibility of supervising, 1) permanent skilled labourers; 2) 30 permanent unskilled labourers; and 3) temporary field labourers ranging from none required in the winter to 45-75 required in the summer. The skilled labourer is assigned the responsibility for adjusting values of properly pressurized laterals and follows established irrigation times. The unskilled labour works basically in gangs of six involved in pipe moving. The staff is adequate to maintain a seven-day interval in the summer and 21-day interval in the winter.

A computerized climatological approach to water scheduling is recommended. To accomplish this, a series of four to six rain gauges should be installed as well as a Class A evaporation pan at the office. Using available computer programmes and field records for each crop, a weekly moisture status

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1 An effort was made to delineate more specifically just how the credit system would work on this project. Questions such as "Would the SDSB open a credit office on the project?" etc. were discussed but there was insufficient time to devise answers. It is not critical this far in advance in any case.

2 Annex 2 details these marketing possibilities; it is entitled "Organization of Marketing Operations."

report can be developed. The irrigation staff would use the report as a basis for scheduling irrigation rounds and demands from the reservoir up to a week in advance. The harvesting faorman would also use the moisture status to gauge crop ripening.

The mechanical supervisor would probably have at least three more specialized foreman: auto, electrical and maintenance. They would be responsible, literally, for "keeping the place going." The project's pumps in particular would need regular attention and the serious and ongoing problems of maintaining machinery and equipment, and structures, are well recognized.[1] The crop processing superintendent would have supervisory help for both harvesting, per se, and for processing. This latter would include any grading, sorting, bagging, binding, sacking, cleaning, baling, etc, needed for off-project sales. This superintendent would also maintain computerized crop yield and water consumption records; among many other things these data will assist with adjusting water charges.

(4) Permanent labour

It is envisioned that about 130 permanent labourers are needed for each IDU of 1,000 ha. Of these, some 30 would be skilled and 100 unskilled. The former require formal or on-the-job training. They are considered as senior employees, would be provided appropriate housing, and would be responsible for the safe operation of machinery and equipment. Job titles would include drivers, mechanics, plumbers, electricians, secretary, etc. The unskilled would work directly under a skilled worker or a foreman. In general they would not handle equipment, but would attend to hand harvesting, hand cultivation and irrigation pipe moving. Their presence precludes the need for temporary labour in the winter months. They would be not provided housing. Seasonal/temporary labour requirements are examined in Section below.

c. Smallholder organisation

A recent study by IFAD examining credit needs of smallholders on small irrigation projects proposed that such farmers form Farmers Associations.[2] These could eventually become cooperative societies. Since there were no nucleus estates in those projects, nor management committees on which smallholders could be represented, it is not known if these Farmers' Association, for each IDU probably, would be germane. There is no reason why they should not be formed to represent smallholders interests. The Tate and Lyle Big Bend Project recommended a smallholder body which would service farmers in place of nucleus estate doing some inputs, etc. This is also an option which could be considered at the time the project goes ahead.[3]

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1 In the Terms of Reference for the design stage of this project we are recommending that a way be found to "fool-proof" the project from the all too common problem of deficient maintenance and repair (Vol. I., Annex 3)

2 IFAD, Swaziland Smallholder Credit and Marketing Project: Appraisal Report (Rome, September, 1982), pp.34-35.

3 Tate and Lyle, op.cit., pp.104-111.

4. Management structures as IDUs increase in number over time

The discussion above concerns one 1,000 ha IDU. While the irrigation project naturally begins with one IDU, it does not stay at that level. Rather, every three-five years a further IDU of 1,000 ha is added. Each has a similar structure. By the time a third IDU is in place (3,000 ha, the base project using 40 MCM) it would very well be that some management integrating or coordinating device or structure is required. This need would be even more apparent were the project to expand to 5,000 ha. In addition, the scale of work might very well justify the employment of specialists servicing all IDUs.

An overall Project Director may then be required, with a small specialized staff serving all IDUs. Probably the first specialist could be an agronomist skilled in variety work, and pest and diseases; constant yield improvement would be his specialty. The second addition could be an agricultural engineer who would concentrate on improving water distribution and drainage efficiencies. And thirdly, a more specialized marketing expert might be needed. As discussed at Section 3 (b) 2 above, a Management Committee could be struck which advised all IDU's through the overall Project Director.

5. Other management elements for consideration

It is important that core management requirements are sustained over time. Discipline must be ongoing with respect to crop schedules, marketing contracts, and the like. Bureaucratic "creep" must continue to be avoided at all costs. Incomes of smallholders must continue to be enhanced, and services to them must steadily improve. All of these require deliberate and sustained management efforts.

As well, every opportunity must be examined to promote investment in agro-industries on the project. As markets are better understood, and as production volumes increase, certain types of processing/treating become more viable e.g. vegetable freezing, juice and pulp production; legume packaging; a maize mill; a small abattoir; a dairy; etc. These can add appreciably to project net income. Consultants/agents can generally run such projects on a business/profit basis.

Certainly, at a project scale of 5,000 ha, but possibly even at 3,000 ha, a Research and Development Section or unit could become an important part of the project (perhaps under a Project Director, as discussed above). This would concentrate on testing crops and products for quality, taste, etc, and on testing for new processing/treatment techniques.

Accounts must continue to be maintained in the most vigorous fashion, and be continuously up-to-date. Computerized monthly statements to smallholders are desirable, as at Vuvulane.

Finally, management must pursue cost-cutting at every opportunity, especially in those areas of major costs e.g. water/electricity and equipment operation. Particular gains can be made in the efficiencies of servicing smallholders.

C. Financial and Economic Analysis

The basic cost and returns data for the development of the 3,000 ha and 5,000 ha irrigation projects are summarized in Table II-20 and Table II-21 respectively. Both project sizes demonstrate relatively high rates of return when the costs of constructing Maguga Dam are excluded--the economic internal rate of return (EIRR) being over 10 percent and the financial rate of return (FIRR) over 8.5 percent in each case. Exclusive of the dam costs, the rates of return differ more significantly with the 5,000-ha model exhibiting the more favourable EIRR of 5.74 percent and an FIRR of 4.32 percent as compared with the EIRR of 3.87 percent and the FIRR of 2.68 percent of the 3,000-ha.

1. Project costs

a. Capital costs

Estimated annual capital costs for the construction of the three IDUs proposed as the base project for initial establishment in the Komati Basin are summarised in Table II-20. The Maguga Dam construction costs are not included as they had already been determined by another study at the time this analysis was undertaken. The latest available data on dam construction costs were obtained from the engineering consulting firm of Olivier, et.al. and have been incorporated into the economic and financial analysis of the current study.

The capital cost data provided in Table II-20 include all irrigation costs, in-field equipment, offices, shops, warehouses, crop-processing facilities and housing for the nucleus farm management personnel and for farm workers. Costs of primary and gravel road construction and the installation of public utilities have also been included. For analytic purposes all costs were assumed to be the government's responsibility although, in practice, some of them could be provided by the end users or recovered from them through user charges. Housing costs, for example, could be recovered through appropriately established charges. This type of cost recovery has not been built in to the analysis, however.

The total capital cost of three IDUs (exclusive of the Dam) is estimated at E31.5 million inclusive of 20 percent allowance for design, supervision and physical contingencies. The cost of initial field equipment pruchases are also included as a share of capital costs. Incorporating E40 million as Swaziland's proposed share in the Maguga Dam construction into the capital costs of the irrigation project would raise total cost to E71.5 million for three IDUs and

Table II-20: Summary Statistics: Base Project (Three IDUs)
(Consuming 40 MCM)

Net Irrigated Area	
Nucleus Estate	1,800 ha
Smallholders	1,200 ha
Total	3,000 ha
Investment Costs	
Total (including dam)	E71.50 million
Of which	
(Irrigation Development)	(E31.50 million)
(Housing and Utilities)	(E 8.36 million)
Operating Costs	
Fixed Costs	E 0.92 million/annum
Direct Operating Costs	E 0.82 million/annum
Total	E 1.74 million/annum
Gross Value Added	
Total Crop Revenues	E 8.27 million/annum
Of which	
(Smallholder Revenues)	(E 3.02 million/annum)
(Foreign Exchange)	(E 4.00-5-60 million/annum)
Annual Agricultural Production	
Field Crops	Tonnes
Maize	2,870
Cotton	1,250
Tomatoes	8,400
Potatoes	14,700
Cabbage	14,800
Fruit Crops	
Mangoes	4,410
Papayas	9,500
Avocadoes	15,200
Citrus	15,000

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Table II-20: Summary Statistics: Base Project (continued)
(Consumming 40 MCM)

Employment Generation	
Smallholders	600 families
Full-time paid farm workers	927
Seasonal workers	627
Personal Incomes Generated	
Smallholder families	E5,035/annum
Paid farm workers	E1,050/annum
Return on Investment	
Exclusive of Maguga Dam	
Economic Return	10.02 percent
Financial Return	8.62 percent
Inclusive of Maguga Dam	
Economic Return	3.87 percent
Financial Return	2.68 percent

Source: Devres Staff Estimates, August 1985

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Table II-21: Summary Statistics: 5000 Ha Project (Five IDUs)
(Consuming 63 MCM)

Net Irrigated Area	
Nucleus Estate	3,000 ha
Smallholders	2,000 ha
Total	5,000 ha
Investment Costs	
Irrigation Development	E92.50 million
Of which	
(Irrigation Facilities)	(E52.50 million)
(Housing and Utilities)	(E13.93 million)
Operating Costs	
Fixed Costs	E 1.53 million/annum
Direct Operating Costs	E 1.38 million/annum
Total	E 2.91 million/annum
Gross Value Added	
Total Crop Revenues	E13.71 million/annum
Of which	
(Smallholder Revenues)	(E 5.03 million/annum)
Annual Agricultural Production	
Field Crops	Tonnes
Maize	4,970
Cotton	2,250
Tomatoes	14,600
Potatoes	25,200
Cabbage	25,400
Fruit Crops	
Mangoes	7,470
Papayas	15,250
Avocadoes	24,400
Citrus	25,000

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Table II-21: Summary Statistics: 5000 Ha Project (Five IDUs)(continued)
(Consumming 63 MCM)

Employment Generation	
Smallholders	1,000 families
Full-time paid farm workers	1,545
Seasonal workers	1,045
Personal Incomes Generated	
Smallholder families	E5,035/annum
Paid farm workers	E1,050/annum
Return on Investment	
Exclusive of Maguga Dam	
Economic Return	10.34 percent
Financial Return	8.75 percent
Inclusive of Maguga Dam	
Economic Return	5.74 percent
Financial Return	4.32 percent

Source: Devres Staff Estimates, August 1985

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Table II-22: Summary of Phased Capital Costs per Hectare, One IDU[a]

	1	2	3	4
Surveying	28000	14000		
Housing for management	699400	349700		
Offices	154700			
Warehouse	99200			
Shops	124900			
Crop processing			285700	
Installation of buried mainlines (12,500m) and balancing reservoir (cap. 45,000 m)	1367900	77500		
Install buried sub-mains (5,500 m)	226000			
Install buried manifolds (10,000 m)		321000		
Install utilities	110900	80200		
Install pumping plants	536000			
Install drainage system				991900
Land preparation (clearing, burning, levelling and ploughing	1331900			
Install roads (5.5 km gravel and 32.5 km primary)		519700		
Purchase, assemble and distribute overhead irrigation system	1005000			
Install nursery facility (10 ha)	76600			
Permanent labour housing (130 units)	772800	772800		
TOTAL	6532400	2135500	285700	991900
PER HECTARE COST OF INSTALLING 1,000 HA IDU				9946

[a] Full capital cost data are on file.

Source: Devres Staff Estimates, August 1985

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Table II-23: Summary of Operating Costs, One IDU (E)

	Percentage of capital cost/year	Project Year 1	2	3	4	5
Energy						
Electrical		10,000	30,000	50,000	78,000	78,000
Petrol/diesel		15,000	30,000	48,000	48,000	48,000
Parts and Supplies						
Irrigation system (portable)	2		5,000	10,000	20,000	20,000
Pumps and mainlines	0.5		3,000	6,000	12,000	12,000
Vehicles maintenance	6	5,000	10,000	10,000	40,000	40,000
Housing/offices	2		3,000	6,000	18,000	18,000
Shops/warehouse	2		1,000	2,000	4,000	4,000
Crop processing	2				4,000	4,000
Utilities	1		500	1,000	1,500	1,500
Drainage system	1				7,500	10,000
Contracted						
On site road grading			5,000	15,000	28,500	28,500
Miscellaneous						
Office supplies		200	4,000	6,000	6,000	6,000
Base cost		32,000	91,500	164,000	267,500	277,500
Physical Contingency 10%		3,200	9,150	16,400	26,750	27,750
Total cost		35,200	100,650	180,400	294,250	305,250[a]

[a] Maintained at this level in subsequent years.

Source: Devres Staff Estimates, August 1985

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Table II-24: Phased Direct Cost Summary, Three IDUs

	1	2	3	4	5	6	7	8
SALARIES								
Management Staff								
General Manager	20000	20000	40000	40000	60000	60000	60000	60000
Office Manager	15000	15000	30000	30000	45000	45000	45000	45000
Field Superdt.	12000	12000	24000	24000	36000	36000	36000	36000
Mechanical Superdt.		12000	12000	24000	24000	36000	36000	36000
Crop Processing Superdt.			12000	12000	24000	24000	36000	36000
Subtotal	47000	59000	118000	130000	189000	201000	213000	213000
Supervisory Staff								
Accounts Clerk		7000	7000	14000	14000	21000	21000	21000
Extension Officer		7000	14000	21000	28000	35000	42000	42000
Marketing Officer			15000	15000	30000	30000	45000	45000
Credit Officer			13000	13000	26000	26000	39000	39000
Cultivation Foreman	7000	14000	21000	28000	35000	42000	42000	42000
Irrigation Foreman		14000	14000	28000	28000	42000	42000	42000
Harvesting Foreman			7000	14000	21000	28000	35000	42000
Automotive Foreman		7000	7000	14000	14000	21000	21000	21000
Electrical Foreman		7000	7000	14000	14000	21000	21000	21000
Crop Process.Foreman			7000	14000	21000	28000	35000	42000
Maintenance Foreman		7000	7000	14000	14000	21000	21000	21000
Warehouse Foreman		7000	7000	14000	14000	21000	21000	21000
Subtotal	7000	70000	126000	203000	259000	336000	385000	399000
Permanent Skilled Labour								
Accounting	2000	2000	4000	4000	6000	6000	6000	6000
Irrig. system maintenance		2000	2000	4000	4000	6000	6000	6000
Automotive maintenance		4000	4000	8000	8000	12000	12000	12000
Electrical maintenance		2000	4000	6000	8000	10000	12000	12000
General maintenance		4000	6000	10000	12000	16000	18000	18000
Warehose maintenance		2000	2000	4000	4000	6000	6000	6000
General transportation		4000	4000	8000	8000	12000	12000	12000
Subtotal	2000	20000	26000	44000	50000	68000	72000	72000
Permanent Unskilled Labour								
Accounting		1400	1400	2800	2800	4200	4200	4200
Irrig. system maintenance		2800	2800	5600	5600	8400	8400	8400
Automotive maintenance		2800	2800	5600	5600	8400	8400	8400
Electrical maintenance		1400	1400	2800	2800	4200	4200	4200
General maintenance		2800	4200	7000	8400	11200	12600	12600
Warehouse maintenance			1400	1400	2800	2800	4200	4200
General transportation			1400	1400	2800	2800	4200	4200
Nursery	2800	4200	7000	8400	11200	12600	12600	12600
Crop processing			2800	2800	5600	5600	8400	8400
Subtotal	2800	15400	25200	37800	47600	60200	67200	67200
Total Base Cost	58800	164400	295200	414800	545600	665200	737200	751200
Physical contingency (10%	5880	16440	29520	41480	54560	66520	73720	75120
TOTAL FOR THREE UNITS	64680	180840	324720	456280	600160	731720	810920	826320 [a]

[a] Maintained at this level in subsequent years

Source: Devres Staff Estimates, August 1975

E89.73 million for five IDUs. Of this, the largest share, or 44 percent of the total, represents the cost of establishing on-farm irrigation facilities. The next largest costs are for housing (including utilities) which accounts for E8.26 million or 12 percent of total investment costs. This amounts to 27 percent of the capital costs of the irrigation scheme alone. A similar estimate of total capital costs for the five IDU model amounts to E52.5 million with E13.93 million being the estimated cost of housing and utilities.

The average capital cost of irrigation development is E9,950/ha or E10,500/ha if field equipment costs are included. The estimates of average capital costs rise to E23,800/ha if the dam costs are added. If housing costs are excluded from the calculations, average cost declines to E7,700/ha.

b. Overhead and operating costs

Summary data on irrigation project operating costs are provided in Tables II-23 and Table II-24. Once again, although the operation and maintenance costs of the dam and water delivery system to the irrigation site have been included in the economic and financial analysis, the details are not provided here as they were based on data generated during the separate feasibility study for the dam construction. Total dam and water delivery system costs were estimated at E280,000 per annum by Olivier et.al.

The major overhead costs for the irrigation project are the salaries and wages of permanent employees and farm workers. As shown in Table II-24, the salaries amount to E275,000 per IDU per annum. They represent almost half of total overhead costs. Materials and services account for the rest.

c. Resettlement costs

Resettlement costs were estimated for purposes of the economic and financial analysis. The total cost estimate for resettling the 900 families in the area of the irrigation project amounts to E6.44 million for 3,000 ha and E8.16 million for 5,000 ha which displaces an additional 276 families. These estimates are for the irrigation project site alone as the costs of resettlement were estimated separately for the dam construction site. The estimate of resettlement cost was the same as had been employed for the dam cost estimations and were obtained from Olivier et.al. They had estimated resettlment costs at E5,000 per homestead in 1981, and the corresponding figure adjusted upwards for an annual inflation rate of 15 percent amounts to E7,250/homestead in September 1984 terms. Total resettlement costs were estimated by applying this rate to the number of homesteads in the area as recorded by the 1984 Agricultural Census. The amounts were included in the economic and financial analysis phased over six years.

Table II-25: Individual Smallholder Cropping Pattern and Earnings, 2 Ha Holding

Crop	Area (ha)	Yield (ha)	Price	Production Cost/ha	Total Return	Net Return
Maize	0.50	3.50	315	860	551	121
Cotton	0.50	2.00	820	1430	820	105
Tomato	0.25	20.00	345	4045	1725	714
Cabbage	0.25	40.00	100	3250	1000	188
Potato	0.50	28.00	200	4575	2800	513
Mango	0.25	9.00	640	4330	1440	358
Avocado	0.25	40.00	175	4670	1750	583
Citrus	0.25	25.00	270	3805	1688	736
Papaya	0.25	25.00	400	3130	2500	1718
Total						5034

Source: Devres Staff Estimates, August 1985

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2. Project benefits

a. Farm crop revenue

The most direct and easily measurable benefit of the irrigation project is the revenue derived from crop sales. As such, the crop revenues accruing to the nucleus farm and smallholder farmers constitute the primary benefit stream for the financial and economic analysis. At full development, as shown in Table II-17, the gross value of production for the 3 IDU model is estimated at E8.28 million. Approximately 63 percent of total value added or E5.26 million would be from production on the nucleus farm; the remaining E3.02 million worth of crops would be produced by smallholders. For the five IDU model the corresponding figures are E13.71 million in gross value added through crop production with E5.03 million being provided by smallholder production. Average estimated net returns on the nucleus farm would be E2,920/ha and slightly lower for the smallholder who would have an annual net revenue of E5,035 (Table II-25).

It is assumed that virtually all of the tree crop production of avocado, mango, papaya and citrus would be sold on export markets. Vegetable crop production is expected to be marketed both domestically and in the Republic of South Africa. Maize and cotton production are intended for the domestic market and it can be expected that much of the smallholder maize output will be consumed by the producers themselves. If this is the case, the total value of crop revenues would be reduced by the value of production being withheld from the market. However, social benefits would accrue in the form of savings in the amount of consumption that is substituted for maize imports. The maximum value of maize production that could be substituted for imports would be E250,000 from three IDUs and E417,000 from five IDUs.

b. Government revenue

Increases in government revenues as a result of the irrigation project are expected to arise from three major sources: receipts from irrigator charges, increased tax earnings and the 20 percent share of SACU revenues from import duties returned to the Swaziland government.

(1) Irrigator charges

For the purpose of this analysis, water charges were determined on the basis of full recovery of the capital costs of dam construction and annual operations and maintenance (O and M) costs of water delivery to the irrigation site. On-farm costs of irrigation were not included in these calculations as they had already been incorporated into the crop budget estimates as an input charge. Data on O and M costs were provided by the consulting engineers Olivier et.al. They estimated O and M costs at E0.28 million per annum, assumed to start in the seventh and final year of dam construction.

Based on total capital and O and M costs of E46.72 million, irrigator charges were determined by discounting this value over the 30-year period at a rate of six percent per annum. This yielded an estimated net present value of these costs at E34.45 million. (All prices were assumed constant at September 1984 levels and the six percent real discount rate was assumed to be reasonable as a real rate of interest, although the calculations could be easily redone for other assumed interest rates.) Assuming a total maximum availability of 63 MCM of water per annum, the irrigation project's water use for development of 3,000 ha would represent only 66 percent of total available water. Hence, attributing an equivalent proportion of cost to the project would result in an estimated net present value of costs at E22.73 million for 3,000 ha. Recovery of this amount was then assumed to be spread over a period of 23 years as full charges can be applied only after the project begins to earn revenues and total potential water supply is delivered on-farm.

On this basis, irrigator charges would amount to E0.98 million per annum which is equivalent to an average of E330/ha. If a uniform rate of water charges is assumed applied to both nucleus farm and smallholders, estimated net returns to both sets of producers will decline resulting in an average net return of E2,590/ha for the nucleus farm and in estimated net returns of E4,375 per annum to the smallholder producer.

Similarly, with the assumption of 100 percent of available water use on the irrigation project that would be required for five units (5,000 ha), total water delivery O and M costs would have to be attributed to the irrigation project. The discounted present worth of per annum costs attributable to the project would rise accordingly to E1.50 million per annum over 23 years. However, for additional units, average costs would be spread over a larger area and would therefore decline somewhat to E300/ha implying net returns of E2,620/ha for the nucleus farm and E4,390 for the smallholder.

An important corollary to this discussion is that the estimated irrigator charges are merely indicative of what might be instituted for full cost recovery. The values obtained here are not necessarily being recommended as the appropriate ones to be adopted as the method of water charge determination employed here is only one among a number that could be used. Thus, estimated costs and hence determined water charges would differ if only O and M costs were being considered for full recovery or if different discount rates were assumed to be more appropriate.[1] Further, based on discounted present worth calculations it would be a policy issue as to what specific charges were adopted. For example, it would be a policy decision as to whether or not the average water charge would be the same for the nucleus estate as for smallholder farmers.

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1 Current World Bank policy is to evaluate irrigation projects on the basis of full capital and O and M cost recovery. Annex 6 discusses alternative cost recovery options for GOS consideration.

(2) Tax earnings

A potential (albeit minor) source of increased government revenue as a result of the irrigation project would be the taxable incomes of smallholder farmers. Workers on the nucleus farm are unlikely to earn much above the minimum taxable annual income of E1,000 and their incomes are, therefore, unlikely to yield tax revenues. It is very difficult to accurately estimate tax returns from smallholders because differential tax rates apply and the actual amount realised by the government would depend upon the relative proportions of single and married men and women who are smallholders. Assuming all smallholders to be married men with one child and based on the estimated net revenue of E5,035/smallholder, tax revenues from smallholders would amount to E126,000 per annum. If it is assumed that most farm workers are married men, their estimated potential earnings would be below the minimum taxable income.

(3) Import duties

As explained in Annex 3 to Volume III, the Swaziland government, as a member of SACU, is entitled to a 20 percent share of the revenue pool derived from import duties levied on goods entering the region. This is an important source of revenue for the government and a project that entails large expenditures on imported capital goods is likely to increase returns to the government. It is however, difficult to estimate exactly by how much revenues increase as a result of the specific capital imports on the irrigation project since the revenue pool shares are divided among member countries according to a formula involving total receipts from duties levelied on all imports into the region.

One way of obtaining a workable estimate for the purpose of this analysis is simply to assume a 20 percent share of the actual foreign exchange expenditure on project capital goods is returned to the government with a two-year lag. This was done for the years in which such expenditures were incurred and the results are employed in the economic analysis. Initial capital investment in the irrigation project exclusive of the dam results in government revenues of E3.99 million over a period of 6 years for 3,000 ha of development. It would be proportionately higher for a 5,000 ha project—about E4.29 million.

c. Employment effects

(1) Direct

Significant employment effects will be generated by the irrigation project for both smallholder farmers and for full-time and seasonal workers on the nucleus estate. At full development, there will be employment for 600 smallholder families on a 3,000 ha project, and 1,000 families on a 5,000 ha project. The nucleus farm on each 1,000 ha IDU is potentially estimated to employ 518 workers of whom 209 are expected to be seasonal workers. Total employment on three IDUs, therefore, is projected at 927 full-time workers and 627 seasonal workers. On five IDU's employment is estimated at a total of 1,545 full-time workers and 1,045 seasonal workers. In

addition, there will be employment for 50 additional workers per IDU in managerial and supervisory work for project administration and skilled and unskilled labour for maintenance work.

Based on the recommended cropping patterns labour requirements on the smallholder unit have been estimated at a total of 459 person days. This implies 1.50 person years of full-time employment which may be supplied by the smallholders' family members themselves or by hiring additional workers if necessary. In the latter case, the project would generate increased employment in the amount of labour hired by the smallholders. In the farmer case, family income would rise proportionately since the wage bill has been deducted in the farm budget analysis.

(2) Indirect

Though more speculative, an estimate has also been made of employment off the project generated through income and employment multipliers. The source of this additional employment and income would be among supplies of goods and services to the project. Transportation firms, for example, would benefit from increased demand for farm inputs and to transport produce destined for export or domestic markets. Farmers and workers receiving increased disposable incomes will spend some of their earnings in local shops and other businesses. To be conservative, a multiplier of less than one has been estimated, some 0.7, or 1,500 jobs generated outside by the 2,100 plus jobs on the 3,000 ha base project; that would rise to over 2,000 indirect jobs engendered by a 5,000 ha project.

d. Social benefits

The primary social benefit of this irrigation project is the impact upon employment followed by increased self-sufficiency in food production and improved productivity in the traditional subsector. Given current trends in population growth and the high rate of labour force growth foreseen in the next twenty years, unemployment problems are expected to increase. The employment potential of this project provides an important social benefit that is difficult to quantify accurately but is significant nevertheless.

The Swaziland Government's stated policy is to enhance employment potential in the rural areas--particularly to improve smallholder agriculture. This has proven particularly difficult in the past as traditional agriculture, which employs virtually all smallholders, has been relatively stagnant in recent years. Although farmers have been willing to adopt new technologies and have thereby increased their yields, total output particularly of maize has been declining. It is not yet clear exactly what accounts for this but certainly improvements in traditional farming cannot be accomplished without provision of appropriate incentives. Specifically, this means that the returns to agriculture for the individual farmer must be improved. It is intended that the relatively high estimated earnings for smallholders on the irrigation project will provide adequate incentives to attract and hold smallholder farmers, thereby fulfilling the important social goal of retaining people in agricultural employment.

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Irrigation farming, and thence everything connected with it, also provides stability and predictability. The family's basic food supply, and much of its cash income, become divorced from the vagaries of rainfall and the insecurities such dependencies provide. As well, with organised projects, the chances are much improved for the provision of basic medical and educational facilities and services which would be of a much lower scale and quality pre-project. In addition, provision of electricity and other public services greatly enhance the quality of life. These are built into the proejct and constitute an additional benefit that is not easily quantifiable.

c. Foreign exchange earnings

Since Swaziland's domestic market potential is limited, cropping patterns were designed to maximize export earnings. Thus, the fruit tree crops on both the nucleus and smallholder farms are intended primarily for export. At full development, if the entire crop of mango, avocado, citrus and papaya is exported, gross foreign exchange earnings will amount to E5.94 million on the 3,000 ha model. Approximately a third of these revenues would be contributed from crop sales of smallholder production. If an allowance is made for losses in handling and storage so that 30 percent of the output is damaged, foreign exchange earnings would still amount to E4.16 million. The corresponding foreign exchange earnings from the 5,000 ha model would amount to E9.84 million or E6.88 million after accounting for crop losses.

3. Financial and economic analysis

a. Introduction

This section reports the results of the economic and financial analysis conducted on the establishment of from 3,000-5,000 ha of irrigated farming in the Komati Basin. Such analysis provides a mechanism for examining the validity of assumptions made, modifying project structures in accordance with economic, financial and social goals and, finally, accepting or rejecting it for implementation. It is important to remember that the project investment decision is seldom made on purely quantitative or economic factors but is a policy decision that is influenced by financial and economic considerations as well as social benefits deemed important to the society concerned. As such, the economic and financial analysis is one among a number of tools (albeit a vital one) which can be used to guide the decision-making process.

The function of economic analysis is to determine the total return or profitability of the project to the society as a whole. The economic analysis evaluates the returns to all the resources committed to the project regardless of who contributes them and who receives the benefits. Financial analysis is differentiated from the economic analysis by examining the return to equity capital contributed by each of the various financial entities that participate in a project such as farmers, entrepreneurs, public agencies, etc.[1] Another

[1] Details on these analyses, and the difference between financial and economic analyses are examined in Annex 3.

way of looking at the financial analysis is as an evaluation of the financial return to equity participation whether by private individuals or by the government through public agencies.

The economic and financial analysis of the Komati Basin Irrigation Project was done in two stages. The first stage was to evaluate the irrigation project exclusively without considering the costs of constructing and operating the Maguga Dam. This was justifiable on the theoretical grounds that enhanced water availability as a result of increased storage capacity does not confine water use to a particular purpose. The irrigation project may be one among a number of uses to which the water is put. In this case, the overall feasibility would have to be jointly determined among the variety of uses. As a second alternative, it was assumed that all the available water would be applied to the irrigation project. The capital cost of the dam and the cost of operating and maintaining it and the water delivery system up to the project site therefore were incorporated into the analysis.

Results are reported separately for each of the economic and financial analyses with and without the dam and for each of the 3,000 ha and 5,000 ha units. The analysis was done for a thirty-year period with appropriate phasing of development cost and benefit streams. The focus of the analysis was on the development of three IDUs of 1,000 ha each and detailed cost and analysis summaries are for the 3,000 ha alternative. However, given the assumption that sufficient water would be available for developing 5,000 ha a separate analysis was conducted to evaluate that alternative. The entire analysis assumed constant prices throughout the period of analysis.[1] Hence the rates of return obtained represent real rather than nominal rates.

b. Economic analysis

In order to evaluate the social costs and returns to the irrigation project investement, the financial costs were modified to reflect the opportunity cost of labour and the value of current production foregone as a result of establishing the project. The benefit stream was augmented by the 20 percent share of foreign exchange costs returned to the Swaziland government as a share of the SACU revenue pool. Other benefits such as public utilities and social services as well as smallholder housing are acknowledged but have been omitted from the analysis because of the difficulty of quantifying the benefits. Additional social services such as schools and clinics were not included in the design or analysis because the justification for providing such services is properly determined independently of an irrigation scheme.

Labour was given a shadow wage rate of E1.50/day which is approximately 42 percent of the current daily wage rate in the project area. This was selected as being a truer representation of the opportunity cost of labour than a zero shadow wage rate. However, the zero shadow wage rate was employed

1 Price/cost assumptions are explored in more detail in Annex 4 of this Volume II.

Table II-26 : Base Case Economic Analysis of Three IDUs

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Capital Costs	6.53	2.13	6.82	3.13	6.82	3.13	0.29	0.99	0	0	0	0	0	0	0	1.01
Equipment Costs	0.12	0.23	0.53	0.23	0.53	0.27	0.49	0.06	0.09	0.05	0.17	0.14	0.44	0.15	0.43	0.21
Operating Costs	0.10	0.28	0.54	0.35	1.12	1.43	1.60	1.73	1.74	1.74	1.74	1.74	1.74	1.74	1.74	1.74
Resettlement Costs	2.97		1.90		1.57											
Value of Current Output	0.29	0.29	0.48	0.48	0.64	0.64	0.64	0.64	0.64	0.64	0.64	0.64	0.64	0.64	0.64	0.64
Total Costs	10.01	2.93	10.27	4.39	10.68	5.47	3.02	3.42	2.47	2.43	2.55	2.52	2.82	2.53	2.81	3.60
Crop Revenues		0.38	0.86	0.97	1.57	2.02	2.79	4.75	6.52	7.24	8.70	9.45	9.65	9.75	9.75	9.75
20% SADC Share			0.86	0.29	0.93	0.43	0.90	0.42	0.14	0.14	0	0	0	0	0	0
Net Returns	-10.01	-2.55	-9.55	-3.43	-8.21	-3.02	1.67	1.77	4.09	5.05	6.15	6.93	6.83	7.22	6.94	6.15
Internal Rate of Return		0.100228														

16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
1.01	0	1.01	0	1.01	0.76	0	0.76	1.29	0.76	2.88	0.16	2.88	0.16	1.60
0.21	0.52	0.15	0.18	0.15	0.26	0.21	0.44	0.15	0.43	0.18	0.43	0.06	0.09	0.08
1.74	1.74	1.74	1.74	1.74	1.74	1.74	1.74	1.74	1.74	1.74	1.74	1.74	1.74	1.74
0.64	0.64	0.64	0.64	0.64	0.64	0.64	0.64	0.64	0.64	0.64	0.64	0.64	0.64	0.64
3.60	2.90	3.54	2.56	3.54	3.40	2.59	3.58	3.81	3.57	5.44	2.97	5.32	2.63	4.06
9.75	9.75	9.75	9.75	9.75	9.75	9.75	9.75	9.75	9.75	9.75	9.75	9.75	9.75	9.75
0	0	0.02	0	0.02	0	0.02	0.11	0	0.11	0.18	0.11	0.41	0.02	0.41
6.15	6.85	6.23	7.19	6.23	6.35	7.18	6.28	5.94	6.29	4.49	6.89	4.34	7.14	6.1

Source: Devres Staff Estimates, August 1985

SWAZILAND: ECONOMIC STUDY OF POSSIBLE USES OF ADDITIONAL WATER ON THE KOMATI RIVER

Table II-27 : Base Case Economic Analysis of Three IDUs With Dam Costs

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Dam Costs	3.22	4.98	8.11	9.05	8.45	6.01	1.28									
Dam O & M Cost							0.28	0.29	0.29	0.28	0.28	0.28	0.28	0.29	0.29	0.28
Capital Costs	6.53	2.13	6.82	3.13	6.82	3.13	0.29	0.99	0	0	0	0	0	0	0	1.01
Equipment Costs	0.12	0.23	0.53	0.23	0.53	0.27	0.49	0.06	0.09	0.05	0.17	0.14	0.44	0.15	0.43	0.21
Operating Costs	0.10	0.28	0.54	0.85	1.12	1.43	1.60	1.73	1.74	1.74	1.74	1.74	1.74	1.74	1.74	1.74
Resettlement Costs	2.97		1.90		1.57											
Value of Current Output	0.29	0.29	0.48	0.48	0.64	0.64	0.64	0.64	0.64	0.64	0.64	0.64	0.64	0.64	0.64	0.64
Total Costs	13.23	7.31	18.38	12.74	19.13	11.49	4.58	3.70	2.75	2.71	2.82	2.80	3.13	2.81	3.09	3.88
Crop Revenues		3.28	9.65	9.97	1.57	2.22	3.79	4.75	6.52	7.24	8.70	9.45	9.65	9.75	9.75	9.75
DDS SACU Share			0.36	0.29	0.93	0.43	0.90	0.42	0.24	0.14	0	0	0	0	0	0
Net Returns	-13.[illegible]	-7.43	-16.66	-11.48	-16.66	-9.03	0.11	1.49	3.81	4.77	5.97	6.65	6.55	6.94	6.66	5.87
Internal Rate of Return	0.038745															

17	18	19	20	21	22	23	24	25	26	27	28	29	30
0.28	0.28	0.29	0.28	0.29	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28
0	1.01	0	1.01	0.76	0	0.76	1.28	0.76	2.98	0.16	2.98	0.16	1.60
0.52	0.15	0.18	0.15	0.26	0.21	0.44	0.15	0.43	0.18	0.43	0.26	0.09	0.08
1.74	1.74	1.74	1.74	1.74	1.74	1.74	1.74	1.74	1.74	1.74	1.74	1.74	1.74
0.64	0.64	0.64	0.64	0.64	0.64	0.64	0.64	0.64	0.64	0.64	0.64	0.64	0.64
3.18	3.82	2.84	3.82	3.68	2.87	3.86	4.09	3.85	5.72	3.25	5.60	2.91	4.34
9.75	9.75	9.75	9.75	9.75	9.75	9.75	9.75	9.75	9.75	9.75	9.75	9.75	9.75
0	0.02	0	0.02	0	0.02	0.11	0	0.11	0.18	0.11	0.41	0.02	0.41
6.57	5.95	6.91	5.95	6.07	6.9	6	5.66	6.01	4.21	6.61	4.56	6.86	5.82

Source: Devres Staff Estimates, August 1985

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in the sensitivity analysis. The net value of land in its current use was determined by reference to current population statistics obtained during the 1984 Agricultural Census and based on landholding and land use data provided in the RDAP Project Report (1984).[1] Since no data were available on current production patterns in the area, Tate and Lyle's estimates of income from traditional agriculture were used with 15 percent per annum allowance for inflation since 1981/82, yielding a net annual income of E357/ha in September 1984.[2] Available arable land in the project area was estimated at 2,596 ha and allowing for acropping intensity of 70 percent total net annual income of about E642,000 which was phased in gradually over five years. For the 5,000-ha model which effects a larger area, the estimate of net annual income was E839,000.

(1) The 3,000 ha model

Table II-26 and Table II-27 show the base case economic analysis for developing three IDUs with and without Maguga Dam respectively. Table II-28 summarises the internal rates of return obtained from the economic analysis. The EIRR is 10 percent for the 3,000 ha irrigation project. This is a relatively high rate of return for a development project, and even with an assumed 10 percent increase in costs the IRR stays as high as 8.6 percent, while an even better rate of 11 percent is obtained if revenues increase as a result of higher prices or improved yields. The exclusion of all housing and resettlement costs raises the rate of return to 14.8 percent while employing a zero shadow wage results in a rate of return that is almost as high at 12.6 percent. Finally, the IRR is very sensitive to changes in cropping intensity, dropping to 5.03 percent if all the loss is sustained on winter crops. In general, the project benefits were estimated assuming a cropping intensity of 200 percent. For the purpose of the sensitivity analysis, however, it was assumed that intensity would be reduced to 150 percent for smallholders and 167 percent for the nucleus farm as a result of winter crop loss.

The second economic analysis imputes the entire capital and O and M costs of the Maguga Dam to the irrigation project. This results in overall rates of return that are lower than the initial analysis excluding dam costs. For the base case, an IRR of 3.87 percent was obtained. This rises to 5 percent assuming increased returns and declines to 2.7 percent if costs should rise by 10 percent. It should be kept in mind also that similar large water development projects in other countries are often subsidised. More favourable economic rates of return were obtained when all housing and resettlement costs were excluded in the sensitivity analysis--5.5 percent. Similarly, the assumption of a zero shadow wage yielded an IRR of 3.5 percent but reduced cropping intensity made the IRR virtually zero. Imposition of irrigator charges made no difference to the analysis from the base case as they represent a tranfer payment.

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1 Swaziland Ministry of Natural Resources, Land Utilization and Energy. Project Report for the RDAP, Phase III (Mbabane, Swaziland: Land Use Planning Section, October 1984).

2 Tate and Lyle, Technical Report No.5.

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Table II-28: Economic Rate of Return Summary of Three IDUs

	Economic Internal Rate of Return (%)		
	Base Case	10% Increase in Costs	10% Increase in Revenues
Economic Analysis (Exclusive of Maguga Dam)			
Base Analysis	10.2	8.57	11.41
Sensitivities			
Exclusive of Housing and Resettlement Costs	14.83	13.0	16.54
Zero Shadow Wage	11.60	10.14	13.00
Reduced Cropping Intensity	5.03	3.62	6.33
Economic Analysis (Inclusive of Maguga Dam)			
Base Analysis	3.87	2.66	5.03
Sensitivities			
Exclusive of Housing and Settlement Costs	5.47	4.17	6.72
Zero Shadow Wage	5.18	3.99	6.34
Inclusive of Irrigator Charges	3.87	2.8	5.03
Reduced Cropping Intensity	-0.11	-0.41	1.08

Source: Devres Staff Estimates, August 1985

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Although the overall assessment of the project's economic viability will depend upon the assumptions made about the opportunity cost of capital as well as social and other non-quantifiable benefits, the results of the economic analysis suggest that there is potential for establishing a viable irrigation project in the Komati Basin. Imputing the full cost of the Maguga Dam construction and operation to the irrigation project would require more careful consideration and perhaps a subsidy element. However, the current costs and benefit data are preliminary and subject to a wide margin of variation. They would have to be confirmed or altered as necessary by a more detailed feasibility study.

(2) The 5,000 ha model

The economic analysis of the 5,000 ha model results in more favourable rates of return than the smaller-sized project when dam costs are included. As might be expected, there is no difference between the models when the dam costs are omitted from the analysis. The results of the analysis with the dam costs included imply that additional water up to 63 MCM could be beneficially employed by the expanded irrigation scheme.

For the analysis, it was assumed that the two additional IDUs would be phased in simultaneously with the third unit and all costs were appropriately adjusted upwards. Similarly, the benefits stream was also adjusted to account for increased returns from augmented crop production phased to coincide with the expected returns from the third IDU.

Table II-21 summarises the estimated costs and potential returns from the expanded irrigation project. Capital costs increase to E52.5 million as do operating costs which rise to E2.91 million per annum. Increased benefits are also realized in comparison with the smaller model. Thus, employment increases to a total of 1,545 full-time workers and 1,045 seasonal workers plus 1,000 smallholder families. Crop production is also increased and value added amounts to E13.7 million on the 5,000 ha model. The internal rates of return are also correspondingly higher at over 10 percent for the EIRR without the dam and 5.7 percent if the Maguga Dam is included. The FIRR is 4.3 percent if the dam is included and 8.8 percent if it is not.

Table II-29 and II-30 present the base case economic analysis with and without the dam respectively. The results of the sensitivity analysis are shown in Table II-31. Even with dam costs included, the results of excluding housing and resettlement costs yields an IRR of 7.7 while applying a zero shadow wage rate gives an IRR almost as high, at 7.1 percent. However, reduced cropping intensity drops the IRR to 1.3 percent but in the case without the dam the IRR stays as high as 5 percent with assumed reductions in cropping intensity. As before, application of irrigator charges do not alter the analysis from the base case as this represents a transfer payment in the economic analysis.

SWAZILAND: ECONOMIC STUDY OF POSSIBLE USES OF ADDITIONAL WATER ON THE KOMATI RIVER

Table II - 29 : Base Case Economic Analysis of Five IDUs

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Capital Costs	6.53	2.14	6.82	3.13	19.88	7.40	0.86	2.98								1.01
Equipment Costs	0.12	0.23	0.53	0.23	0.77	0.72	1.29	0.69	0.10	0.14	0.22	0.16	0.45	0.15	0.62	0.47
Operating Costs	0.10	0.28	0.53	0.38	1.74	2.02	2.55	2.91	2.91	2.91	2.91	2.91	2.91	2.91	2.91	2.91
Resettlement Costs	2.97		1.90		3.67											
Value of Current Output	0.29	0.29	0.48	0.48	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84
Total Costs	10.01	2.94	10.26	4.82	26.5	10.98	5.54	7.42	3.85	3.89	4.07	3.91	4.2	3.9	4.37	5.23
Crop Revenues		0.38	0.86	0.97	1.57	2.02	5.29	6.48	9.35	10.56	13.48	15.51	15.92	16.22	16.22	16.22
10% SACU Share			0.86	0.29	0.90	0.43	0.26	1.00	0.13	0.42	0	0	0	0	0	0
Net Returns	-10.01	-2.56	-9.54	-3.56	-24.03	-9.53	0.01	0.06	5.63	7.09	9.41	11.6	11.72	12.32	11.85	10.99
Internal Rate of Return		0.103424														

	17	18	19	20	21	22	23	24	25	26	27	28	29	30
		1.01		3.02	0.76		0.76	1.28	2.29	2.38	0.16	5.44	0.16	4.81
	1.20	0.16	0.19	0.30	0.60	0.24	0.45	0.15	0.62	0.44	1.11	0.69	0.10	0.17
	2.91	2.91	2.91	2.91	2.91	2.91	2.91	2.91	2.91	2.91	2.91	2.91	2.91	2.91
	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84
	4.95	4.92	3.94	7.07	5.11	4.09	4.96	5.19	6.66	7.07	5.02	9.38	4.01	9.73
	16.22	16.22	16.22	16.22	16.22	16.22	16.22	16.22	16.22	16.22	16.22	16.22	16.22	16.22
	0	0.15	0	0.15	0	0.45	0.11	0	0.11	0.18	0.32	0.41	0.02	0.78
	11.27	11.45	12.28	9.3	11.11	12.58	11.37	11.04	9.67	9.33	11.52	6.75	12.23	8.27

Source: Devres Staff Estimates, August 1985

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Table II- 30: Base Case Economic Analysis of Five IDUs With Dam Costs

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Dam Costs	3.22	4.88	9.11	8.05	8.45	6.01	1.28									
Dam O & M Costs							0.28	0.28	0.28	0.28	0.28	0.29	0.28	0.28	0.28	0.28
Capital Costs	6.53	2.14	6.82	3.13	19.98	7.[illegible]	0.86	2.98								1.01
Equipment Costs	0.12	0.23	0.53	0.22	0.77	0.7[illegible]	1.29	0.69	0.10	0.14	0.22	0.16	0.45	0.15	0.62	0.47
Operating Costs	0.10	0.29	0.53	0.98	1.24	2.02	2.55	2.91	2.91	2.91	2.91	2.91	2.91	2.91	2.91	2.91
Resettlement Costs	2.97		1.90		3.67											
Value of Current Output	0.29	0.29	0.48	0.48	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84
Total Costs	13.23	7.32	18.37	12.87	24.95	16.99	7.1	7.7	4.13	4.17	4.25	4.19	4.48	4.18	4.65	5.51
Crop Revenues		0.38	0.86	0.97	1.57	2.32	5.29	6.48	9.25	10.56	13.46	15.51	15.92	16.22	16.22	16.22
20% SACU Share			0.36	0.29	0.90	0.43	0.26	1.00	0.13	0.42	0	0	0	0	0	0
Net Returns	-13.23	-7.44	-16.65	-11.61	-32.48	-14.54	-1.55	-0.22	5.35	6.81	9.13	11.32	11.44	12.04	11.57	10.71
Internal Rate of Return		0.057474														

	17	18	19	20	21	22	23	24	25	26	27	28	29	30
	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.28	0.28	0.28	0.28	0.28	0.28	0.27
		1.01		3.02	0.76		0.76	1.25	2.29	2.88	0.15	5.44	0.16	4.[illegible]1
	1.20	0.16	0.19	0.30	0.60	0.34	0.45	0.15	0.62	0.44	1.11	0.69	0.10	0.17
	2.91	2.91	2.91	2.91	2.91	2.91	2.91	2.91	2.91	2.91	2.91	2.91	2.91	2.91
	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84
	5.23	5.2	4.22	7.35	5.39	4.37	5.24	5.46	6.94	7.35	5.3	10.16	4.29	9.01
	16.22	16.22	16.22	16.22	16.22	16.22	16.22	16.22	16.22	16.22	16.22	16.22	16.22	16.22
	0	0.15	0	0.15	0	0.45	0.11	0	0.11	0.18	0.32	0.41	0.02	0.78
	10.99	11.17	12	9.02	10.83	12.3	11.09	10.76	9.39	9.05	11.24	6.47	11.95	7.99

Source: Devres Staff Estimates, August 1985

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Table II-31: Economic Rates of Return Summary of Five IDUs

	Base Case	10% Increase in Costs	10% Increase in Revenues
Economic Analysis (Exclusive of Maguga Dam)			
Base Analysis	10.34	8.89	11.75
Sensitivities			
Exclusive of Housing and Resettlement Costs	14.83	13.08	16.54
Zero Shadow Wage	11.97	10.51	13.40
Reduced Cropping Intensity	5.09	4.67	6.42
Economic Analysis (Inclusive of Maguga Dam)			
Base Analysis	5.74	4.50	6.95
Sensitivities			
Exclusive of Housing and Resettlement Costs	7.73	6.38	9.04
Zero Shadow Wage	7.14	5.90	8.34
Inclusive of Irrigator Charges	5.14	4.63	6.95
Reduced Cropping Intensity	1.38	0.06	2.60

Source: Devres Staff Estimates, August 1985

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Table II-32 : Base Case Financial Analysis of Three IDUs

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Capital Costs	6.53	2.13	6.82	2.13	6.82	3.13	0.29	0.99	0	0	0	0	0	0	0	1.01
Equipment Costs	0.12	0.22	0.53	0.27	0.53	0.27	0.49	0.36	0.09	0.05	0.17	0.14	0.44	0.15	0.43	0.21
Operating Costs	0.10	0.29	1.54	0.85	1.12	1.43	1.50	1.33	1.74	1.74	1.74	1.74	1.74	1.74	1.74	1.74
Resettlement Costs	2.97		1.9		1.57											
Total Costs	9.72	2.64	9.79	4.21	10.04	4.83	2.28	2.78	1.83	1.79	1.91	1.88	2.18	1.89	2.17	2.96
Crop Revenues		0.21	0.69	0.77	1.29	1.69	3.21	4.36	5.58	6.27	7.41	8.03	8.20	8.28	8.28	8.28
Net Returns	-9.72	-2.33	-9.1	-3.44	-8.75	-3.14	0.93	1.28	3.75	4.48	5.5	6.15	6.02	6.39	6.11	5.32
Internal Rate of Return		0.086230														

	17	18	19	20	21	22	23	24	25	26	27	28	29	30
	0	1.01	0	1.01	0.76	0	0.76	1.28	0.76	2.38	0.16	2.38	0.16	1.60
	0.52	0.15	0.18	0.15	0.26	0.21	0.44	0.15	0.43	0.19	0.43	0.06	0.09	0.08
	1.74	1.74	1.74	1.74	1.74	1.74	1.74	1.74	1.74	1.74	1.74	1.74	1.74	1.74
	2.26	2.90	1.92	2.90	2.76	1.95	2.94	3.17	2.93	4.30	2.33	4.69	1.99	3.42
	8.28	8.28	8.28	8.28	8.28	8.28	8.28	8.28	8.28	8.28	8.28	8.28	8.28	8.28
	6.02	5.38	6.36	5.38	5.52	6.33	5.34	5.11	5.35	3.49	5.95	3.6	6.29	4.86

Source: Devres Staff Estimates, August 1985

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Table II-33 : Base Case Financial Analysis of Three IDUs With Dam Costs

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Dam Costs	3.22	4.98	8.11	9.05	8.45	6.01	1.28									
Dam O & M Cost							0.28	0.28	0.29	0.28	0.28	0.29	0.28	0.28	0.29	0.29
Capital Costs	6.53	2.13	6.82	3.13	6.92	3.12	0.29	0.99	0	0	0	0	0	0	0	1.01
Equipment Costs	0.12	0.23	0.53	0.23	0.53	0.27	0.49	0.96	0.09	0.05	0.17	0.14	0.44	0.15	0.45	0.21
Operating Costs	0.10	0.28	0.54	0.85	1.12	1.43	1.60	1.73	1.74	1.74	1.74	1.74	1.74	1.74	1.74	1.74
Resettlement Costs	2.97		1.9		1.57											
Total Costs	12.94	7.52	17.90	12.26	18.49	10.84	3.94	3.76	2.11	2.07	2.19	2.15	2.46	2.17	2.45	3.24
Crop Revenues		0.21	0.69	0.77	1.29	1.69	3.21	4.06	5.58	6.27	7.41	8.33	8.20	8.26	8.28	8.28
Net Returns	-12.94	-7.21	-17.21	-11.49	-17.2	-9.15	-0.73	1	3.47	4.2	5.22	5.87	5.74	6.11	5.83	5.04
Internal Rate of Return	0.02a761															

	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Dam Costs														
Dam O & M Cost	0.28	0.28	0.28	0.29	0.28	0.28	0.28	0.29	0.28	0.28	0.29	0.28	0.29	0.29
Capital Costs	0	1.01	0	1.01	0.76	0	0.76	1.29	0.76	2.99	0.16	2.98	0.16	1.60
Equipment Costs	0.52	0.15	0.19	0.15	0.26	0.21	0.44	0.15	0.43	0.18	0.43	0.06	0.09	0.08
Operating Costs	1.74	1.74	1.74	1.74	1.74	1.74	1.74	1.74	1.74	1.74	1.74	1.74	1.74	1.74
Resettlement Costs														
Total Costs	2.24	3.18	2.20	3.18	3.04	2.23	3.22	3.45	3.21	5.39	2.61	4.76	2.27	3.70
Crop Revenues	8.28	8.28	8.28	8.29	8.29	8.28	8.28	8.28	8.28	8.28	8.28	8.28	8.28	8.28
Net Returns	5.74	5.1	6.08	5.1	5.24	6.05	5.06	4.83	5.07	3.2	5.67	3.52	6.01	4.58

Source: Devres Staff Estimates, August 1985

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Table II-34: Financial Rates of Return Summary of Three IDUs

	Financial Internal Rate of Return (%)		
	Base Case	10% Increase in Costs	10% Increase in Revenues
Financial Analysis (Exclusive of Maguga Dam)			
Base Analysis	8.62	7.3	9.9
Sensitivities			
Exclusive of Housing and Resettlement Costs	13.13	11.58	14.7
Reduced Cropping Intensity	4.2	2.9	5.4
Financial Analysis (clusive of Maguga Dam)			
Base Analysis	2.68	1.55	3.78
Sensitivities			
Exclusive of Housing and Settlement Costs	4.19	2.99	5.37
Inclusive of Irrigator Charges	3.98	3.00	4.96
Reduced Cropping Intensity	-1.0	-2.2	0.2

Source: Devres Staff Estimates, August 1985

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c. Financial analysis

(1) The 3,000 ha model

The base case financial analysis for the 3,000 ha model is shown in Table II-32 and Table II-33 shows the financial analysis including the dam costs. The complete results of the financial analysis are summarised in Table II-34. The overall financial rate of return from the 3,000 ha irrigation project is 8.6 percent which reduces to a still favourable 7.3 percent with cost increases of 10 percent. If revenues increase, the IRR becomes 9.9 percent. Excluding all housing and resettlement costs increases the IRR to 13.1 percent while decreased cropping intensity lowers the rate substantially to 4.2 percent.

When the cost of the Maguga Dam is included the FIRR drops to 2.7 percent. Exclusion of all housing and resettlement costs from the base analysis raised the IRR to 4.2 percent while the assumption of reduced cropping intensity dropped the IRR to -1.0 percent. The imposition of irrigator charges raises the FIRR to a favourable 4.1 percent. The irrigator charges make a difference in the financial analysis conducted from the point of view of the government as these charges bring in revenues and thereby reduce the total costs incurred by the government. They are shown in Table II-33 as a reduction in costs.

(2) The 5,000 ha model

The base case financial analysis with and without the dam is shown in Table II-35 and II-36 respectively results of this analysis and the sensitivity analysis are summarized in Table II-37. As in the economic analysis there is no difference in the models when dam costs are excluded. However, the results are much more favourable for the 5,000 ha model when dam costs are included. The overall financial IRR is 4.3 percent. This falls to 3.1 percent if costs increase by 10 percent and rise to 5.5 percent if revenues increase by 10 percent. The return rises to 6.2 percent when housing and resettlement costs are excluded but drop almost to zero if cropping intensity is assumed reduced. Imposition of irrigator charges raised the IRR to 5.6 percent for the base case and as high as 6.7 percent with a 10 percent increase in revenues.

d. Further cost recovery possibilities

Built in to the crop and financial budgets for the nucleus estates and the smallholders are a series of charges (in addition to an irrigation water charge). These include payments for on-project water distribution system O and M, for machinery and equipment services and for processing/marketing services. These are deductions from revenues earned to achieve gross margin data. As with the SACU payments, however, they could be added to project revenue. Doing so would enhance viability enormously. Such cost recovery options are explored further in Annex 6 to this Volume II.

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Table II - 35 : Base Case Financial Analysis of Five IDUs

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Capital Costs	6.53	2.14	6.82	3.13	19.38	7.40	0.86	2.98								1.01
Equipment Costs	0.12	0.23	0.53	0.23	0.77	0.72	1.29	0.69	0.10	0.14	0.32	0.16	0.45	0.15	0.62	0.47
Operating Costs	0.10	0.28	0.53	0.38	1.34	2.02	2.55	2.91	2.91	2.91	2.91	2.91	2.91	2.91	2.91	2.91
Resettlement Costs	2.77		1.90		3.67											
Total Costs	9.72	2.65	9.78	4.24	25.56	10.14	4.7	6.58	3.01	3.05	3.23	3.07	3.26	3.06	3.53	4.39
Crop Revenues		0.21	0.69	0.77	1.29	1.69	4.41	5.42	7.97	9.00	11.42	13.13	13.46	13.71	13.71	13.71
Net Returns	-9.72	-2.24	-9.09	-3.57	-24.27	-8.45	-0.29	-1.15	4.96	5.95	8.2	10.06	10.1	10.65	10.18	9.32
Internal Rate of Return	0.087473															

	17	18	19	20	21	22	23	24	25	26	27	28	29	30
		1.01		3.32	0.76		0.76	1.28	2.29	2.88	0.16	5.44	0.16	4.81
	1.20	0.16	0.19	0.30	0.60	0.34	0.45	0.15	0.62	0.44	1.11	0.69	0.10	0.17
	2.91	2.91	2.91	2.91	2.91	2.91	2.91	2.91	2.91	2.91	2.91	2.91	2.91	2.91
	4.11	4.08	3.1	6.23	4.27	3.25	4.12	4.34	5.82	6.23	4.18	9.04	3.17	7.89
	13.71	13.71	13.71	13.71	13.71	13.71	13.71	13.71	13.71	13.71	13.71	13.71	13.71	13.71
	9.6	9.63	10.61	7.48	9.44	10.46	9.59	9.37	7.89	7.48	9.53	4.67	10.54	5.82

Source: Devres Staff Estimates, August 1985

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Table II-36: Base Case Financial Analysis of Five IDUs With Dam Costs

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Dam Costs	3.22	4.98	8.11	8.05	8.45	6.01	1.29									
Dam O & M Costs							0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28
Capital Costs	6.53	2.14	6.82	3.13	19.88	7.40	0.86	2.98								1.01
Equipment Costs	0.12	0.23	0.53	0.23	0.77	0.72	1.29	0.69	0.10	0.14	0.32	0.16	0.45	0.15	0.62	0.47
Operating Costs	0.10	0.28	0.53	0.98	1.34	2.02	2.55	2.91	2.91	2.91	2.91	2.91	2.91	2.91	2.91	2.91
Resettlement Costs	2.97		1.90		3.67											
Total Costs	12.94	7.53	17.89	12.39	34.11	16.15	6.26	6.86	3.29	3.33	3.51	3.35	3.64	3.34	3.81	4.67
Crop Revenues		0.31	0.69	0.77	1.29	1.69	4.41	5.43	7.97	9.00	11.43	13.13	13.46	13.71	13.71	13.71
Net Returns	-12.94	-7.22	-17.2	-11.62	-32.82	-14.46	-1.85	-1.43	4.68	5.67	7.92	9.78	9.82	10.37	9.90	9.04
Internal Rate of Return		0.043170														

	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Dam Costs	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28
Dam O & M Costs		1.01		3.02	0.76		0.76	1.28	2.29	2.89	0.16	5.44	0.16	4.81
Capital Costs	1.20	0.16	0.19	0.30	0.60	0.34	0.45	0.15	0.62	0.44	1.11	0.69	0.10	0.17
Equipment Costs	2.91	2.91	2.91	2.91	2.91	2.91	2.91	2.91	2.91	2.91	2.91	2.91	2.91	2.91
Operating Costs														
Resettlement Costs														
Total Costs	4.39	4.36	3.38	6.51	4.55	3.53	4.4	4.62	6.1	6.51	4.46	9.32	3.45	8.17
Crop Revenues	13.71	13.71	13.71	13.71	13.71	13.71	13.71	13.71	13.71	13.71	13.71	13.71	13.71	13.71
Net Returns	9.32	9.35	10.33	7.2	9.16	10.18	9.31	9.09	7.61	7.20	9.25	4.39	10.26	5.54

Source: Devres Staff Estimates, August 1985

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Table II-37: Financial Rates of Return Summary of Five IDUs

	Base Case	10% Increase in Costs	10% Increase in Revenues
Financial Analysis (Exclusive of Maguga Dam)			
Base Analysis	8.75	7.41	10.08
Sensitivities			
Exclusive of Housing and Resettlement Costs	13.00	11.41	14.59
Reduced Cropping Intensity	3.96	2.60	5.26
Financial Analysis (Inclusive of Maguga Dam)			
Base Analysis	4.32	3.14	5.50
Sensitivities			
Exclusive of Housing and Settlement Costs	6.21	4.94	7.50
Inclusive of Irrigator Charges	5.95	4.61	6.70
Reduced Cropping Intensity	0.02	-0.11	1.45

Source: Devres Staff Estimates, August 1985

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V. FINDINGS AND RECOMMENDATIONS

A. Findings

1. A project of 3,000 ha of combined smallholder and nucleus estate irrigation is financially sound, economically viable, and has a wide range of other benefits. This base project would use some 40 MCM/year.

2. A project of 5,000 ha has even higher levels of justification, using up to 63 MCM annually. The only possible constraint (at this time), might be the shortage of Class 1 and Class 2 land, suitable for irrigation.

3. Preliminary analysis suggests that the alternative economics of river pumping versus a canal carrying some 95-100 MCM/year should be re-examined if and when these larger volumes of water use may be serviced by one canal.

4. The project area currently suggested for this project may very well be the last available in the country of this size with proper soils and economically low levels of pumping lift.

5. The use of the 1,000 ha module, or Irrigation Development Unit (IDU) proved an effective device for phasing in projects of larger sizes. Those alternate project sizes can be conditioned by water availability.

6. There would be some economics of scale in management, specialist services affordable, work shops, transportation, marketing, and other areas as the base project expanded in size.

7. The on-project irrigation delivery system appears to be ideally suited to the project's physical and agronomic requirements. The buried system and the use of a balancing reservoir (for each IDU) reduce both running costs and maintenance.

8. Social infrastructure costs, particularly housing, weigh very heavily in the financial/economic analyses.

9. Crop selection was based on a combination of agronomic, marketing and familiarization factors. The nine crops combine high returns (tree crops for export) with the need for local market and smallholder food supply (e.g. maize, vegetables); with an eye to minimizing water use (no sugar or rice, modest cotton production, maximize tree crops).

10. Crop rotations decided upon should maintain soil fertility and yields.

11. All crops can be marketed. Solid markets have been identified domestically, in the RSA, and in the Northern Hemisphere (fruits only). Those findings are discussed at Volume III. It is established here however, that crops, cropping patterns, and the volumes produced were all subject to a market and marketing screening, including, especially, transportation.

12. An organizational structure has been suggested for each IDU. The point is made that, once two or three IDUs are established, an umbrella project organization may be required.

13. It was also found that a Basin-level Development Board, or authority, would clearly be required to integrate the management of all elements of water supply and water demand in the Komati River Basin.

14. The project's financial and economic benefits are significant. Without the cost of the dam and its maintenance, rates of return are very satisfactory. By adding back to the net revenue streams various project cost recovery activities, the project could cover the costs of the dam as well.

15. Other water users charges should also be levied in a manner to be determined. Such levies can consistently build up funds to finance continuing development investments.

16. The project's direct and indirect employment impacts are significant, particularly in the light of the continuing economic malaise.

17. Other benefits of the irrigation project include the stabilization/predictability of income and hence living standards; the provision of needed local and national food supplies; the development of social facilities and services very much superior to those available pre-project.

18. The irrigation project has a 30-year life. Orchards require replacement at 23-33 years. So do buildings, other civil works, and on-project water delivery and drainage systems. Another advantage of the "module" development process is that the re-development process can also be phased.

B. Recommendations

1. The base irrigation project of 3000 ha should be started with all deliberate speed and expanded up to 5,000 ha.

2. The development must be planned, coordinated and otherwise moved forward most carefully and in an integrated manner.

3. This will require the development of:

- An appropriate planning/institutional environment;
- An appropriate executing agency and environment;
- An appropriate funding/financing institutional environment; and
- An appropriate set of linkages to external funding/techincal assistance systems.

4. The detailed feasibility work on the project as described in the TOR at Annex 3 of volume I must be started. These TOR recommend consideration of numerous on-project issues and question marks to be addressed. These include, for example, soil/conservation/delivery system relationships; smallholder settlement; how to keep the farmer on his land; what to do about livestock; how to enforce production discipline; how to develop irrigation within the context of the present land tenure system on SNL.

ANNEX 1

AGRICULTURAL CROPS, CROPPING AND BUDGETS

ANNEX 1

Agricultural Crops, Cropping and Budgets

A. Introduction

This annex supplements the Chapter discussion of crops, cropping, rotations in Chapter IV. The first section looks at the long list of crops available for production in southern Africa and selects those for the project which are suitable for lowveld irrigation farming and which, simultaneously, can be marketed. The second presents worksheets indicating smallholder crop rotations and crop build-up; the third does the same for the nucleus estate. The proforma work sheet used for these crop build-up is Figure II-A-1. Finally, the translation of these sets of assumptions into farm budgets is at section V.

B. Eliminating otherwise Suitable Lowveld Crops

The Devres TOR call for such a crop/product classification. It is at Table II-A-1.

Table II-A-1: Eliminating Some Climatically Adapted (Lowveld) Enterprises for Techno-Economic and Other Practical Reasons

Enterprise Crops	Lowveld[a]	Reasons for Elimination
Avocado	X	
Allspice	X	No significant commercial value
Anise	X	No significant commercial value
Aubergine	X	No significant market demand
Black Wattle	X	Land too limited. Could become a weed.
Beetroot	X	No significant market demand
Butternut	X	No significant market demand
Barley	X	Irrigation needed. Best grown on estate nucleus
Banana	X	
Butter Beans	X	No significant commercial value
Blue Grass	X	No significant commercial value
Bean (common)		
Cashew nut	X	Irrigation needed. Best grown in humid tropics
Cabbage	X	
Chillies	X	Estate production only
Caraway		No significant market demand
Chop Suey Green		No significant market demand
Chick Pea		No significant market demand
Chicory		Unproven. Research needed.
Coffee arabica		
Coffee robutsa	X	
Coriander		No significant market demand
Carrot	X	No significant market demand
Clover	X	Only relevant as livestock pasture
Clove	X	No significant market demand
Cotton	X	
Cucumber/Pumpkin	X	No significant market demand
Citrus (Grapefruit)	X	Irrigation needed. Unsuitable for smallholder production.
Citrus (Navel)		Irrigation needed. Unsuitable for smallholer production.
Cassava	X	No significant commercial value to smallholder
Cape Gooseberry		No significant market demand
Castor Oil	X	An estate scale crop
Dill		No significant market demand
Frescue		Only relevant as livestock pasture
Ginger	X	No significant commercial value
Green pepper		No significant market demand

Table II-A-1: Eliminating Some Climatically Adapted (Lowveld) Enterprises for Techno-Economic and Other Practical Reasons (continued)

Granadilla, purple		Production technicalities too complex
Granadilla, yellow	X	Production technicalities too complex
Groundnut	X	
Guar	X	Too innovative
Guava	X	
Japanese millet		No significant commercial value
Japanese raddich	X	Only relevant as livestock feed
Kenaf	X	No significant market demand
Kidney vetch		No significant commercial value
Kola nut	X	Unproven
Lettuce	X	Too perishable. No significant market demand
Lentil	X	No significant market demand
Lespedeza	X	No significant market demand
Linseed		Only extensive estabe production viable
Lupin	X	Only relevant as livestock feed
Lucerne	X	Irrigation needed. Mechanization excessive and demand limited.
Macadamia	X	Irrigation required. Too innovatible.
Mango	X	
Millet grain	X	Insignificant market demand
Maize	X	
Nile grass	X	No significant commercial value
New Zealand Hemp	X	Unstable market. Economically non-viable
Onions		
Old man salt bush	X	Only significant as livestock feed in arid environment
Oats		No significant market demand
Pineapple		
Papaya	X	
Quick grass	X	No significant commercial value
Paspalum	X	No significant commercial value
Potato		
Pigeon Pea	X	No significant commercial value
Pyrethrum		Unproven. Research needed.
Rhodes grass	X	Only relevant as livestock pasture
Rice	X	Water resource too limited
Rye		No significant market demand
Red clover	X	Only relevant as livestock pasture
Sisal	X	Decortication problem. Best grown on estate scale
Sugar beet		Conflict with sugar can industry
Sword bean	X	No significant market demand
Sunflower		No significant market demand
Sweet potato	X	

Table II-A-1: Eliminating Some Climatically Adapted (Lowveld) Enterprises for Techno-Economic and Other Practical Reasons (continued)

Soya bean		
Sugar cane	X	
Strawberry		Production technicalities too complex; very high production costs
Sunflower		
Seradella	X	No significant market demand
Sesame	X	No significant market demand
Sorghum	X	No significant commercial value
Tung nut		An estate scale crop
Tea		Unproven. Availability of suitable sites uncertain
Tomato	X	
Teff		Only relevant as livestock feed
Thatch grass		Only extensive production
Tobacco		
Timothy		No significant commercial value
Velvet bean	X	No significant market demand
Watermelon	X	Prohibitive transport costs to RSA markets
Wheat		Extensive estate production value
Yam	X	No significant commercial value
LIVESTOCK		
Dairy		Limited number of potential participants
Beef	X	Excessive constraints imposed by traditions
Goat (meat)	X	No commercial significance to smallholder
Goat (dairy)		No commercial significance
Pig		Limited number of potential participants
Sheep		Communal grazing system
Poultry		Limited number of potential participants

[a] Those with an "X" are suited to lowveld. Those with an "X" but no comment in col. (3) could be (or are) grown under lowveld irrigation conditions.

Source: Adapted from A Preliminary Study of Possible Agricultural Projects for Swaziland (Mbabane : East African Technical Services, April, 1985) USAID.

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C. Smallholder Cropping

Six displays present the build-up of crops, and their rotations, on the 200 smallholder farms of the first IDU. Build up of settlement and planted area takes one year less on subsequent IDUs simply because it is assumed that acceleration is permitted by the settlement experience of the first IDU. Two displays are provided for each of PY 4, 7 and 11, one for winter crops, one for summer. Note that these are PY, not crop years; smallholder cropping begins in PY 4 (while the dam is under construction, and after some cropping has begun on the nucleus estate.

Figures II-A-2 through II-A-7 show the build-up to a cropping intensity of 200 percent at PY 11, which is 100 ha field crops, summer and winter, and 100 ha permanent tree crops.

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SMALLHOLDER
CROP BUDGET SUMMARY WORKSHEET
PROJECT 4 SUMMER ____ WINTER x

10 Year 1 Citrus	10 Year 1 Mango		
10	10	10 Year 1 Avocado	10 Year 1 Papaya
10	10	10	10
10	10	10	10
10	10	10	10
			10

A. INCOME (GROSS)

	CROP	Total Area, ha	Est. Yield t/ha	Est. Return E/t	Extended Total Return, E
1.	Tomato	50	20	347	347,000
2.	Cabbage	50	40	100	200,000
3.	Potato	100	28	200	560,000
4.					
5.					
6.					
7.					
8.					
9.					
10.					
11.				E	1,107,000

B.

	OPERATION	Units	E/Unit[a]	Extended Total Direct Cost, E
1.	Tomato	50	4896	244,800
2.	Cabbage	50	3266	163,300
3.	Potato	100	4520	452,000
4.				
5.				
6.				
7.				
8.				
9.				
10.				
11.			DIRECT COST TOTAL	E 860,100
12.			GROSS MARGIN (line A.11 minus B.11)	E 246,900

SWAZILAND: ECONOMIC STUDY OF POSSIBLE USES OF ADDITIONAL WATER ON THE KOMATI RIVER

Figure II-A-2: Worksheet for Cropping Budgets

[a]Note that these were raised, subsequently, at the project level to allow for subsequent adjustment to the labour costs. That dropped gross margins slightly from those shown.

SMALLHOLDER
CROP BUDGET SUMMARY WORKSHEET
PROJECT 4 SUMMER x WINTER ____

10 Year 1 Citrus	10 Year 1 Mango		
10	10	10 Year 1 Avocado	10
10	10	10	10 Year 1 Papaya
10	10	10	10
10	10	10	10
			10

A. INCOME (GROSS)

	CROP	Total Area, ha	Est. Yield t/ha	Est. Return E/t	Extended Total Return, E
1.	Maize	100	3.5	313	109,550
2.	Cotton	100	2.0	820	164,000
3.					
4.					
5.					
6.					
7.					
8.					
9.					
10.					
11.				E	273,550

B.

	OPERATION	Units	E/Unit[a]	Extended Total Direct Cost, E
1.	Maize	100	870	87,000
2.	Cotton	100	1422	142,200
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				
11.			DIRECT COST TOTAL	E 229,200
12.			GROSS MARGIN (line A.11 minus B.11)	E 44,350

SWAZILAND: ECONOMIC STUDY OF POSSIBLE USES OF
ADDITIONAL WATER ON THE KOMATI RIVER

Figure II-A-3 : Worksheet for Cropping Budgets

[a]Note that these were raised, subsequently, at the project level to allow for subsequent adjustment to the labour costs. That dropped gross margins slightly from those shown.

SMALLHOLDER
CROP BUDGET SUMMARY WORKSHEET
PROJECT 7 SUMMER ____ WINTER x

31 Year 4 Citrus	31 Year 4 Mango		
31 Year 3 Citrus	31 Year 3 Mango	31 Year 4 Avocado	31 Year 4 Papaya
31 Year 2 Citrus	31 Year 2 Mango	31 Year 3 Avocado	31 Year 3 Papaya
31 Year 1 Citrus	31 Year 1 Mango	31 Year 2 Avocado	31 Year 2 Papaya
31	31	31 Year 1 Avocado	31 Year 1 Papaya
			50

A. INCOME (GROSS)

CROP	Total Area, ha	Est. Yield t/ha	Est. Return E/t	Extended Total Return, E
1. Tomato	50	20	347	347,000
2. Cabbage	50	40	100	200,000
3. Potato	100	28	200	560,000
4.				
5.				
6.				
7.				
8.				
9.				
10.				
11.			E	1,107,000

B.

OPERATION	Units	E/Unit[a]	Extended Total Direct Cost, E
1. Tomato	50	4896	244,800
2. Cabbage	50	3266	163,300
3. Potato	100	4520	452,000
4.			
5.			
6.			
7.			
8.			
9.			
10.			
11.		DIRECT COST TOTAL	E 860,100
12.		GROSS MARGIN (line A.11 minus B.11)	E 246,900

SWAZILAND: ECONOMIC STUDY OF POSSIBLE USES OF ADDITIONAL WATER ON THE KOMATI RIVER

Figure II-A-4: Worksheet for Cropping Budgets

[a]Note that these were raised, subsequently, at the project level to allow for subsequent adjustment to the labour costs. That dropped gross margins slightly from those shown.

SMALLHOLDER
CROP BUDGET SUMMARY WORKSHEET
PROJECT 7 SUMMER x WINTER

31 Year 4 Citrus	31 Year 4 Mango		
31 Year 3 Citrus	31 Year 3 Mango	31 Year 4 Avocado	31 Year 4 Papaya
31 Year 2 Citrus	31 Year 2 Mango	31 Year 3 Avocado	31 Year 3 Papaya
31 Year 1 Citrus	31 Year 1 Mango	31 Year 2 Avocado	31 Year 2 Papaya
31	31	31 Year 1 Avocado	31 Year 1 Papaya
			50

A. INCOME (GROSS)

	CROP	Total Area, ha	Est. Yield t/ha	Est. Return E/t	Extended Total Return, E
1.	Cotton	100	2.0	820	164,000
2.	Maize	100	3.5	313	109,550
3.	Papaya	25	25.0	400	250,000
4.					
5.					
6.					
7.					
8.					
9.					
10.					
11.				E	523,550

B.

	OPERATION	Units	E/Unit[a]	Extended Total Direct Cost, E
1.	Cotton	100	1422	142,200
2.	Maize	100	870	87,000
3.	Papaya	25	3363	84,075
4.				
5.				
6.				
7.				
8.				
9.				
10.				
11.			DIRECT COST TOTAL	E 313,275
12.			GROSS MARGIN (line A.11 minus B.11)	E 210,275

SWAZILAND: ECONOMIC STUDY OF POSSIBLE USES OF ADDITIONAL WATER ON THE KOMATI RIVER

Figure II-A-5: Worksheet for Cropping Budgets

[a]Note that these were raised, subsequently, at the project level to allow for subsequent adjustment to the labour costs. That dropped gross margins slightly from those shown.

SMALLHOLDER
CROP BUDGET SUMMARY WORKSHEET
PROJECT 11 SUMMER ____ WINTER x

31 Year 8 Citrus	31 Year 8 Mango		
31 Year 7 Citrus	31 Year 7 Mango	31 Year 8 Avocado	31 Year 8 Papaya
31 Year 6 Citrus	31 Year 6 Mango	31 Year 7 Avocado	31 Year 7 Papaya
31 Year 5 Citrus	31 Year 5 Mango	31 Year 6 Avocado	31 Year 6 Papaya
31	31	31 Year 5 Avocado	31 Year 5 Papaya
			50

A. INCOME (GROSS)

CROP	Total Area, ha	Est. Yield t/ha	Est. Return E/t	Extended Total Return, E
1. Tomato	50	20	347	347,000
2. Cabbage	50	40	100	200,000
3. Potato	100	28	200	560,000
4.				
5.				
6.				
7.				
8.				
9.				
10.				
11.				E 1,107,000

B.

OPERATION	Units	E/Unit[a]	Extended Total Direct Cost, E
1. Tomato	50	4896	244,800
2. Cabbage	50	3266	163,300
3. Potato	100	4520	452,000
4.			
5.			
6.			
7.			
8.			
9.			
10.			
11.			DIRECT COST TOTAL E 860,100
12.			GROSS MARGIN E 246,900 (line A.11 minus B.11)

SWAZILAND: ECONOMIC STUDY OF POSSIBLE USES OF ADDITIONAL WATER ON THE KOMATI RIVER

Figure II-A-6: Worksheet for Cropping Budgets

[a]Note that these were raised, subsequently, at the project level to allow for subsequent adjustment to the labour costs. That dropped gross margins slightly from those shown.

SMALLHOLDER
CROP BUDGET SUMMARY WORKSHEET
PROJECT 11 SUMMER x WINTER ____

31 Year 8 Citrus	31 Year 8 Mango		
31 Year 7 Citrus	31 Year 7 Mango	31 Year 8 Avocado	31 Year 8 Papaya
31 Year 6 Citrus	31 Year 6 Mango	31 Year 7 Avocado	31 Year 7 Papaya
31 Year 5 Citrus	31 Year 5 Mango	31 Year 6 Avocado	31 Year 6 Papaya
31	31	31 Year 5 Avocado	31 Year 5 Papaya
			50

A. INCOME (GROSS)

CROP	Total Area, ha	Est. Yield t/ha	Est. Return E/t	Extended Total Return, E
1. Cotton	100	2	820	164,000
2. Maize	100	3,5	313	109,550
3. Papaya	50	25	400	500,000
4. Mango	50	9	642	288,900
5. Avocado	50	40	176	352,000
6.				
7.				
8.				
9.				
10.				
11.				E 1,414,450

B.

OPERATION	Units	E/Unit[a]	Extended Total Direct Cost, E
1. Cotton	100	1422	142,200
2. Maize	100	870	87,000
3. Papaya	50	3363	168,150
4. Mango	50	4303	215,150
5. Avocado	50	4478	223,900
6.			
7.			
8.			
9.			
10.			
11.		DIRECT COST TOTAL	E 836,400
12.		GROSS MARGIN (line A.11 minus B.11)	E 578,050

SWAZILAND: ECONOMIC STUDY OF POSSIBLE USES OF
ADDITIONAL WATER ON THE KOMATI RIVER

Figure II-A-7: Worksheet for Cropping Budgets

[a]Note that these were raised, subsequently, at the project level to allow for subsequent adjustment to the labour costs. That dropped gross margins slightly from those shown.

D. Nucleus Estate Cropping

Figures II-A-8 through II-A-15 provide background on the nucleus estates' crop development programme; this is the first IDU and subsequent IDU development (two more in the 3000 ha base project) take only three-quarters of the time.

Figure II-A-8 lists the cropping activities on the estates' 600 ha year by year. The first three years' rotations are portrayed schematically at the next two Figures. Figure II-A-10 indicates the cropping by 31 ha block for the first five cropping years. Figures II-A-12 through II-A-15 provide the equivalent of earlier smallholder tables--winter and summer cropping work sheets for PY 3 and 10. At full development the estate has 450 ha of tree crops, the balance going to both winter and summer field crops (plus the nursery).

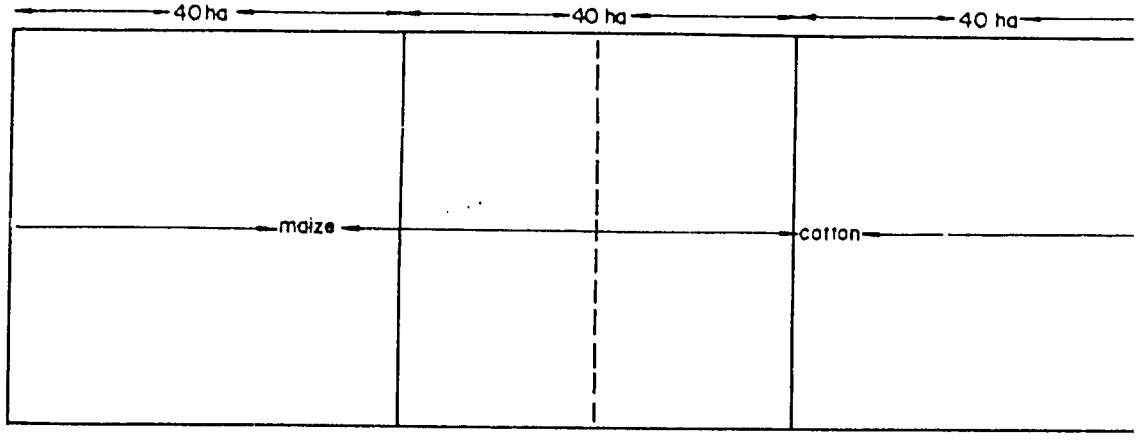
Figure II-A-8: Cropping Pattern for the Nucleus Farm, First 1000 ha IDU

	600 ha	(Fruit trees	450 ha	
		(Nursery	30 ha	
		(Maize	60 ha)	Summer Crops
		(Cotton	60 ha)	
		Vegetables	120 ha	Winter Crop
PY 1	Dam Design -	No Crops		
PY 2	Nursery 10 ha	Summer Crops:	Maize	60 ha
			Cotton	60 ha
		Winter Crops:	Vegetables	120 ha
PY 3	Nursery:			
	10 ha + 10 ha	Summer Crops:	Maize	135 ha (60 ha + 75 ha)
	= 20 ha		Cotton	135 ha (60 ha + 75 ha)
		Winter Crops:	Vegetables	270 ha
			Citrus	30 ha
			Mango	33 ha
			Papaya	33 ha
			Avocado	33 ha
PY 4	Nursery:	Summer Crops:	Maize	135 ha
	20 ha + 10 ha		Cotton	135 ha
	= 30 ha	Winter Crops:	Vegetables	270 ha
			Citrus	60 ha (30 ha + 30 ha)
			Mango	60 ha (33 ha + 33 ha)
			Papaya	66 ha (33 ha + 33 ha)
			Avocado	66 ha (33 ha + 33 ha)
PY 5	Nursery 30 ha	Summer Crops:	Maize	60 ha
			Cotton	60 ha
		Winter Crops:	Vegetables	120 ha
			Citrus	150 ha (60 ha + 90 ha)
			Mango	100 ha (60 ha + 33 ha)
			Papaya	100 ha (66 ha + 33 ha)
			Avocado	100 ha (66 ha + 33 ha)

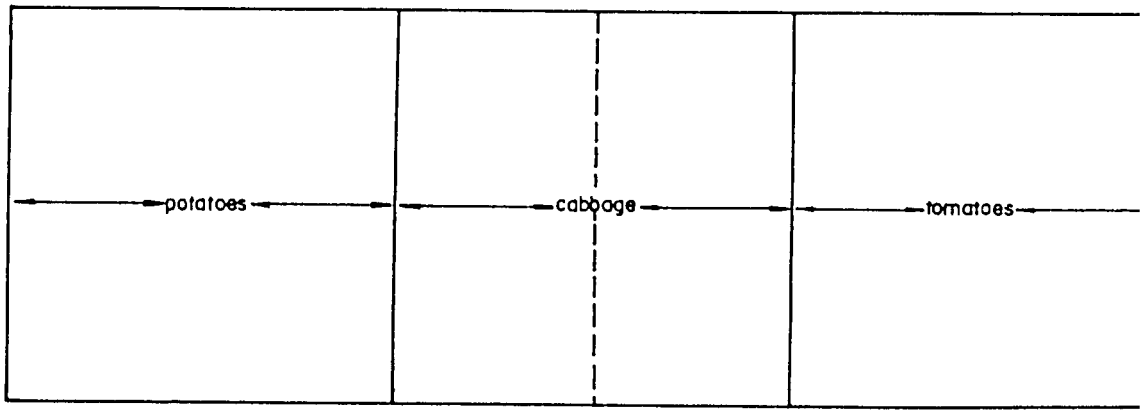
Note: Nursery plots will be used for growing fruit tree seedlings to serve the farmers' needs, to provide plants for fill-ins on the nucleus farm, for testing and evaluating new and potential fruit tree varieties and for variety testing and evaluation.
Fruit trees should preferably be planted on the higher ground.

Source: Devres Staff Estimates, August 1985

320



1st Year Summer Crops Rotation

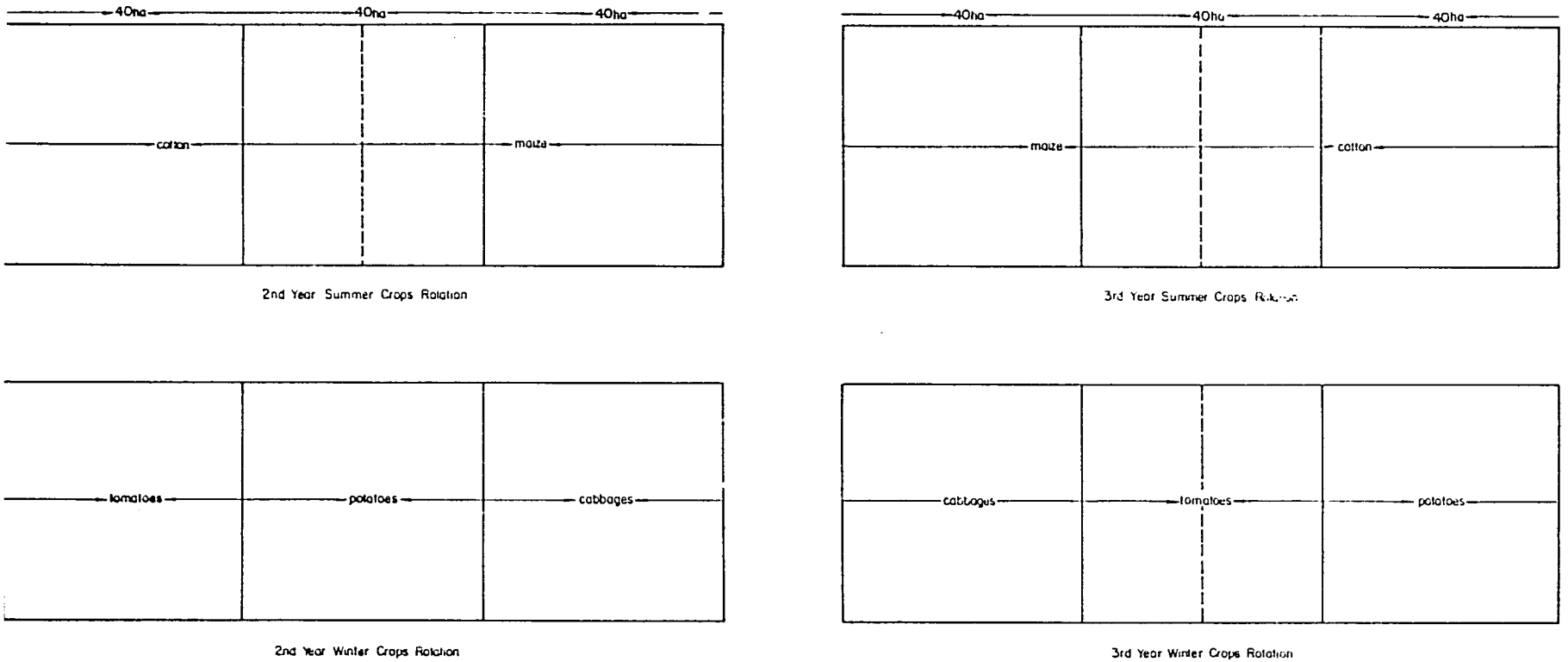


1st Year Winter Crops Rotation

SWAZILAND: ECONOMIC STUDY OF POSSIBLE USES OF ADDITIONAL WATER ON THE KOMATI RIVER

Figure II-A-9: Annual Crop Rotation Plan (Year 1)

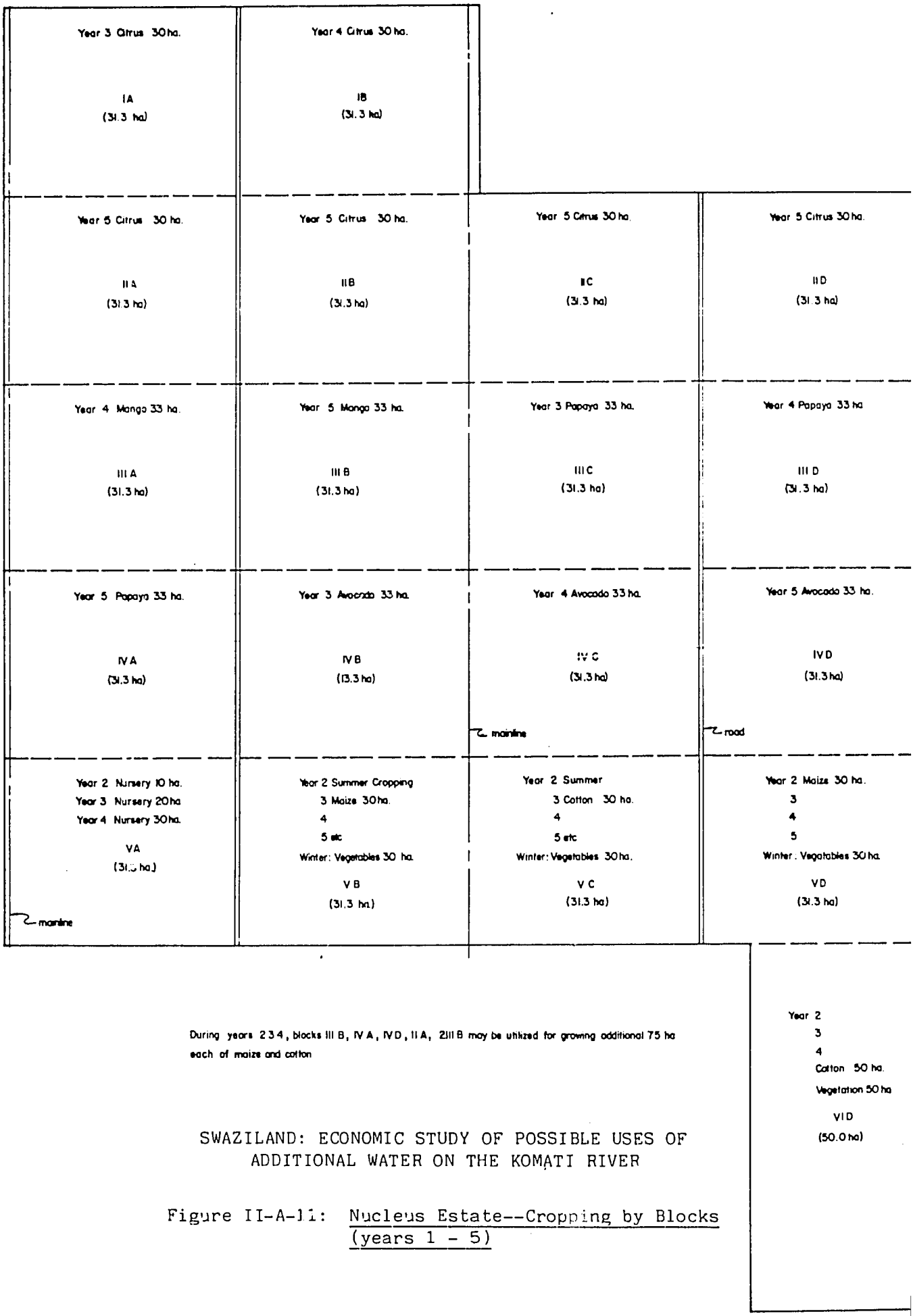
321



SWAZILAND: ECONOMIC STUDY OF POSSIBLE USES OF
ADDITIONAL WATER ON THE KOMATI RIVER

Figure II-A-10: Annual Crop Rotation Plan (Year 2 and 3)

322



During years 2 3 4, blocks III B, IV A, IV D, II A, 2 III B may be utilized for growing additional 75 ha each of maize and cotton

SWAZILAND: ECONOMIC STUDY OF POSSIBLE USES OF ADDITIONAL WATER ON THE KOMATI RIVER

Figure II-A-11: Nucleus Estate--Cropping by Blocks (years 1 - 5)

NUCLEUS FARM

CROP BUDGET SUMMARY WORKSHEET

PROJECT 3 SUMMER ____ WINTER x

31 Plant Citrus	31		
31	31	31	31 Plant Mango
31	31	31 Plant Papaya	31
31	31 Plant Avocado	31	31
31 Nursery 20 ha	31 Vegetables	31 Vegetables	31 Vegetables
			50 Vegetables

A. INCOME (GROSS)

CROP	Total Area, ha	Est. Yield t/ha	Est. Return E/t	Extended Total Return, E
1. Cabbage	90	55	100	495,000
2. Tomato	90	30	347	936,900
3. Potato	90	35	200	630,000
4.				
5.				
6.				
7.				
8.				
9.				
10.				
11.			E	2,061,900

B.

OPERATION	Units	E/Unit[a]	Extended Total Direct Cost, E
1. Cabbage	90	4318	388,620
2. Tomato	90	7183	646,470
3. Potato	90	5121	460,890
4.			
5.			
6.			
7.			
8.			
9.			
10.			
11.		DIRECT COST TOTAL	E 1,495,980
12.		GROSS MARGIN (line A.11 minus B.11)	E 565,920

SWAZILAND: ECONOMIC STUDY OF POSSIBLE USES OF ADDITIONAL WATER ON THE KOMATI RIVER

Figure II-A-12: Worksheet for Cropping Budgets

[a]Note that these were raised, subsequently, at the project level to allow for subsequent adjustment to the labour costs. That dropped gross margins slightly from those shown.

NUCLEUS FARM

CROP BUDGET SUMMARY WORKSHEET

PROJECT 3 SUMMER x WINTER ____

31 Plant Citrus	31		
31	31	31	31 Plant Mango
31	31	31 Plant Papaya	31
31	31 Plant Avocado	31	31
31 Nursery 20 ha	31 Maize	31 Cotton	31 Maize
			50 Cotton

A. INCOME (GROSS)

CROP	Total Area, ha	Est. Yield t/ha	Est. Return E/t	Extended Total Return, E
1. Cotton	135	2.5	820	276,750
2. Maize	135	7.0	313	295,785
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				
11.			E	572,535

B.

OPERATION	Units	E/Unit[a]	Extended Total Direct Cost, E
1. Cotton	135	1776	239,760
2. Maize	135	1329	179,915
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
11.		DIRECT COST TOTAL	E 419,175
12.		GROSS MARGIN (line A.11 minus B.11)	E 153,360

SWAZILAND: ECONOMIC STUDY OF POSSIBLE USES OF ADDITIONAL WATER ON THE KOMATI RIVER

Figure II-A-13: Worksheet for Cropping Budgets

[a]Note that these were raised, subsequently, at the project level to allow for subsequent adjustment to the labour costs. That dropped gross margins slightly from those shown.

NUCLEUS FARM

CROP BUDGET SUMMARY WORKSHEET

PROJECT 10 SUMMER ____ WINTER x

31 7 Year Citrus	31 6 Year Citrus		
31 5 Year Citrus	31 5 Year Citrus	31 5 Year Citrus	31 7 Year Mango
31 6 Year Citrus	31 5 Year Mango	31 7 Year Papaya	31 6 Year Papaya
31 5 Year Citrus	31 6 Year Avocado	31 6 Year Avocado	31 6 Year Avocado
31 Nursery 30 ha	31 Vegetable	31 Vegetable	31 Vegetable
			50 Vegetable

A. INCOME (GROSS)

CROP	Total Area, ha	Est. Yield t/ha	Est. Return E/t	Extended Total Return, E
1. Cabbage	40	55	100	220,000
2. Tomato	40	30	347	416,400
3. Potato	40	35	200	280,000
4.				
5.				
6.				
7.				
8.				
9.				
10.				
11.				E 916,400

B.

OPERATION	Units	E/Unit[a]	Extended Total Direct Cost, E
1. Cabbage	40	4318	172,720
2. Tomato	40	7183	287,320
3. Potato	40	5121	204,840
4.			
5.			
6.			
7.			
8.			
9.			
10.			
11.			DIRECT COST TOTAL E 664,880
12.			GROSS MARGIN E 251,520 (line A.11 minus B.11)

SWAZILAND: ECONOMIC STUDY OF POSSIBLE USES OF ADDITIONAL WATER ON THE KOMATI RIVER

Figure II-A-14: Worksheet for Cropping Budgets

[a]Note that these were raised, subsequently, at the project level to allow for subsequent adjustment to the labour costs. That dropped gross margins slightly from those shown.

NUCLEUS FARM

CROP BUDGET SUMMARY WORKSHEET

PROJECT 10 SUMMER x WINTER ____

31 7 Year Citrus	31 6 Year Citrus		
31 5 Year Citrus	31 5 Year Citrus	31 5 Year Citrus	31 7 Year Mango
31 6 Year Mango	31 5 Year Mango	31 7 Year Papaya	31 6 Year Papaya
31 5 Year Papaya	31 6 Year Avocado	31 6 Year Avocado	31 5 Year Acovado
31 Nursery	31 Cotton	31 Maize	31 Cotton
			50

A. INCOME (GROSS)

	CROP	Total Area, ha	Est. Yield t/ha	Est. Return E/t	Extended Total Return, E
1.	Citrus	150			
2.	Avocado	100	40	176	704,000
3.	Mango	100	9	642	557,800
4.	Papaya	100	25	400	1,000,000
5.	Cotton	60	2.5	820	123,000
6.	Maize	60	7	313	131,460
7.					
8.					
9.					
10.					
11.					E 2,536,260

B.

	OPERATION	Units	E/Unit[a]	Extended Total Direct Cost, E
1.	Citrus	150		
2.	Avocado	100	4478	447,800
3.	Mango	100	4403	430,300
4.	Papaya	100	3363	336,300
5.	Cotton	60	1776	106,560
6.	Maize	60	1329	79,740
7.				
8.				
9.				
10.				
11.			DIRECT COST TOTAL	E 1,400,700
12.			GROSS MARGIN (line A.11 minus B.11)	E 1,135,560

SWAZILAND: ECONOMIC STUDY OF POSSIBLE USES OF ADDITIONAL WATER ON THE KOMATI RIVER

Figure II-A-15: Worksheet for Cropping Budgets

[a]Note that these were raised, subsequently, at the project level to allow for subsequent adjustment to the labour costs. That dropped gross margins slightly from those shown.

E. Crop and Farm Budgets

Four further tables present field crop and tree crop cost and return data. Table II-A-2. shows smallholder farm field crop budgets; there are five--cabbage, tomato and potato in the winter, and maize and cotton as summer crops. As expected, tomatoes and potatoes provide the highest net returns. Maize requires the least labour and tomatoes the most. Cotton requires the most water, however, followed fairly closely by tomatoes. Were resources available, it would have been useful to calculate the net return per M^3 of water used for each of these crops. As a further exercise, the labour costs could be added back to the net return/ha if the farm family performed all its own labour and if that labour were priced at market rates.

Table II-A-3 provides the equivalent data for the nucleus estates' field crops. Net returns are somewhat higher because of higher yields and lower production costs/t of output--the incidence of machinery/equipment operation is higher than on the small farms.

Table II-A-4 indicates the equivalent data for the projects four tree crops--mango, papaya, avocado and citrus. Costs yields and returns are assumed to be the same for both smallholders and the estate. Variable costs/ha are not too different as between crops (E3,130-E4,609) but net returns vary a great deal, from E1,446/ha for mango up to E6,870 for papaya. Since the four crops are assumed to consume the same volume of water, the returns/M^3 are clearly the highest with papaya. At this time of development of and experiment with the first IDU, it was deemed prudent to recognize a market constraint for papaya,and, as well, to be somewhat conservative and not "put all the eggs in one basket." These constraints can of course be released with subsequent IDU development.

Finally, Table II-A-5 collates the smallholder data into a budget for a 2 ha farm producing three hectares of crop annually. Net returns, or the gross margin, just exceed E5,000. Up to E1,000 could be added to that to the degree the family does its own farm work. Simultaneously, that value may not all be cash since perhaps half the maize, and some of the vegetables and fruit, could be consumed by the family.[1]

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1 In the marketing analysis (Volume III) it was assumed that 30% of smallholder vegetable output, maize, and papaya, was consumed by the producer families themselves.

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Table II-A-2 : Smallholder Farm Field Crop Budgets

CROPS	Maize (E/ha)	Cotton (E/ha)	Cabbage (E/ha)	Tomato (E/ha)	Potat (E/ha
Production Costs					
Seed	39	17	360	190	16
Fertilizer	176	116	289	458	5
Chemicals	22	167	113	86	
Mechanical operations	137	99	194	123	2
Irrigation Maint. & Repair	55	55	55	55	
Insurance Contingencies	49	68	148	138	2
Irrigation	160	292	155	245	1
Subtotal Production Costs	638	814	1314	1295	30
Processing and and Marketing Costs					
Packaging Materials	15		355	1467	3
Transport	88	75	1000	500	7
Levies		109			
Subtotal Processing and Marketing Costs	103	184	1355	1967	10
Labour Costs (Production, Harvesting & Processing)	120	430	580	785	4
TOTAL VARIABLE COSTS	861	1428	3249	4047	45
YIELD (T/HA)	3.50	2.00	40.00	20.00	28.
PRICE (E/T)	313	820	100	347	2
TOTAL RETURN	1096	1640	4000	6940	56
NET RETURN	235	212	751	2893	10

Source: Devres Staff Estimates, August 1985

Table II-A-3 : Nucleus Estate Field Crop Budgets

CROPS	Maize (E/ha)	Cotton (E/ha)	Cabbage (E/ha)	Tomato (E/ha)	Potato (E/ha)
Production Costs					
Seed	40	17	360	998	1620
Fertilizer	200	134	578	977	542
Chemicals	71	228		368	193
Mechanical operations	104	218	313	316	391
Irrigation Maint. & Repair	55	55	55	55	55
Insurance			165		
Contingencies	148	85	213	300	320
Irrigation	335	365	155	245	153
Subtotal Production Costs	953	1102	1839	3259	3276
Processing and and Marketing Costs					
Packaging Materials	38		489	2200	466
Transport	226	94	1375	750	875
Levies		136			
Subtotal Processing and Marketing Costs	264	230	1864	2950	1341
Labour Costs (Production Harvesting and Processing	310	445	590	875	610
TOTAL VARIABLE COSTS	1527	1777	4293	7084	5227
YIELD (T/HA)	7	2.5	55	30	35
PRICE (E/T)	313	820	100	347	200
TOTAL RETURN	2191	2050	5500	10410	7000
NET RETURN	664	273	1207	3326	1773

Source: Devres Staff Estimates, August 1985

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Table II-A-4 : Fruit Crop Budgets for Nucleus Estate and Smallholder Farms

CROPS	Mango	Papaya	Avocado	Citrus
Production Costs	(E/ha)	(E/ha)	(E/ha)	(E/ha)
Seed & planting material	50		92	
Fertilizer	164	90	93	217
Chemicals	295	20	213	336
Mechanical operations	86		23	
Irrigation maint. & repair	20		30	
Insurance & other	27		175	94
Contingencies	75	15	78	229
Irrigation	610	610	610	610
Subtotal Production Costs	1327	735	1314	1486
Harvesting and and Marketing Costs				
Packaging materials	1515	120	1647	1023
Transport	758	1770	796	
Levies & contingencies	262		212	
Subtotal Harvesting and Marketing Costs	2535	1890	2655	1023
Labour Costs (Production, Harvesting & Processing)	470	505	700	1295
TOTAL VARIABLE COSTS	4332	3130	4669	3804
YIELD (T/HA)	9	25	40	25
PRICE (E/T)	642	400	176	271
TOTAL RETURN	5778	10000	7040	6775
NET RETURN	1446	6870	2371	2971

Source: Devres Staff Estimates, August 1985

Table II-A-5 : Individual Smallholder Cropping Pattern and Earnings for 2 ha Unit

Crop	Area (ha)	Yield/ha	Price	Production Cost/ha	Total Return	Net Return
Maize	0.50	3.50	315	860	551	121
Cotton	0.50	2.00	820	1430	820	105
Tomato	0.25	20.00	345	4045	1725	714
Cabbage	0.25	40.00	100	3250	1000	188
Potato	0.50	28.00	200	4575	2800	513
Mango	0.25	9.00	640	4330	1440	358
Avocado	0.25	40.00	175	4670	1750	583
Citrus	0.25	25.00	270	3805	1688	736
Papaya	0.25	25.00	400	3130	2500	1718
TOTAL						5034

Source: Devres Staff Estimates, August 1985

ANNEX 2

THE ORGANIZATION OF MARKETING OPERATIONS

ANNEX 2

The Organization of Marketing Operations

The Marketing Operation and a Marketing Unit

A. General

It is recommended that a project marketing unit should be created to coordinate harvesting with market opportunities, and to provide the facilities and services for collection, grading, packing, storage and delivery to the markets at the right time. The organization would be responsible for making advance purchase, at agreed prices, of produce pre-harvest from smallholders, and for establishing a common pool representing consolidated domestic and export earnings for distribution to smallholders at the end of the season or agreed period, less a percentage deduction to cover all direct product/market related costs and other changes as required.

It is proposed, for the purpose of this report, that the marketing unit could be known as the Komati Agricultural Produce Marketing Authority (KOMAPRO). The marketing function would be classified in two distinct categories.

1. Domestic Marketing

Primarily concerned with the distribution of fresh produce to the local and central markets, and the delivery of maize and cotton to the appropriate centres.

2. Export Marketing

The shipment of high priced out-of-season fruits to competitive overseas markets--where consumer preferences can differ widely from country-to-country--and for distributing fresh vegetables to neighbouring African countries whenever an identified demand exists.

B. Domestic Marketing

The marketing of vegetables in Swaziland, and especially in the densely populated centres around Mbabane and Manzini in the Central region, is characterized by a lack of information on the quantities and types of vegetables grown, the periods when they are available for sale, and fluctuations in volume and demand levels. Smallholders have no idea of the magnitude of the market for their vegetables.

The MOAC's Market Advisory Unit collects daily price data at the Mbabane and Manzini markets and broadcasts prices twice weekly on the local radio. The unit also publishes a monthly bulletin on average prices and volume sold, but is not equipped to estimate or provide supply and demand information.

Currently, TDL farmers are the main sources of supply providing 68 percent of sales to the Central area and 67 percent local supplies. These farmers sell 39 percent of their vegetables to the Central area, and 35 percent locally.

SNL farmers have neither the resources nor the skills to market their produce, let alone to compete with the larger and more efficient TDL farmers. Dealers prefer to buy from regular suppliers located in the Central areas, and go out to the RDAs only when undersupplied by TDL farmers locally. Consequently, the supply potential from smallholders has not hitherto been fully tapped with the result that local prices are far higher than in RSA.

A continuation of the existing supply constraints during the period of the first IDU would ensure a ready outlet for the project area's vegetables in the Central markets, and would fully justify major consideration being given to the vegetable component in cropping patterns. But the contrary situation may well be the case, leading to significant changes in the project's horticultural development programme. The determining factor will stem from the impact of the recently established National Agricultural Marketing Board (NAMB), and the construction of the proposed wholesale market at Mahlanya (more details on the NAMB in Volume III of this report).

The National Agricultural Marketing Board will compile a register of distributors, importers and exporters. It will establish a list of "scheduled products". The structure and functions are covered in detail in the formal recommendations drafted by IFAD, the co-funding agency. Briefly, activities include the regulation of the market process for all fresh produce regardless of source of supply, the introduction of quality standards, rationalization of domestic supply in relation to demand, the provision of marketing and transport services, the arrangement of market outlets for large scale farmers, and the handling of exports to neighbouring countries. Operational components will include the following:

- Central Market Depot. Two cold rooms, bulk grain storage (5,000T), general storage and sales floor area. Grading and packing facilities. Fleet of 20 trucks (8T) and 5 pick-ups 2 1/2T) for local and distant collection;

- Collection Centres. Comprising a shed and small office, 50 M^2. Total 16;

- Market Intelligence Unit. The unit will collect and compile regular market information on prices and volumes in the major markets in Swaziland and neighbouring countries, so as to determine weekly buying prices at the grading and collection centres; and

- Transceivers. RDA's (Rural Development Areas) are to be equipped with a new UHF (Ultra High Frequency) communications network with four frequency channels, establishing direct links between the Central Wholesale market and the main fruit and vegetable growing

centres. Information on market prices and conditions will be exchanged for feed-back information on production availability to the market authorities and wholesale/traders.

It is assumed that, by Project Years 2 and 3, when the first supplies of vegetables become available, the NAMB and central wholesale market will have become fully operational. It will be essential that KOMAPRO should work in close collaboration with NAMB, and also that full benefit should be received from this association in terms of the sources made available to smallholders and estate farms. In particular KOMAPRO should be linked in to the transceiver network, so that harvesting and delivery of produce can be geared to central market requirements.

C. Export Marketing

It is vitally important to establish a systematic, yet uncomplicated procedure covering all stages between collection of produce at farmgate to delivery into the export markets, in the following activity sequence:

- Transport from farmgate to packing house;
- Washing, first quality inspection;
- Pre-cooling;
- Second quality control, sorting, grading and packing;
- Cold storage (if required);
- Requisition of transport to port of departure; and
- Export documentation. Customs documents, way bills, certificates of origin, export entry, shipper's despatch instructions, customs invoices, letters of credit, etc.

Many of these functions will be handled by a shipping agent who can arrange to transport the produce from the project area to the port of departure, and deal with most of the complicated documentation. This presupposes that KOMAPRO has already appointed a sole importer/agent in the export market. It also assumes that KOMAPRO is appropriately staffed with very experienced management to control and direct the complex and critical operations from the start.

The alternative is to appoint an export agent in RSA specializing in perishable produce who, in turn, will have importer connections in each export market. The export agent handles all documentation and arranges shipments by sea or air according to the urgency indicated by market opportunity. The complete operation is handled on an agreed fruit commission, with prompt payments less deduction of all charges, taxes, etc. Johannesburg exporters indicated their willingness to enter into negotiations with the Komati project administration, which would include provision of containers, or consolidating loads with silimar produce from Eastern Transvaal, if required. The disadvantage could be a possible penalty in the forfeiting of the foreign exchange earnings. On the other hand, a three-year contractual arrangement wi n an experienced organization on a sole agency agreement would ensure that management's learning curve would reduce operational losses while achieving effective market penetration and export revenue.

Another option would be to utilize the resources of PRODEX, the non-citrus marketing wing of the South African Citrus Exchange. PRODEX was set up in 1982 with a view to feeding into its extensive citrus distribution network, a more broadly based produce range. The idea is theoretically sound, but in practice, has hit several serious problems, partly due to inexperienced South African exporters having h too high expectations, and partly due to the inability of the citrus colossus to think small enough. It may well be that the need for diversification may result in Prodex emerging as a useful adjunct to the working arrangement that already exists through the Swaziland Citrus Board. As Project Years 2 and 3 approach, this and other possible avenues should be studied more closely.

D. Staffing

Staffing policy of KOMAPRO would be based on minimum personnel with maximum skills, motivation and mobility. Initial staff requirements would be:

- Marketing Manager;
- Domestic Marketing Officer/Transport Officer;
- Cold Storage Officer;
- Secretary/Typist/Telex; and
- Driver

Equipment would include telex, UHF transceiver, typewriter and pick-ups/ land rover vehicles.

It may be argued, and correctly so, that the above staff would be disproportionate to the scale of the first IDU. This is correct, but the skills required will be the same for 1,000 ha as for 5,000 ha; and regrettably, so single individual could be expected to be sufficiently expert in export marketing, domestic marketing and cold storage quite apart from being in three places at the same time.

A solution could be a technical assistance programme which would support project implementation. A Marketing Advisor, on two-year contract, could discharge the functions of marketing manager, set up the project marketing body KOMAPRO, and train the Domestic Marketing Officer. During this period, the latter would be motivated by the prospect of promotion to Marketing Manager on the Advisor's departure, which would be achievable on the basis of two years on-the-job training. A job description for the Marketing Advisor is attached.

Technical assistance would also be required for the highly specialized role of Produce Storage Officer. His period of assignment would be for three months following the construction of the cold storage and pre-storage units. A job description for this Advisor is also attached.

Attachment 1 to Annex 2

Outline Job Description--Marketing Advisor (Agricultural Produce)

1. Duties:

1.1 Advice to the Komati Project Manager on the establishment of the Komati Agricultural Produce Authority (KOMAPRO).

1.2 Assistance in organisational and evaluation of market intelligence.

1.3 Assistance in diversification of exports and product mixes.

1.4 Assisting KOMAPRO to optimize foreign exchange earnings through better utilization of available transport facilities by air, sea, road and rail.

1.5 Advise KOMAPRO in methods for the creation of an effective promotional campaign in neighbouring and overseas export markets.

1.6 Advise on methods of quality inspection pre- and post-farmgate, and recommend methods for systematic quality control of produce before storage and before shipment.

1.7 Instruct the marketing staff of KOMAPRO on all aspects of the marketing mix, and provide on-the-job training for smallholders on the harvesting and handling of perishable produce for export markets.

2. Qualifications and Experience:

2.1 Extensive practical experience as marketing manager of large-scale organizations of international repute engaged in the export or import of fresh and processed fruit and vegetables.

2.2 Experience in marketing and distribution methods in West European and Middle East fruit and vegetable markets. Knowledge of the Japan market would be an advantage.

2.3 Knowledge of quality control requirements of OECD, EEC and importing countries in Western Europe, Middle East and Japan.

2.4 Practical knowledge of package design, packaging for shipment, palletization for transport by road, air, sea and rail to export markets. Knowledge of the packaging industry, trends in packing materials, design and methods.

2.5 Specific experience in dealing with the principal markets of Western Europe with special reference to France and Scandanavia, West Germany, the Netherlands and the United Kingdom.

3. Period of Assignment: Two full man-years.

4. Location: Komati region with extensive travel in neighbouring Africa and export markets.

Attachment 2 to Annex 2

Outline Job Description--Storage Consultant

1. Duties:

   1.1 Assist the cold store manager to operate and maintain cold storage facilities at acceptable standards of use and utilization.

   1.2 Advise the Project Marketing Organization on suitable equipment for cleaning, grading and packing of fruits and vegetables.

   1.3 Arrange seminars on storage, handling and packing of fresh produce.

   1.4 Arrange a hands-on training programme for the Cold Storage Officer. This programme should cover the technical aspects of operation and routine maintenance of refrigeration equipment as well as the proper use of cold and controlled atmosphere storage for actual and potential Komati project produce.

   1.5 The Consultant should write a concise, illustrated, practical manual for cold storage maintenance and operation. Prevalent equipment should be covered with the aid of manufacturer's information.

2. Qualifications and Experience

   2.1 The Cold Storage Consultant should have at least five years of actual hands-on experience in cold storage operations for fruits and vegetables.

   2.2 His formal education should be preferably at the intermediate technical level, directly related to refrigeration technology.

3. Period of Assignment: Three man-months during Project Year 2.

4. Location: Komati region.

ANNEX 3

FINANCIAL/ECONOMIC MODEL OF AN IRRIGATION PROJECT

ANNEX 3

Financial/Economic Model of an Irrigation Project

A. Introduction

This Annex's purpose is to provide, in a generalized and schematic way, the rudiments of the financial and economic analysis process by which an irrigation project of this type is assessed. The policy-maker wants to know, in the typical case, whether or not the scarce funds and other resources he is investing in any given project will provide a reasonable return to the country. Secondly, under some circumstances, he will certainly want to know if that particular investment will provide a real return to the nation as great as any other allocation of those same resources; if some other project in the same sector (or in any other sector for that matter) will provide more benefits, should not ce other project have priority?

The "model" discussed here can be applied to a project doing anything--a factory, a fishing enterprise, a farming operation, a sawmill, an extension to a road or a hospital, or whatever. The financial and economic analysis process is similar. What differs is the production system base, which must be described, measured and priced as the core activity. Every activity (canning a pineapple, farming maize, whatever) requires an "enterprise" of some sort, or an economic unit. This can be a peasant farm, a government corporation, a private firm, a project management unit of an irrigation projecct. It is this organization or enterprise which arranges for and pays for all of the external inputs for the project, then puts them all together with its own capital and labour resources to make something. This project output--goods or services--is then sold or otherwise sent to the domestic or international outside world.

Some of these enterprises, or economic units, are expected to make a profit, and not require financial or economic subsidization in any way. Others are designed to make a positive financial return, but are subsidized by the rest of the economy in the overall national interest. Economic analysis can show that a project can be financially viable (with subsidies, protection, concessions, etc) but a net drain on the economy as a whole. Conversely, a project can be financially weak, and even negative but because of the national purpose it serves overall is economically good for the country as a whole. Some enterprises are designed to be financially and economically viable, but, over time, go sour and weaker. Yet they still continue for political/bureaucratic reasons; many third world nations have numerous such enterprises.

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B. The Economic Unit

1. Physical Production Analysis

Figure II-A-1 attempts to illustrate the concept of an economic unit; its own resources (internal inputs); the inputs it receives from outside--usually purchased; and outputs, which are usually sold. "Value added", or the net increase in output value which adds to the national income, is quite simply the value of output less the value of inputs.

As suggested on the diagram, the place to start is the physical analysis. That analysis describes the production process, inputs required and outputs generated. It details how the "internal inputs", or factors of production--labour, management, equipment, etc--combine with the external inputs to provide that particular output. The assessment and descriptions of all aspects of this physical process are put in a time sequence.

The model then permits the analyst to move in two directions. One direction is the details of a financial analysis of the project, its ability to support itself with internally generated funding, and its profitability. The second direction is an economic analysis; what is the value of the project to the economy. In that analysis some of the financial aspects are ignored since they are merely transfers within the economy, e.g. tax income, and others are adjusted e.g. shadow wages.

2. Financial Analysis and Value Added

It can also be seen very readily that the level of value added depends heavily on the prices received for the output. If one irrigation project had a protected domestic market for its output, prices and revenue would be very much higher than those accruing to a project selling in a more competitive market. Yet purchased inputs could be the same, so value added on the former would be much higher.

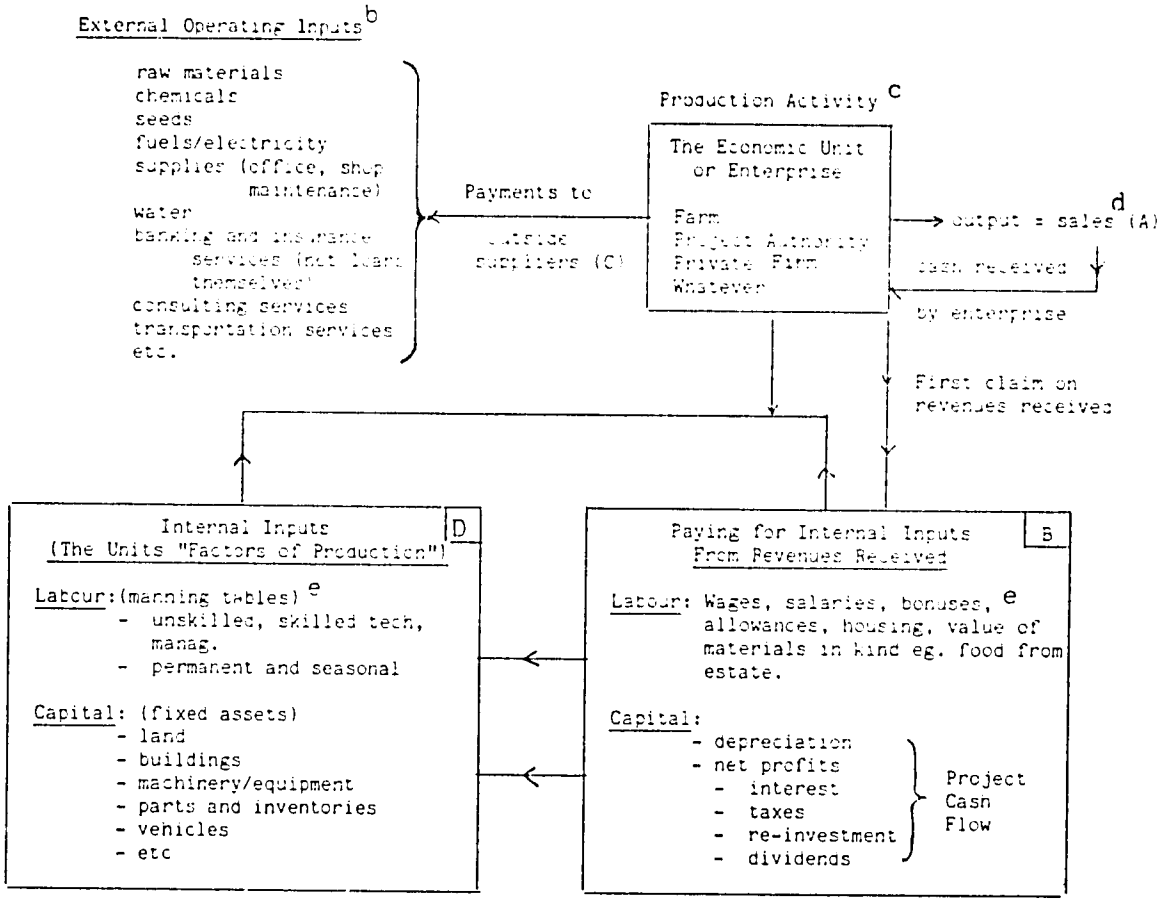
It is essential to realize that value added represents the amount of value created or generated within the production unit itself. It is this amount of value which is the true "output"--the true "production"--for which the economic unit itself can take credit. The enterprise itself can take no credit for values purchased from outside the project. The main point of project evaluation is to make decisions on how best to allocate resources particularly capital. One of the main questions always asked is: How much economic value can we get from using a particular amount of capital in a specific project? This is, we want to know the relationship between a given amount of capital and the amount of "value added" it will be capable of generating. The latter will be the true "output" of the capital embodied in the project.

This is in fact precisely what the "capital/output" ratio refers to--it does not refer to the relationship between the amount of capital being used and the value of the total output in the ordinary sense. The latter represents the sum of purchased inputs plus value added. Not infrequently one finds project reports which are confused on this point and which represent the

SWAZILAND: ECONOMIC STUDY OF POSSIBLE USES OF ADDITIONAL WATER ON THE KOMATI RIVER

I **Physical/Production Analysis:** Technology, Engineering, Agronomy, Manpower, Organisation, Processes, etc.[a]

II **Inputs and Outputs:**



III **Financial and Economic Analysis**

	Value Added by Project to Economy	= A minus B minus C
		= value of output less cost of internal inputs less cost of purchased inputs.
2.	Useful value added ratios	- VA/worker - VA/hectare in production - VA/unit of capital investment - VA/unit of cash flow - VA/unit of prime input eg. water
3.	Other Relationships	
	- Benefit/Cost Ratio:	All costs (capital + operating) and all revenues/benefits discounted to time zero at a rate of interest considered to be the opportunity (or real) cost of capital over life of project (not useful longer than 30 years). Present worth of benefits over present worth of costs. Ratio should be greater than 1.0 if project any good.
	- Internal Rate of Return: (or economic return) (or IRR)	That rate of discount which equates benefit and cost streams at time zero. Good project should indicate IRR greater than real cost of capital in the country.
	- Net Present Worth:	Net out cost and benefit streams over project life, discount at cost of capital. Value resulting can then be compared to, for example, present worth of capital cost; or relate to per-worker, to m³ of water, whatever.

Figure II-A-16: General Model of an Irrigation Project for Financial and Economic Analysis

Notes to Figure II-A-16 on the General Model

a All construction and construction implementation schedules over time, including O & M and any replacement investments; crop development schedules, including tree crop investments and on-farm for any smallholders. Detail over life of project. Describe, quantity and price all purchased inputs over project life. Yield assumptions critical. Don't assume highest technical yields right at the start. Allow for wastage, spoilage, breaking etc. of inputs and outputs-also healthy conting ncy factor. On first cut, project at what you think market prices of these materials, civil work and inputs will likely be.

This production base provides, first of all, a streamed display of all capital costs associated with the project. It is these capital costs which are added to the variable costs (discussed as "B" and "C" below) to achieve a total cost stream over the life of the project. Since that life may be 25-30 years, some of the initial capital e.g. drainage piping, may need to be replaced. The streaming over time also provides the physical volumes of output generated, either one crop or commodity or, more typically, a range of these. But with prices received at the project gate for those items (not export prices, or prices in a domestic market) the production streaming thus generates a project revenue (income) curve.

It is clear that the subsequent quality of the financial and economic analysis rests upon the quality of the technical matters of these production analyses. Variable costs are highly sensitive to the factors, ratios and other elements delineated in this initial section.

b The list of external inputs used to create outputs, and for the internal capital equipment etc. and labour to use, is exemplary only. They are the essentials needed to produce agricultural output and to keep the equipment and plant working. Projects do differ, however. On larger projects, for example, virtually all spares and items needed for maintenance may be produced in the project's own shops. Some inputs also may be in kind, e.g. some seed may be supplied by a research station in return for some water delivered or the use of a tractor from time to time. The "barters" all must be priced at market prices whether outgoing or incoming. Area "C" is the process of payments to outside suppliers.

c The exact nature of the Komati Irrigation Project's organizational structure will be decided by Government when a project is decided upon. Several alternatives are presented in this Volume II. Experience dictates that it should probably be run as a private enterprise firm, independently of Government bureaucracy. Should project decision making, funding and other processes resemble those of the typical Government, efficient use of project resources is at serious risk. On-the-spot and rapid decision making are essential.

d These sales, of course, will be typically in a variety of markets (Area "A"). For export markets prices are FOB less all values between the project and the border to provide a project (or farm) - gate price. For

products/commodities marketed domestically, these are the domestic market prices also worked back to the project/farm gate. The analyst may need to deduct any taxes/duties levied as well as transport, handling, packing, etc values. As with costs, revenues are charged/credited to the project in the year incurred, regardless of when payment actually takes place e.g. often delays in payment.

e Areas "B" and "D" are fairly straightforward. Once again the closer this financial analysis can be to that of a profit oriented business enterprise, generally speaking, the better. Viable projects cannot be managed in a financially sound way if subject to normal Government financial processes. They just bog down and become less credit-worthy. There likely will be no dividends for some years. The financial cost of land (SNL) may be zero in this project, though its economic, or "opportunity" cost should be allowed for, usually in the form of deducting the value of pre-project output from the new projects net values (or adding them to costs).

f In principle, the IRR in any given case, caeteris paribus, should be higher than that of alternative investment possibilities in the nation at that time. It should also be higher than the real, or opportunity cost of capital. The financial rate of return must be greater than the "market" price for capital.

capital/output ratio of the project as being the amount of capital embodied in the project over the total value of project output. This can be a useful ratio, but is not the capital/output ratio; it is in fact the "turn-over ratio". While the capital/output ratio is of some interest and usefulness in project appraisal, its significance is distinctly limited. It is certainly far from sufficient by itself to give us any final judgement about the economic desirability of a project.

A second important point about "value added" is that it corresponds exactly to the total remuneration of the factors of production attached to the production unit. The relation between the payment of those factors and value added is that of an identity, i.e. they are simply different ways of looking at the same thing. In many project appraisals it may not be enough simply to arrive at a single overall estimate of value added; we may want to know in considerable detail what the distribution of this value is among the various factors of production--how much for wages, how much for taxes, how much for depreciation, how much for profits, etc.

Indeed it is impossible to make a calculation of the financial or economic rate of return of the project without separating out that part of value added which represents remuneration of capital--then further separating out the five distinct components of the total represented by depreciation, interest payments, income taxes, reinvested earnings, and dividends; this last is especially important of course in completely or partially privately owned enterprises. While an irrigation project such as the Komati Irrigation Project may be parastatal enterprise, attempting to run at a profit, the individual private smallholders will definitely want a profit on any investment he makes in his enterprise.

3. Rates of Return

The most important of all the many calculations that go to make up a good project appraisal is the comparison of costs and benefits, usually done as a reate-of-return calculation. The use of the external and internal resources in the project enterprise represents the use of both capital and current/recurrent inputs, uses which are represented by capital costs and operating or recurrent (or "current") costs. There may be different ways of measuring and labelling costs, but however they are measured or named, costs represent the amount of value used up or consumed in turning out a particular volume of outputs.

The central question in project appraisal is always whether or not the benefits represented by the outputs are worth the costs or sacrifices involved in producing them. At a very general level one may say that if the same amount of resources could have been used to produce an even larger volume of benefits, then the proposed project should be abandoned in favour of the opportunity with the larger benefits. If one went ahead with the proposed project, even though it might yield a profit, one would nevertheless pay an additional "cost" over and above the costs explicitly taken into account in the project appraisal. This additional net cost would be the difference between the amount of net benefit realized in the project you chose and the

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larger net benefit in the alternative project. The latter would represent an opportunity missed. Conversely, could the same volume of benefits be generated with a lower level of resource use?

This same type of analysis is naturally useful in designing a project to a particular scale, each scale analysed as a seperate project with different purchased and internal inputs, and outputs. In many cases the difference between two projects or scales of the same project may be so small or so uncertain that no precise comparison is possibe. Or it might be that after completing the less desirable project one could then take up the more desirable one--even though it might have been preferable, from a theoretical point of view, to take up the more desirable project first. Nevertheless, this concept of "opportunity costs" is central to the economic aspect of project appraisal since it focuses attention, not on whether a proposal can pass a certain minimum test of acceptability, but the harder test of whether or not there are any other possible projects which might yield greater benefits for the same amount of costs. The optimum economic size of a project is often different from an optimum engineering or biological size.

Selecting between irrigation alternatives or sizes of projects provides an excellent opportunity for this exercise. There are many different ways of carrying out such comparisons, and there are often different points of view as to which kinds of calculations are most appropriate for particular types of projects. There is no one calculation which can be relied on as universally applicable to projects in different sectors. Even if there were a single agreed test of project profitability there are so many knotty technical problems in carrying out satisfactory measurements of costs and benefits that the results must be regarded as human estimates, not as revelation from on high. This is one important reason for not giving cost/benefit calculations overly excessive weight in the final decision whether or not to proceed with a project. This consideration applies especially to irrigation projects where factors such as location, food self-sufficiency and other "immeasurables" may be highly relevant and overshadow certainly modest changes in economic returns.

C. Concluding Note

A distinction must always be drawn between a survey/pre-feasibility level of data generation, collection, and analysis, on the one hand (such as this current effort on the Komati Irrigation Project); and, on the other, a more detailed feasibility study. The former level will generally provide "first impressions" on probably outdated materials, often itself based on a host of assumptions and little (if any) directed research/inquiry. There will be many gaps and blank spaces where best-as-possible assumptions will have to do. Nonetheless, first orders of magnitude at financial and economic viability are indeed possible, and have been generated, recognizing at all times that such analytical results are built heavily upon statistical sand and are very sensitive to a range of factors. One hopes that biases and inconsistencies cancel one another out, as they have a habit of doing so often.

Such a pre-feasibility level of information inadequacy is not useful for some types of decision-making including that for relatively large projects (the Komati Irrigation Project is very large for Swaziland--it would be miniscule in Egypt or India); where projects are being compared (this Komati Project stands alone at this point); where the private sector is asked to help with equity participation; or where international donor(s) assistance is needed. In all these instances, proper and detailed feasibility is required. The pre-feasibility study is of course the first step, indicating data gaps and where more work must be done.[1] As well, there can often be a reluctance to flesh out the financial data--cash flows, balance sheets, profitability estimates and rates, etc--simply because those conducting the studies are often both technicians and bureaucrats with little awareness or understanding of these financial dimensions of project work. That is not a criticism; it is something to watch out for however, since the "best" technological, agronomic or biological option, as indicated already, is not necessarily at all the best financial on economic alternative.

1 Indeed, at Annex 3 of Volume I of this report, the Terms of Reference for a detailed feasibility study have been documented.

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ANNEX 4

ECONOMIC AND FINANCIAL ANALYSIS: SUPPORTING NOTES

ANNEX 4

Economic and Financial Analysis : Supporting Notes

A. Price Data

1. General

Both costs and revenues at the various levels have been based upon 1984 prices whenever possible. Where not possible, the exceptions have been noted and brought forward (or backward) by a factor judged to be relevant. In some instances this was the rate of change in the general price level. When difficulties were experienced with existing data or with data generated (e.g. farm gate prices needed by working backwards from an export market price) any assumptions made to span that difficulty have been spelled out clearly. The economic analysis changed only the value of labour used, giving it a shadow price called for in the TOR. Speculation on the shadow prices of water, land, management and financial resources used in the proposed project were considered as not very contributory and were not attempted. The "real" price for water could be considered to be the project's total investments. The "real" value of the land was assumed to be the value of annual output forgone (usurped) by the project. That value was not added to project costs since it was considered very modest; as well, no reasonable estimates were available. Its omission is more than balanced by selected benefits not included for the same reasons.

2. Changing Prices/Inflation

Simplifying assumptions were also made in connection with changing prices. Unless there were compelling reasons to the contrary, it was generally assumed that the prices of project benefits would rise to the same degree as the value of project costs. This was done principally because readily available information on past price trends for the extensive packages of inputs were not at hand. It was done, too, recognizing fully that for shorter periods of time prices of certain products would change at rates lower than equivalent changes in the values of costs; and vice versa. Over the 30 year life of the project it was perforce assumed that these shorter term abberations would cancel one another out.

Prices change not only because of financial inflation (money supply issues), but because of a myriad of the reasons, many of which Swaziland has little on no control over. Important in this context is the exchange value of the Emalangeni, tied as it is to the Rand, which is a free-floating currency and subject to considerable changes vis-a-vis external currencies over time. This causes fluctuation therefore in the values received for exports and values paid for imports. It would be very tempting to assume that, in concert with the rest of the developing would, the real terms of trade will continue to move against Swaziland (more and more sugar, citrus etc. tonnage exported in exchange for any given amount of imported industrial items e.g. lorries, tractors). Data deficiencies prelude such an assumption, however.

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As well, Swaziland is an highly open economy with very large shares of its gross domestic product imported and exported. It thus becomes captive to price changes in other countries, regardless of the reasons for those changes. Given all these unpredictables, in the caeteris paribus case (all things remain relatively equal) has been assumed. It should be noted, however, in spite these unknowns, that it would be most surprising if the outside world treated Swaziland much differently in the future from the manner in which it deals with other small, vulnerable and less economically viable nations. Pressures, however amorphous, are in concert generally downwards on rates of return and value added generated by new projects or additions to existing projects. This should be borne in mind when assessing rates of return for this project.[1]

B. Project Phasing

1. General

While the details have been provided in the individual discussions (construction, cropping patterns, etc), it is useful to review the streaming of costs and benefits over time for financial and economic analyses.

Several criteria have been used to guide the formulation and position of the irrigation projects phasing. As realistic and feasible, without prejudicing any other elements, costs are pushed into the future as far as possible--spread them out; and benefits have been advanced in time as realistically possible.

More specifically, every effort was made to engender benefits without long waits by starting nurseries, planting trees, and growing rainfed crops even while the dam is under construction, using run-of-river water for the first Irrigation Development Unit (IDU).

On site water delivery system construction was delayed until 18 months before dam construction was completed and then completed for each of the modules only when needed.

Given project implementation capacities, the three IDUs, each of 1,000 ha, were not begun simultaneously, but separated by several years. While this does delay benefits arising from the later IDUs it likewise delays on-site development investments.

2. The dam

Documentation available suggests a six-year construction period for Maguga Dam, including one year for design and tendering. This was felt to be unnecessarily protracted, and the period was reduced to five years. The dam comes on stream in year 5 (possibly earlier), with the diversion weir and canal (if built) in years 4 and 5.[2]

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1 Macro-economic considerations are dealt with at more length in Chapter II.A of this Volume II and Chapter III of Volume I.

2 In the event, our engineering/economic analysis showed that a weir-cum-canal was heavily more expensive than river pumping. It did not enter our calculations, therefore.

Phasing has been expressed in terms of project years (PY1, PY2, etc), thus divorcing the analysis from the calendar. PY1 is when dam design begins and capital funds are spent. Though some dates have been suggested e.g. April 1987 for dam construction start-up, there is no accurate way of providing an actual date. Slippages can occur in implementing any major aspect of the project, such as inter-country negotiations, the acquisition of funds to finance the dam, the allocation of land from the traditional authorities, and the establishment of an organization (or organizations) to implement the project. The idea behind the development of 1,000 ha. production modules (IDUs) was to permit, among other things, the placing of these "building blocks" along any time spectrum desired by the analysts.

3. Timing/Phasing of Costs

The initial TOR for the consultant requested financial and economic analyses be conducted in both 30 year and 50 year time frames. Since the present worth of any net benefits after 25-30 years is virtually zero, even at low rates of discount, it was agreed with the client (USAID) that the 50 year analysis was not really necessary. In any case the replacement period for the delivery systems and infrastructure could very well be closer to 30 years; than to 50 years, in that case we have a new project on our hands, not a continuation of this one.

In principle, project costs should be attributed to the year in which they occur. The E40 million, the government's assumed share of dam costs on the Komati, should no doubt be recorded in year 1 of the project as it is committed then (or even in PY 1 or PY 2. The base project of 3,000 ha--three IDUs--would have a dam cost of 13,333/ha. Even at 5,000 ha, that is a dam cost of E8,000 (or $US 4,000) per hectare. Only the best irrigation projects in the world can stand that level of economic burdern, regardless of how charged to the project, particularly in the light of a range of other capital costs which will raise that per-hectare cost to substantially higher levels. The additional arithmetic exercise was conducted, therefore, of spreading that E40 million over longer periods. These are exercises for client consideration.[1]

Module development phasing was highly judgemental in the light of the many unknowns. It was assumed that full development of the nucleus estate would take some 4 years after planting commenced, as would the settlement of smallholders. These time periods seem consistent with the initial capacities of new organizations, financing systems, and relatively inexperienced staff. Before the first unit reaches its peak, the second can start; the third follows more quickly. The development period is assumed to be less on these subsequent units, however, since experience is gradually acquired and

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1 In the event, the Devres Staff developed a project financial structure which allows dam costs to be covered.

development work can be less protracted. Once again, however, the analyst can slide these module "building blocks" backwards and forwards in time at his discretion.[1]

Cropping schedules, detailed elsewhere in this report, are designed to have field crops (and their revenues) as of PY 3. Tree crops will start producing in PY 4 (papaya) with the other tree crops maturing consecutively. The cumulative build-up allows a reasonable development pace for storage, handling, transporting etc systems.

The same concept is applied to smallholder establishment. Given teething problems, staff newness to the project, and the like, it is reckoned that about 50 new families a year may be settled on their 2 ha plots on the first IDU. With experience, however, the pace can be accelerated somewhat for subsequent IDUs. If plots are to be 4 ha, then 50 families a year means only a two year settlement time on each IDU. Once again the need to supply credit, farm services, inputs etc requires experience and thus a few years of doing it before maximum effectiveness is reached. By the end of PY 9 some 600 families are established (or 300 if 4 ha plots provided) on 1200 irrigated hectares; and the estates have built up a further 1800 ha. It is this progressive build up in area cultivated which in turn determines the flow of costs and revenues over time. Were these planting programmes to change in any way, so too of course would the cost and benefit streams.

C. Basic Hydraulic and Engineering Assumptions Underlying Phasing and Costing Analyses

As the Devres agriculture engineer was developing his capital and operating cost structures and flows, he documented the assumptions he made regarding hydraulics and engineering. Those assumptions naturally bear heavily on subsequent costs and their phasing. They are listed here in their "shortcut" form:

1. Supply flows to the IDU are available on a reasonable demand basis.

2. "Effective" rainfall is 65 percent of mean monthly rainfall.

3. Basic consumptive use data taken from Tate and Lyle. Crosschecked for reasonableness.

4. Overhead irrigation efficiencies of 75 percent on the nucleus farm and 60 percent on the smallholder.

5. Basic inflation rate of 15 percent P.A. to arrive at 1984 figures.

6. Pricing sources as noted on tables or figures. Direct pricing of irrigation components from Impompi (Swaziland) Ltd. electric power from Swaziland Electricity Board and all project infrastructure from Tate and Lyle.

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1 Chapter IV.A.4 of this Volume II describes project phasing in detail.

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7. Breakdown of direct and indirect foreign exchange, and local expenses on a percentage basis as determined from Tate and Lyle for comparable works.

8. Allow 6 man-hours for each move of a 600 m portable aluminium lateral.

9. Design for sprinkler uniformity of application of 80 to 85 percent (Christians Uniformity Coefficient).

10. Select sprinkler based on the experience of the SIS sugar estate as it relates to acceptable application rates.

11. Competitive bidding prices as used in the financial analysis; quotation from Impompi reflects a 20 percent discount from the list prices quoted.

12. In general pricing of infrastructure reflects a 10 percent allowance for design and supervision and a 10 percent physical contingency - exceptions as noted.

13. Required field equipment and vehicles are pro-rated from Tate and Lyle from Big Bend study and verified by consulting staff.

14. Useful life table from judgement.

15. Mean monthly rainfall determined by a mean annual for the site of 700 mm distributed monthly as per surrounding raingauge stations.

16. Field cropping efficiency of 90 percent on the nucleus farm and 60 percent on the smallholders.

17. Design of mainlines and pumping units based on a peak monthly consumptive use of 150 mm over 90 percent of the field area (i.e. 900 ha).

18. Assumed consumption of water by households at $30m/^2/C/A$. Water required by livestock at 45l/Head/Day.

19. Minimum operating pressure on sprinkler heads of 35.2 m. Limit lateral headloss to 20 percent of inlet pressure.

20. Pipelines headloss calculations per Hazen-Williams formula with C = 120 for steel pipe or aluminium irrigation laterals and C = 150 for plastic pipe.

21. Topographic information (i.e. slopes, pumping heads, etc.) per maps scale 1:50,000 with 50 ft. contour required on 50 percent of the project.

22. Assumed pump efficiencies of 75 percent and electric motor efficiencies of 90 percent.

D. Engineering Assumptions Underlying Capital and Operating Costs

1. Cost information

Detailed cost information is provided in the computer generated summary sheets used in of this Volume II. The following paragraphs describe the basis of costing and the factors included. The useful life of each capital item is shown in Table II-A-2. Replacement investment costs were based on this schedule.

a. Capital costs

(1) Dam

The Swaziland share of construction costs of Phase I dams is E40 million. Given an annual inflation rate of approximately 15 percent and a need for a detailed design phase, the current study assumes the following rate of debt incurement relative to the dam.

Project Year	Debt Incurred (E million)	Comments
PY 1	2.22	Design phase expense
PY 2	4.88	Design phase expense, contractors start
PY 3	8.11	Progress payments to contractors
PY 4	8.05	Progress payments to contractors
PY 5	8.45	Progress payments to contractors
PY 6	6.01	Progress payments to contractors
PY 7	1.28	Retained for completion until approved

Final design is required before questions of physical and price contingencies can be decided, if indeed such elements are necessary at all under these circumstances. The original (1983) estimates of Swaziland's share were only E26.3 million. Subsequent analysis of costs and benefits includes calculations which exclude dam costs. As well, dam cost recovery programmes are planned.

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Table II-A-2: Estimated Useful Life for Project Components

	Item			Useful Life (Years)
1.	Housing	-	Management	30
		-	Permanent Labour	30
2.	Project Structures			
		-	Offices	30
		-	Warehouse	30
		-	Shops	30
		-	Crop Processing Facilities	20
3.	Pipelines	-	Buried Steel Mainlines	25
		-	Buried Plastic (PVC) Sub-mains and manifolds	20
4.	Utilities	-	Electrical	30
		-	Water Supply and Sanitation	30
5.	Sub-surface Drainage System			20
6.	Portable Overhead Irrigation System (sprinkler, pipe, valves and fittings)			15
7.	Pumping Plants			20
8.	Field Equipment	-	Tractors	15
		-	Cultivation Equipment	5
		-	Planters and Grain Drills	10
		-	Sprays	5
		-	Combines and Harvesters	10
		-	Trailers	10
9.	Vehicle	-	Sedans (management)	6
		-	Pick-ups	5
		-	Trucks/Buses	8
10.	Conveyance and Storage			
		-	Dams	50
		-	Main Canals (if built)	40
		-	On-farm reservoirs	30

Source : Devres Staff Estimates, August 1985

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(2) Irrigation projects

The basic costing of the project was derived from Tate and Lyle[1] with the exception of the complete irrigation system. Material quotations for the pumps, mainlines, portable sprinkler systems, and all related valves, fittings, and supplies were obtained from Impompi (Swaziland) Ltd.[2] Material pricing was FOB job site. Tata and Lyle pricing from 1982 and Impompi pricing from 1985 were adjusted for a 15 percent annual inflation rate to reflect 1984 equivalents. The latter list prices were also discounted by a further 20 percent to reflect competitive bid pricing more realistically.

(a) Pumping plants

Material costs from Impompi were combined with construction costs from Tate and Lyle. A 20 percent contingency was provided for design and supervision and a 10 percent physical contingency was included.

(b) Main delivery system

Material costs from Impompi were combined with installation costs from Tate and Lyle. A 5 percent physical contingency was included on the material costs. In addition, material quantities were increased by 5 percent to allow for spare parts. Installation costs reflect a 20 percent contingency for design and supervision and a 10 percent physical contingency.

(c) In-field distribution systems

Material costs were all as quoted by Impompi and included a 5 percent physical contingency and a 10 percent increase in quantities to provide for spare parts.

(d) Land preparation

A 20 percent physical contingency was included. Design and supervision will be provided by the IDU management with their expenses included in overhead. Basic unit pricing was per Tate and Lyle.

(e) Sub-surface drainage

Basic unit pricing per Tate and Lyle. Includes 10 percent for design and supervision, and a 10 percent physical contingency.

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1 Tate and Lyle, Usutu River Basin, Report No.10; and Tate and Lyle Core Programme, Phase I, Big Bend.

2 J. Bond, Personal correspondence with E.M. Norum dated June 20, 1985.

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(f) Farm infrastructure

Included in this area is roads, utilities, water supply, and sanitation. All pricing was taken from Tate and Lyle. A 10 percent allowance was included for design and supervision and 10 percent for physcial contingency.

(g) Building

All building pricing was taken from Tate and Lyle with a 10 percent allowance for design and supervision, and 10 percent for physical contingency. In addition, a 5 percent allowance was provided for warehouse interior facilities, a 10 percent allowance for office furniture, and a 15 percent allowance for shop tools and equipment.

(h) Crop processing facilities

Basic building pricing was taken from Tate and Lyle and includes a 10 percent allowance for design and supervision, and 10 percent for physical contingencies. A budget estimate of E40,000 was included for the grading and packing line, and E10,000 for the chiller unit.

(i) Vehicles and field equipment

A listing of vehicles and field equipment required for the project is shown at Table II-A-3. All pricing is taken taken from Tate and Lyle. A physical contingency of 15 percent was added to these figures.

b. Operation and maintenance costs

(1) Dam

The operating and maintenance costs on the dams as estimated by Olivier et.al.[1] are as follows:

- Civil works - 1/4 percent per annum;
- Mechanical and electrical installations - 4 percent per annum; and
- Operating costs and staff - E75,000 per annum/dam.

Using a current dam cost to Swaziland of E40 million and apportioning the mainteance and operating costs of an 80:20 percent basis, the total annual operating and maintenance cost to Swaziland would be E175,000. This excludes the maintenance of the mechanical and electrical installations which should be considered in the power generation option (were there to be power generation). As with the dam cost itself, cost recovery programmes for all users should cover these costs

[1] Olivier et al, Komati Development, Part I, Vol.1, p.107

Table II-A-3: Required Field Equipment and Vehicles per IDU

Item	Number Required	Estimated Price per Unit (E)
Field Equipment		
1. 60 KW Tractor	3	21,000[a]
2. 46 KW Tractor	1	17,500
3. 35 KW Tractor	3	13,500
4. Plough (3 furrow)	2	5,000
5. Disc (2.2 m)	1	2,500
6. Cultivator (7 tyne)	1	2,500
7. Planter (4 row)	2	1,200
8. Grain Drill	1	1,200
9. Sprayer (300 L)	4	1,200
10. Sprayer Chopper	1	1,000
11. Trailer (5 tonne)	3	4,500
12. Maize Combine	1	79,000
13. Cotton Harvester	1	98,000
Vehicles		
1. Sedans	1	15,000
2. Pick-ups	8	10,000
3. Trucks	5	15,000

[a] All pricing is taken from Tate and Lyle. A physical contingency of 15 percent was added to their figures.

(2) Irrigation project

Costs as presented in this section were related initially to an individual IDU of 1,000 ha; these were then streamed over time as more IDU's were added.

(a) Direct cost for irrigation system/cost recovery

These costs are presented as: (1) the actual cost for water based on recovering the dam construction and operating and maintenance costs, and (2) the direct costs of applying the water.

Table II-A-4 gives a water and application cost to be charged against specific crops for purposes of financial analysis. It is these figures which are charged to crop budgets (smallholder and nucleus estates) for purposes of cost recovery.

(b) Overhead costs

The following areas were included in the overhead charge with an explanation of source.

- Salaries. Tate & Lyle data were checked by personal communication with SIS personnel to verify levels of compensation and relative relationships between levels of employment. All compensations were adjusted to 1984 levels and a physical contingency of 10 percent was added. Fringe benefits such as housing, vehicles, vacation, utilities are handled as direct charges to overhead;

- Energy. Charges are based on estimates of usage and current unit costs. A physical contingency of 10 percent was added;

- Parts and supplies. Estimated annual charges for these items are based on the following percentages of original capital cost:

Area	Percentage
Irrigation system	2
Pumps and mainlines	1/2
Vehicles	6
Housing and offices	2
Shops and warehouse	2
Crop processing	2
Utilities	1
Drainage	1

A physical contingency of 10 percent was added;

Table II-A-4: Estimated Gross Water Required for Selected Crops with Resulting Water and Application Costs

	Crop	Gross Irrigation Water Required[a] (M^3/ha)	Water Cost[b] (E/crop)	Application Cost[c] (E/crop)
1.	Summer			
	Cotton	8,100	440	365
	Maize	7,400	400	335
	Groundnuts	6,000	325	275
	Soya Beans	6,400	345	305
	Sorghum	5,900	320	275
2.	Winter			
	Maize	4,500	245	215
	Soya Beans	4,700	255	215
	Beans	2,800	150	125
	Wheat	4,000	215	185
	Potatoes	3,400	185	155
	Onions	4,400	240	215
	Tomatoes	5,100	275	245
	Cabbage	2,900	155	155
	Green Beans	3,100	170	155
	Green Maize	4,200	225	185
3.	Annual			
	Cane	17,100	925	760
	Citrus and other fruits	13,700	740	610

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a Basic consumptive use estimated from Tate & Lyle, Usutu Basin Report No. 10, p.31 Assume an application efficiency of 75 percent and rainfall efficiency of 65 percent of mean.

b Basic water cost per Olivier et.al, Komati Basin Development, Part I, p. 107.

c Adjusted for 15 percent p.a. inflation rate to 1984 (5.4 c/m^3). Includes power and system operation and maintenance. Does not include system "owning" cost.

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- Contracted services. This allowed for road repair and maintenance using cost estimates from Tate & Lyle; and

- Miscellaneous. This included a provision for office and shop supplies and a physical contingency of 10 percent.

E. Assumptions Regarding Crop Yields and the Total Variable Costs of Production

1. The total variable costs of production and the yields of the fruit-tree crops are assumed to be the same on both the nucleus and the smallholders' farms. To make the enterprise economically viable it is anticipated that the nucleus farm management will expend all possible effort to implement the high technology and production and management practices on both the nucleus and the smallholders' farms as they relate to the fruit trees.

2. It is assumed, however, that the smallholders will be far more independent in the production and management practices of the annual summer and winter crops. This does not mean that they should not be encouraged to follow the improved practices. In the light of these factors the total variable costs of production and the yield of individual crops grown on the smallholders' farms will be less than those in the case of these crops on nucleus farms. The average yield data used naturally mask what will no doubt be meaningful differences between individual farmers.

3. It is expected that over the medium and long run, the smallholders will accept, by and large, the production and management practices adopted on the nucleus farms. In practical terms, as most farmers tend to be somewhat conservative, the diffusion of new technology will be slow and gradual. The pace of diffusion will depend partly upon the level and extent of the extension services available to the farmer-settlers, and on financial incentives.

ANNEX 5

PROJECT RISKS

ANNEX 5

Project Risks

A. General

No irrigation project, regardless of location, can expect to be entirely risk-free; God, bugs, politics and bankers can and do provide, singly or in concert, insecurities and unknowns. The more novel and the more remote the project, however, the greater the risks become, particularly in an institutional environment not experienced with this particular form of enterpise. Such is this project. Risks which can be recognized in a preliminary way for this Komati Irrigation Project include technical/climatic, agronomic, institutional, financial, socio-political, and marketing; this latter is especially critical and is treated at some length.

B. Technical/Climatic

Several areas of risk are included here, partly because of data deficiencies or data conflicts. A good deal of work has gone into the formulation of water availability and, secondly, water requirements for the Basin's future. This would not be the first project, however, where such work has proven unreliable, certainly at the edges. That is to say, while the figures for the main body of water available and land which could be irrigated may be substantially correct, the "fine-tuning" at the edges may not be. Yet it is the "fine tuning" of 5 million MCM, 10 MCM, 15 MCM on which the size of the project and project modules is based. Generally speaking such data can overstate the amount of water available, but they can understate as well, thus depriving a country of a region, at least in the first instance, of the opportunity to plan for its complete use.

There has not been time to pursue meteorological records and hydrological data in any detail. It is commonly understood from available knowledge, however, that, on average, one year in five will see water shortages (post-reservoir) and that existing irrigation systems (e.g. SIS) should be protected against further eventualities by the establishment of reservoirs and storage.

It is worth pointing out, however, that climatic regimes in sub-Saharan Africa have altered rather remarkably in the last 15-20 years. Entire dam, reservoir, hydro power, irrigation and related systems, large and small, are becoming starved of water:rainfall amounts and timings, run-off amounts and rates, etc have all been changing rapidly. Conversely, some areas also experiencce typhoons and other abnormal monsoon-type conditions. It is not being claimed that this project can truly defend itself against these conditions should they materialize in the future. There is some evidence that these drought cycles are already becoming a routine event; and it could behove Governments to consider the planning of the expansion of irrigation with these elements very clearly in mind. What was a once-in-200-years now happens with unfortunate regularity.

C. Agronomic

1. General

When water is being applied to a given area for the first time there is always the likelihood that a range of pests and diseases will appear which does not affect the same crop under non-irrigated conditions. By the same token, crops grown with this intensity and/or on this scale can often develop similar problems. For many years also proper crop rotations to maintain nitrogen, etc will need to be experimented with; there are always risks of reduced yields. Salinization and drainage prospects are also unknown when a new irrigation project begins, and they too could provide elements of risk particularly when water quality itself may be involved. Proper management and continuous application of sound agronomic practices should minimize these risks, however. By the same token, it behoves the analyst not to assume that high average crop yields will appear immediately.

2. Agronomy and Crop Production

There is always an element of risk in the crop production enterprise as it depends upon a variety of factors such as the climatic which are by and large beyond the control of man. Apart from these there are economic factors which determine the profitability of this endeavour.

In the proposed project, the fruit tree crops are the core of the cropping pattern and as such the economic viability of the project depends upon their performance in terms of yields and quality. Although the tree crops recommended in this report are not unfamiliar to Swaziland, most of them have not been grown on any commercial scale requiring high level management and production techniques. Fruit trees are specialty crops and they require specialized attention for optimum performance. Also in order to have market acceptability, they are required to meet high quality standards.

There are various diseases and insect pest hazards which if not controlled quickly and on time, can do extensive crop damage.

Specialised skills are needed to grow, harvest, process and market these crops. Cotton, maize and vegetables also form an important component of the agricultural production programme of this project. These, especially the vegetables, require high level management, production and marketing strategies.

Most of the agricultural production and management problems can, however, be tackled provided well-qualified, experienced and highly motivated field-production and farm management staff are available to initiate, organize, develop and execute the crop production related programme.

The overall success of the programme also would depend upon how quickly the improved production technology is implemented on the smallholders' farms. It is reasonable to expect that the nucleus farms would perform a leadership

role not only in using the proven highly successful crop production methods, but also in generating new technology for the smallholders to suit their farming systems.

The diffusion of technology across the board at an accelerated pace would require a well-established agricultural research, extension and training scheme.

Production inputs supply, management and water use are also important aspects of the overall farm management strategies. Availability of the inputs must be assured at the times when they are needed. How to use, when to use and in what quantities to use these inputs are also of importance.

Modern farming is a commercial enterprise and requires the necessary skills and expertise commonly considered essential to operate a commercial activity.

D. Institutional

As discussed at some length in this pre-feasibility study, the institutional framework through which to organize, structure, finance, and physically implement this project is by no means clear-cut. Several options have been presented, relying partly on those devised initially in the Tate and Lyle work. What is known is that any organisational structure adopted will be novel--there is no experience with such projects in Swaziland, and one can envisage an iterative process of trial and error over time in the ongoing search for the structure which works best. Continent-wide one can examine the carcasses of project authorities which appeared just fine on a piece of paper but which failed to function. New structures threaten existing and well established systems, both governmental and traditional, and resistance to any threat to usurp authority or power must be expected.

It is well recognized also that every care should be taken to not divorce the irrigation smallholder too drastically from his customary production systems whenever possible. Similarly, an institutional structure must be designed which takes advantage of recognized systems and authority structures. One is sometimes caught between the need for disciplined efficiencies to have projects pay for themselves, and the maintenance of more traditional life-styles.

In addition, Swaziland has already begun to think out and implement services systems which are viable and effective. To date, for the most part, there has been only limited success with small farmer credit and small farmer extension--there is limited experience with the type of irrigated smallholder envisaged for this project. Perhaps the most fragile area is that of marketing; there is every reason to think that the earliest stages of this project will experience serious marketing problems from both the estate and the smallholders (discussed at G. below). These institutional risks once again underline the need to attempt to minimize them in the intial design and, secondly, not make overly optimistic assumptions about the rate of increase in project output and revenues.

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A further institutional weakness in this project which hopefully would be resolved prior to project commencement is where the project unit fits into a Basin/Regional Development/Regulatory Agency, and/or the national planning/implementation process. This issue is addressed in Volume II. Without such an integrating structure--financial, administrative, technical and other umbilical cords--projects all too often wither away.

E. Financial

1. The Means Whereby the Total Project is Financed

This area of risk has several components, each important. The first is the means whereby the total project is financed. The Devres Consultant's TOR requires that we deal with the dams' capital cost share of E40 million, which in itself is some E13,000 per ha of a 3000 ha project (40 MCM) and still E8000/ha for a 5000 ha project using 63 MCM. But spread out over the earlier years of the project are roughly these amounts again of other capital costs--where do those funds come from? While it is not this report's purpose to answer that question, it is appropriate to point out that the total capital expenditure on all economic services by the government, in recent years (agriculture, plus industry and mining, plus water and sewerage, plus transport and communications, plus, plus) has averaged that amount (E32-42 million) annually. Total project capital costs (share of dams plus other capital costs) exceed total average annual capital expenditure by government by 30-35 percent. It thus become highly legitimate to assume that there will be some risk of at least protracted delays if government attempts to fund this projects capital requirements on its own (all, or even only part).

It is argued of course that all or most of these capital funds can be borrowed internationally. That is certainly true and perhaps a combination of donors would indeed provide sufficient grants or very soft loans. A multilateral agency such as the World Bank, however, or for that matter many bilateral agencies, would seek documentation indicating that the project has a reasonable rate of economic return. It would still need to be borne in mind that the Swaziland government's outstanding external debt has been steadily rising, and now sits at an estimated level (1983) of E350 million or nearly six times the annual capital budget. Fiscal matters are discussed more fully at Chapter I.A.5 in this Volume II.

2. Current Operating Expenses

In addition to these capital funding issues, the current operating expenses of the project would need to be met, certainly until the project's cash flow proved sufficient. Various sections of the project's pre-feasibility analysis have attempted to formulate the project authority's budgets. There has not been time to delve into these matters, but if this project authority is like so many others, there is a chronic need for more funds to meet operating/recurrent expenses. This becomes especially so when the project is enmeshed to some degree in governmental financial systems and processes.

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3. Cost Recovery

Another element is cost recovery. These cash flow funding issues suggested above are naturally mitigated somewhat if both the estate and the smallholders are paying charges/levies/taxes of one kind or another. These are highly sensitive issues and often require protracted periods to resolve. It would be riskly to assume, for example, that funds recovered on the first 1,000 IDU ha would be sufficient to finance the establishment of the subsequent module. We have attempted to build, into the budgets, funds for the recovery of water charges, irrigation system O M and R, marketing services, and machinery and equipment services. These are paid by the smallholder to the project and, in the case of the nucleus estate, are in-house financial transfers to ascertain if the project can pay its own way. The funds received for water charges would presumably be transmitted to government against investment costs. By adding these elements back in to the project's benefit stream, the project becomes viable and, in fact, pays for the dam as well. Annex 6 to Volume II discusses cost recovery at greater length.

4. Incentives

Finally, labelled a "financial" issue but it could be labelled "incentives", is the matter of financial return to the smallholder. Net returns must be sufficient compared to the amount of work, and for income and of risk in alternative occupations. So often on these projects the gross returns are reasonably high but the net, after all deductions, is too small for many. Indeed it is not uncommon for the smallholder to operate two "farms", his traditional operation, and the new one on the project. Then project yields can suffer. Under the ideal conditions of this project, the net returns per family should be sufficient; they approximate E5,000 at full development (including fruit trees).[1]

F. Socio-Political

Without being able to articulate this area of risk with great assurance, it nevertheless appears that several very basic features of Swazi society have a direct and immediate bearing on any project using traditional resources such as land and water. Cornerstones of Swazi society and ethos are the traditional land tenure system and, accompanying, the livestock syndrome. It is difficult to imagine land being released for a project without such a transfer somehow infringing upon these traditional authority and rights systems. Even though government may allocate the land by fiat, there is the strong risk that, at some point, difficulties of leasing, control, usufruct, etc will arise. They certainly have in other projects and can provide meaningful delays and administrative difficulties.

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1 On the Gezira scheme, Sudan, the smallholder farmer has a phrase to the effect that "the haiwasha eats all the profits!"

G. Marketing

This area of risk is treated at some length since the whole subject is one of lesser experience here in Swaziland. There has been some experience, after all, in dam construction, in growing crops by irrigation, and the like. There has been virtually no experience with the rigorous marketing and market windows called for by this project. Such processes require knowledge, skills and experience heretofore not developed in Swaziland. The major marketing risks are listed here.

Marketing is in itself a risk because within the limits of each market place, the success of one element can be the failure of the other. The determining factors may not necessarily have anything to do with the fruit or food item itself. The "product" is the total mix which includes its presentation, packaging, price, and delivery. Swaziland's mangos, avocados and papaya will be as good, or even better, than anyone else; they still might not sell!

Harvesting too soon or too later results in the product arriving unripe or over-ripe in the market place. If unripe its price will be low; nil storage may be available to allow for ripening.

Packaging: If one fruit is ruined, then others will become contaminated. Care in packaging on the packing line means very close supervision.

Cold Storage: Each fruit and vegetable requires different temperatures and humidity levels. It is risky to store mangoes and papaya together. The temperature which suits one will damage another; unfortunately chilling damage is not evident until the fruit is placed in normal room temperatures.

Packaging: Damage to cartons in transit, especially for small quantities which cannot be palatised; poorly constructed cartons which collapse when wrongly stacked in transit.

Transportation: Changes in temperature enroute; this happens when aircraft have to stop over for a few hours. Doors are opened and fruit starts to cook. Reason why direct flights only are feasible.

Market Price: Daily price fluctuations on wholesale markets. Unscrupulous importers can claim produce sold at "bottom" price, or that produce was sub-standard etc. Safeguards exist, but they can be thwarted. High risk in not appointing an agent of good standing.

Failure to deliver on time: This, and poor quality control, is the principal hazard confronting third world countries, and results from an easy going attitude at many stages in the marketing chain.

The key constraint will be transportation. The market window is only open for a few months before heavy competition starts up from suppliers nearer to the market. Sometimes the only way in, within the time available, is by air. Swaziland and RSA require cargo space for the same markets at the same

time. The concentration of volumes into a few months each year, means a sudden demand for air cargo space. A 747 freighter, for example, can lift no more than 46 tonnes.

Competition and market saturation: Extended growing periods have already squeezed out produce from the Southern Hemisphere from the main markets viz. egg plant, capaicums (bell pepper), etc all of which are now being grown under cover in Western Europe. Massive supply by Mexico or Brazil could force in-market prices down below the economic level for Swaziland. Tree crops are the best guarantee because many smaller exporting countries cannot afford to underwrite the lead times required for "a tree to grow!" But climatic conditions, fruit fly, root disease etc can damage an orchard with little or no chance of recovery during the "season".

Varieties can fall out of favour: There are too many grapefruit, it seems, on the market. Pretoria does not know why demand has fallen, but believe that consumers are changing their breakfast diet away from grapefruit. Easy peel oranges are being preferred to Valencias in many markets.

Markets: No one knows what the saturation point is for tropical fruits. Most tropical countries produce the same fruit. Initial high prices often trigger new competition, creating glut, and subsequent low prices. Today's planting programme, based on indirect market needs, could mean an excess of orchards producing unwanted, or uneconomical fruits, in 5 years time. Yet the greater risk may lie in not taking the risk!

Fluctuating exchange rates: This can be a killer of course especially for low margin produce.

Increasingly strict sanitat[illegible] laws: Especially in the EEC; UK is fairly lax on this subject; West Germany is very strict. Sooner or later all markets will come into line. The risk of falling below the highest quality standards is a very real one (Japan almost wrecked the New Zealand exports of Kiwi fruit in 1982 because one carton was contaminated!)

The risk of neighbouring markets e.g. Mocambique failing to meet payment obliga ons due to currency constraints.

The risk of RSA not allowing refrigerator rolling stock out of the country. This would only apply in the case of Zimbabwe and Mocambique, which markets have not been included as export markets of special importance at this stage.

The risk of insufficient skills and know-how being available for the effective running of the operation.

H. Final Note: Known Risks

The Rural Development Area programme included a major element of small farmer irrigation in a range of smaller irrigation projects. "Despite the extensive extension service offered by the Ministry (MOAC), the production

from these schemes is well below the potential for good irrigated farms. The problems facing the extension staff vary considerably from one scheme to another but the main difficulties can be summarized as follows:

1. Absentee Farmers: Since all the plots are allocated under the traditional system of land tenure, no action can be taken against farmers who consistently fail to utilize their plots.

2. Marketing: All the farmers on the RDA schemes are encouraged to concentrate on vegetable production, but the lack of marketing facilities frequently results in crops rotting in the fields.

3. Short Term Credit: Many farmers find it difficult to obtain short term credit for crop inputs.

4. Cooperation Between Farmers: On most schemes there is a Chairman and a Farmers' Committee elected by the members to organize the allocation of water, maintenance etc., but since these committees have no real power to discipline members they are usually weak and ineffective.

5. Allocation of Water: There is very little control of water, with farmers taking water whenever they wish. This practice inevitably leads to very poor irrigation efficiencies.

6. Limited Expansion: Since the size of a scheme is fixed by the design engineer and all the plots are allocated to farmers it is virtually impossible for a progressive farmer to expand. However, there are cases where a farmer rents or borrows an unproductive plot from his neighbour."[1]

While the new IFAD project is directed heavily to the farmers described above, it surely should be possible to avoid these known risks in the Komati Irrigation Project?

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1 N.C. Portch, "Irrigation Schemes on Swazi Nation Land", Proceedings of a Conference, Royal Swaziland Society of Science and Technology, Vol.3, No.1, November 1980, pp.23-24. Mr. Portch was an Irrigation Officer in the MOAC. The same issue includes a paper on Vuvulane Irrigated Farms.

ANNEX 6

COST RECOVERY POLICIES IN IRRIGATION PROJECTS GENERALLY AND THE KOMATI IRRIGATION PROJECT IN PARTICULAR

ANNEX 6

Cost Recovery Policies in Irrigation Projects Generally and the Komati Irrigation Project in Particular

A. Cost Recovery Charges Generally

1. Introduction

Irrigation is expensive. The toal investment and recurrent costs of providing water are high and continuing per hectare (ha) and per project beneficiary. Few other agricultural sector investment cost so much. Particuarly in the poorer developing countries, such as those in sub-Saharan Africa, even a modest irrigation project can oom very large relative to government's budget and its ability to finance such projects.

It become essential, therefore, that government endeavour to recover capital and operating costs from project beneficiaries. There are three finaical and economic elemnets, or principles in such deliberations:

- Economic efficiency in the use of scarce water resources; is the particular use of water in any given project providing maximum benefits to the nation?

- Income distribution: who gets what share of the net benefits generated by the project; and

- Public Savings: the extent to which government can capture some of these net benefits to help finance, not only the given project, but also future investments in development activity.

2. Principles

a. Economic efficiency

The price to be paid for water by its users should be such that water is not wasted and, simultaneously, is used so as to maximise output. It must be recognised that determining "economic efficiency" is difficult without measuring with some accuracy the volume of water used by each recipient. This requires either volumetric measurements or at least accurate estimates. Simultaneously, the price cannot be so high as to discourage water use below desirable levels. Clearly such pricing is loaded with both technical and socio-political issues. But even a nominal price for water goes a long way to discourage the waste and overwatering which lead so often to waterlogging and drainage problems, and salinization.

A further difficulty with the efficiency pricing concept is that such prices are not always consistent with other income distribution and savings/investment goals of government. Other methods therefore may need to be considered to ensure, first, an "equitable" economic impact of the project with charges that are well within the ability to pay; and, second, do not discourage the incentive to participate. Some recovery of benefits and costs will naturally occur from existing general income, export and other taxes. Such recoveries are not geared to the specific project, however, and may in fact hurt those in the economy who are not direct or even indirect beneficiaries of the project. We are after a system of "benefit taxes" related to a specific project.

b. Income distribution

Benefit taxes must be related to the ability to pay. They must therefore allow for differences in net benefits generated by the project as between beneficiaries (or groups of beneficiaries) as well as for differences in pre-project income levels. Benefit taxes clearly therefore should be progressive, but must nonetheless allow for disincentives, problems of cost allocation, and of course, of tax evasion.

The increase in income generated by the project can be considered as "rent" to the project, or "rent" to individual farmers or groups of farmers. Such rent can be defined as the incremental gross value of farm production less any identifiable and measurable elements. Such deductions could include the value of all incremental cash payments; incremental depriciation of farm assets; imputed values for incremental family labour used; inremental own capital used; and incremental general taxes. It is recognised fully that many of these, depending on specific circumstances, will be difficult to assess. The basic objective nonetheless is to identify the "value added" at the household farm level--what is left after all farm-level costs of achieving that increment in output have been deducted. The matter can be complicated further if the farm family in question is newly settled on the irrigation scheme; if the land was being used by someone else, or if not used at all, what is the increment? And to whom does it go?

A further element here is that the people in households experiencing this increase in rent will no doubt be of quite different income levels before going in to the project, or at least at the time when a water charge is contemplated. In addition, because of differential management skills and other factors, some households will become much better off than their neighbours and could afford to pay more. Working on the premise that water charges/taxes should be established to "equalize the hurt", then perhaps the rates could also be related to income levels.

How one makes these income distinctions is naturally going to vary from one society to the next. One system is in use is to classify households (or groups of households) by the critical consumption level (CCL). Technically, this is the level at which the social value of a unit of extra consumption by the household (from an additional increment in income) equals the social value of a unit of incremental public revenue--the contemplated tax. It could very well be that all or most of the farming households affected are so poor that,

even with an increment in income, they clearly should not be taxed. For those above the CCL, however, water rates could rise progressively. The CCL is generally considered to be about one-half of the per capita GDP, but could be form one-third in a less poor region up to two thirds in a very poor area. The definition of the CCL should not vary as between projects for obvious reasons, though the share of the farmers in any given project above or below the CCL could of course vary.

c. Public savings

Most governments in developing countries are short of fiscal resources for development, and such resources are therefore at a premium by comparison with additional consumption, at least that of relatively more affluent citizens. Consequently, it may be desirable for the government to collect more revenues than would result solely from efficiency pricing (which in any case, is frequently impractical). This would help make projects financially self-supporting and enable governments to undertake additional rural development projects that would reach a still larger number of the rural poor.

On the other hand, as suggested above, the project beneficiaries may be so poor, i.e., below the CCL, that it would be undesirable to recover costs greater than would result from efficiency pricing of water, and it may be desirable to recover less. The trade-offs between these considerations will determine the appropriate level of cost recovery. Swaziland is not among the poorest of African countries, however, but government budget data suggest that revenue to fund recurrent budgets would have a high premium. It is important to recognise as well that the Komati River Irrigation Project will probably be the first smallholder-cum-nucleus estate project of this scale to be implemented in the country. The model and precedents established here would no doubt be replicated over time in other similar projects

3. Sector-wide setting

a. Consistency and uniformity

Recommendations on benefit taxes and cost recovery policies for a particular project should be related to nationwide cost recovery policies in the irrigation sector, both to ensure consistency of principles and because in practice it is often difficult to change policies through a single project. Changes in sector policies at any gien time are often desirable as well. The consistency referred to aove does not mean uniformity of water charges or benefit taxes. Volumetric water charges should reflect marginal supply costs, which may differ from project to project and between different areas within countries; and benefit taxes should differentiate between income classes, as well, preferably on a progressive basis, as discussed above.

b. Volumetric pricing

To meet the goal of efficiency, volumetric pricing of water is desirable in all irrigation schemes, but is likely to be most easily adopted in public tubewell and pumping schemes where deliveries are relatively easily metered; they would be so metered in the Komati Project with no meaningful increase in costs. Where metering is too difficult or costly to allow volumetric pricing, it may sometimes be feasible to use alternative charging schemes that have similar efficiency effects. However, unless proxies for volumetric pricing (for example, differential taxes on crop production related to the water consumption of the crops) are carefuly constructed, they may induce uneconomic cropping patterns and water use--under use of water can beas economically negative as over-use in some circumstances. Simplicity is also required to permit farmer understanding and to preclude squabbles between groups.

4. Benefit taxes

a. General discussion

Efficiency pricing, or a form of volumetric pricing, together with the effects of general taxation, are likely to meet fully the objectives of income distribution and public savings. Should that be the case it is then necessary to consider the possibility of levying a benefit tax. The most robust form of benefit tax in some parts of the world is a land betterment tax spread over, say, the life of the project. As long as the tax base is an accurate measure of the benefits conveyed, which implies carefully revaluation of land values at reasonably frequent intervals, it should meet the test of user acceptability. Land taxes offer scope for a progressive rate structure and thus achievement of distributional objectives. It is not known if a land tax on SNL lands used for an irrigation project would be acceptable or not.

To achieve income distribution and public sector savings objectivices, recovery policy in the context of a specific project should concentrate on selective benefit taxes that are to be paid by beneficiaries of the project and not by others. The effects of a project on revenues from general taxation should be taken into consideration, i.e. they are deducted in the computation of the available rent on which water charges and benefit taxes may be levied, but adjusting such general taxation to achieve the cost recovery objectives of a particular project is generally difficult as this involves much wider fiscal considerations.

The level of benefit taxes should preferably incorporate a degree of progressivity, subject to the constraints of disincentives to work and tax evasion propensities. Thus, it may be desirable to charge very poor farmers (i.e., those with incomes below the Critical Consumption Level (CCL)) at a low rate, while those beneficiaries whose incomes are above the CCL might be taxed progressively up to the limit of their rent. Imparting a degree of progressivity into benefit taxes should lead to higher levels of cost recovery than otherwise would be the case.

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b. Benefit tax design requirements

There are four basic requirements for designing satisfactory benefit taxes:

(1) Identification of the project's beneficiaries and their classification into a number of income groups; total farm income when the project is at full development is to be estimated. Preferably the classification should be on the basis of total income (farm plus non-farm);

(2) Estimation of the distribution of the "rent" by these income groups defined earlier. the "rent" accruing to an individual indicates the maximum amount he can pay and still benefit from the project;

(3) Ability to make suitable provisions for making the benefit tax system selective, progressive, and acceptable to the beneficiaries, taking into account administrative problems and the disincentive effects of such taxation, if any;

(4) Judgement on the appropriate "social" weights for valuing gains to different income groups, both relative to each other and relative to the needs for additional revenues of the government. The design of benefit taxes will, of course, be greatly facilitated if explicit judgements on these weights are available, which are in any case implicit in all cost recovery decisions. Such judgements might be developed on the basis of the treatment that others in similar situations receive, but this is not always a helpful basis.

It was stated earlier that, for reasons of efficiency and equity, recovery of costs and benefits should be project-specific. It should be recognized that the design and implementation of desirable benefit taxes are in practice often contrained by various administrative and political factors, and the full implementation of such taxes may thus be a prolonged process. Two common difficulties, for example, relate to the measurement of income and the problems of controlling tax evasion.

First, accurate monitoring of the incomes of project beneficiaries may be very difficult, especially when the beneficiaries also have non-agricultural sources of income. This is particularly prevalent in Swaziland. Even apart from this, the land ownership pattern, and changes in the pattern, need to be taken into consideration, as progressivity implies that, say, a person or 10 hectares should pay more than 10 times the tax payable by another with only 1 hectare.

Second, partly because of the income measurement problem, it is difficult to avoid tax evasion, especially if the tax structure is made too progressive: the higher the progressivity, the higher is likely to be the incentive to evade and also the greater may be the political problems of implementing taxes. there are reportedly serious problems in tax collection in Swaziland. By the same token, however, the need for water charges becomes even more important.

Benefit taxes should be chosen and designed so as to minimise any adverse effects that these taxes may have on production and consumption decisions of the farmers and of others in the economy. For example, in some cases, it may be possible to recover costs by selling farm inputs to the project beneficiaries at prices higher than those paid by others.

However, such discriminatory pricing of farm inputs, even if feasible, could induce the farmers to adopt the wrong production techniques. Similarly, discriminatory taxes on farm outputs (or monopolistic "marketing margins") may induce the choice of wrong crops by the farmers. Although it may be impossible in practice to avoid such adverse effects completely, project specific betterment levies on land holding are generally the best of the available options.

The above indices should always be computed in real (constant price level) terms and in present value terms. The discount rate used should represent the best estimate of the economic opportunity cost of capital, or 10% if no estimate is available. The grace period, and the period over which recovery should be made for adjusting charges in the light of actual developments during the course of the project, is of course subject to economic judgement.

b. Income classes and recovery indices

To facilitate evaluation of the recommended water charges and benefit taxes, rent recovery indices should be presented separately for beneficiaries in different income classes. It is suggested that, where feasible and relevant, the following income classes be distinguished:

--those with incomes below the CCL;

--those with incomes between the CCL and the national average;

--those with incomes above twice the national average.

Where available data on the distribution of income cannot be fit into these suggested classes, other income classes may be used. It is sometimes, but in a project where all smallholders have the same sized plot that is of little use.

The derivation of the recovery indices defined might be conveniently presented in tabular format on the following pages (Table II-A-5).

It is not easy to estimate project rent or the rent, as defined here, of different income groups because of difficulty in determining various non-cash or imputed values of costs; however, using benefits gross of these costs does not solve this problem because the judgement whether a sufficient proportion of benefits is being recovered involves necessarily an estimation of the very same cost elements which are deducted from gross farm income to arrive at project rent. Still less can one fall back on some principle of cost recovery

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Table II-A-5 Rent and Cost Recovery Indices[a]

		Income Group for Beneficiaries[b]				Total Project
		d_1	d_2	d_3	d_4	
1.	Gross value of farm production at farm gate ex sales taxes	----	----	----	----	----
2.	less production (cash) costs	----	----	----	----	----
3.	equals net cash income [1 - 2]	----	----	----	----	----
4.	less - depreciation	----	----	----	----	----
5.	- imputed value of family labour	----	----	----	----	----
6.	- imputed value of management services	----	----	----	----	----
7.	- imputed return on own capital	----	----	----	----	----
8.	- allowance for risk/uncertainty	----	----	----	----	----
9.	- general taxes	----	----	----	----	----
10.	equals rent/surplus	----	----	----	----	----
11.	rent as a percentage of net cash income [10 ÷ 3]	----	----	----	----	----
12.	volumetric water charges	----	----	----	----	----
13.	benefit taxes	----	----	----	----	----
14.	total direct charges/taxes [12 + 13]	----	----	----	----	----
15.	rent recovery index [14 ÷ 10][c]	----	----	----	----	----
16.	public sector outlays (capital + O&M)	----	----	----	----	----
17.	cost recovery index [14 ÷ 16][c]					----
18.	farmers income per capita, in project year _____, at full development					----
19.	estimated critical consumption level (CCL), same project year	----	----	----	----	----
20.	estimated national per capita income, same project year					----
						----

a Items 1 through 17 are incremental, discounted values at constant year-prices, or ratios derived from them.

b If feasible and relevant, income groups should preferably be:

d_1 = below the CCl.

d_2 = between the CCL and c, where c is the national per capita income.

d_3 = between c and 2c.

d_4 = above 2c.

Whatever income groups are used, the income groups should refer to total farm and non-farm income at full development. Individual farmers may, of course, move from one income catergory to another, over time.

If the ratios are defined on a gross basis, item 9 (general taxes) should be included in item 10 (rent).

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because, whether one should recover more or less than the full project costs (investment plus O and M costs), while an important issue for public savings, depends also on the ability to pay and considerations of equity.

How are the imputed costs of family labour, management services, return on capital and risk/uncertainty to be determined? In principle, the value of family labour should be determined by its supply price. Where this is difficult to estimate in practice, it is suggested that a weighted average of seasonal market wages be used as a proxy for the supply price. An allowance of about 5 percent of the net value of incremental farm output would probably be sufficient for incremental management costs.

The imputed return on the farmer's own capital should be based on the incremental net value of assets financed by farmers out of their own savings and should reflect the rate of return that their funds should be built into the value of incremental gross farm output i.e., the value of gross farm output should be its expected value, derived from the estimated probabilities of a range of outcomes. In addition, however, some farmers may prefer a lower more certain income to a higher but riskier income; a risk allowance, not to exceed 10 percent of the value of net farm output, may be in order (line 8).

6. Extent of cost recovery

What can reasonably be expected with respect to capturing part of the benefits and recovering the benefits and recovering the costs of project? The amount of revenue which could be collected from water charges and benefit taxes will always be less than total project rent, as defined here, for several reasons. Leaving aside questions of equity for the moment, if each farmer were charged the rent that remains after making adequate allowances for depreciation, imputed farm family labour, management costs, return on own capital, increase in general taxes, and a realistic allowance for risks, he should still have sufficient incentives to participate in the project.

Taking equity considerations into account, however, it is clear that 100 percent of project rent should be regarded as the upper limit that cannot be reached if allowances are made for income distribution. For example, if project beneficiaries below the CCL rate are to be charged water charges and benefit taxes only to the extent necessary to discourage wasteful use, and those total less than project rent, and if the benefit tax system is to benefit tax system is to progressive, recovery of 100 percent of total project rent could be achieved only by charging the richer farmers more than 100 percent of their rent. This is obviously both undesirable and impractical.

Thus, the extent to which project rent can be recovered will depend upon the distribution of incomes in the project area and upon the degree of tax progressively deemed desirable and feasible. In addition, an allowance may have to be made for political acceptability and administrative constraints. It should be noted that if appropriate recovery is determined by ability to pay of beneficiaries, as measured by their "rents" and income levels, then the extent of cost recovery become a residual. While cost recovery is important for its impact on public revenues and savings, these aspects are implicitly taken into account when determining the CCL.

Project rent adjusted for income distribution is the desirable amount of benefit tax the farmer should pay.

What is the practical significance of this rule for cost and rent recovery? To put it another way, is there any lower limit of the recovery ratios which can be set as a guideline? Since judgements are involved in estimating many of the items which have to be deducted from incremental net farm income to arrive at a measure of incremental rent, and since judgements also involved in making allowances for income distribution, as well as political and practical problems, clearly it is difficult to set a precise lower limit to the norm of capturing part of the project benefits.

There is therefore no prima facie reason why any particular share of costs, such as O & M costs, should normally be recovered. The most desirable level of recovery should exceed the total financial costs incurred by the irrigation project on the other hand, if all or most beneficiaries have levels of income below or near the CCL, the desirable cost recovery may well be close to zero. It is for this reason that the level of O & M cost may be a poor yardstick by which to measure the adequacy of water charges and benefit taxes.

Nevertheless, it is important for irrigation authorities which are not autonomous and depend upon their governments for annual subventions, that these subventions be fully adequate to cover O & M costs and other financial obligations, if any, of the irrigation authorities. Where irrigation authorities are autonomous and do not receive annual budget subventions, it is important that they receive revenues from charges sufficient to cover not only O & M costs and other financial obligations but also as much of the costs of their justified future investments as is possible when farmers are charged an adequate proportion of their rent.

In the Komati Irrigation Project, the Devres team has attempted to build in effective cost-recovery programmes. Water charges are levied by crop, geared to anticipated crop water consumption. These naturally will require constant monitoring with the accumulation of experience. In Chapter IV of this Volume II we point out that one of the menagement's functions is to maintain computerised water use/yield records; they are partly for the purpose of water charges. Though the project would collect such charges, they would be transmitted to Central Government. These, and the three other types of anticipated cost-recovery operations, are discussed in subsequent sections.

B. Cost Recovery Charges on the Komati Irrigation Project, Adding Back Variable/Production Costs.

In the light of the need to cover the costs of the Swaziland share of Phase I dam costs (E40 million) plus a continuing share of the Phase I dam's O & M costs, the Devres team built into the operating on-farm cropping budgets allowances for various charges and services. The financial and economic rate of return analyses of the project are calculated after these (and all other) costs are deducted from project revenues. Such rates of return are reasonably adequate.

To produce even greater viability, however, if GOS wished to do this as a matter of financial policy it would be entirely legitimate to add back, as a contribution to project revenue, some of the production costs which are, in fact, revenues to the project. There are four such charges in the smallholder and nucleus estate budgets:

1. An irrigation water charge;

2. An irrigation (on-project) operation and maintenance charge; a charge for machinery and equipment services; and a charge for marketing, processing and otherwise handling the produce. Each crop budget contains these charges as deemed appropriate to its cultivation and handling. They are detailed in Annex 1 of this Volume II.

For the project as a whole, the first approximates E320/ha croped; the last three combined as just over E1500/ha cropped. Even assuming a cropping intensity of 150, that would provide an annual sum per project hectare of E2730 (E320 + E1500 x 150 percent). That comes to E2.7 million annually at full development for each IDU, with a gradual build-up to that point from PY2 when the estate begins cropping.

This Devres team has not effected these sorts of calculations further; the whole matter is far too discretionary at this point. But the very legitimate calculation route is there, nonetheless.

C. Cost Recovery Analysis: Other Routes

Building upon the analyses in Chapter VII, Volume I, the following discussion presents a variety of options regarding cost recovery under the different scenarios of possible future volumes and uses of Komati water. It is not meant to replace the analysis of possible cost-recovery measures for the first IDUs discussed at section B above. It is designed to complement that discussion by looking at the much longer term and, second, by considering Swaziland's total entitlement to water, and its use of that water, assuming a greater cost for total dam development of the entire Basin system (6 dams).

Developed earlier (in Chapter VII Volume I) were three possible scenarios of future water requirements. Each built up to a total water requirement (above and beyond present Swaziland uses of some 192 MCM) by sector (irrigation; forestry and thermal plants). The details of these three scenarios include assumptions about resources used (ha of irrigation; ha of afforestation; MW of power generation) and thus their sectoral water requirements into the future.

Dealing with these net additional water requirement of an expanded reservoir system in the Komati Basin (excluding current run-of-river use), Table II-A-6 shows the net additions needed to Swaziland's water supply under the three, and different, scenarios of possible economic use for these resources. Only irrigation, forestry and thermal power requirements are dealt with.

Table II-A-6: Alternate Future Scenarios Regarding Uses of Net Additions of Komati Basin Water Supplies

	Use Scenarios		
	I (Minimum)	II (Moderate)	III (Maximum)
Total Water Used - MCM	112	127	158
Of which - %			
Irrigation	75	66	80
Forestry	23	31	16
Thermal	2	4	4
Total Dam Cost @ E0.351/M³) E million	39.3	44.6	55.0
Of which - applying above percentages			
Irrigation	29.5	29.4	44.0
Forestry	9.0	13.8	8.8
Thermal	0.8	1.8	2.2
Resource used at full development			
Irrigation (ha)	6,000	6,000	9,000
Forestry (ha)	20,000	30,000	20,000
Thermal (MW)	150	200	300
Dam Costs per unit of resources used			
Irrigation E/ha	4917	4900	4889
Forestry E/ha	450	460	440
Thermal E/MW	5333	9000	7333

Source: Devres Staff Estimates, August 1985

This could be explained still further with more allowance for forestry and for thermal use, taking it to some 177 MCM. In that case the proportions and values would change from those shown.

The conclusion is that, without any further adjustments, the dam cost per hectare goes down slightly per ha new irrigation as irrigation expands; there is no material change in dam costs/ha of forestry, and thermal water costs range from E5,300 to E9,000/MW produced. That is really very cheap. The fact remains, though, that the capital cost for the dam is a rather heavy load on each hectare of newly irrigated land if, repeat if, the bulk of these costs (66-80 percent) are applied to each hectare irrigated, and if no cost recovery processes are put in train (as per B. above). It has been suggested that the water charge payments built in to the financial analysis of the earliest developed modules (IDUs) could very well recover the Swaziland share of the cost of dam building in Stage I. The figures are purely "seat-of-the-pants", and must be fine-tuned. The basic fact is, nonetheless, that an administratively effective process of cost recovery can indeed pay for Stage I dam costs without punishing new producers to the point where incentives to continue producing begin to drop away. These suggested cost recovery "first cuts" by the Devres consulting team must be considered just that, and no more; they can be "tinkered with".

Perhaps of greater relevance is the need to establish cost recovery programmes for all users of Komati water, old and new. Prior to Stage I development, Swaziland uses some 192 MCM of Komati/Lomati water annually, most of it irrigating SIS land in the Mbuluzi Basin. Total areas irrigable with Komati water (1983) were 12,300 ha. Table II-A-7 displays the methodology of arriving at per hectare and other unit costs, post-Maguga, assuming existing uses are to be included in the cost-recovery process.

The numbers so calculated indicate that each hectare under irrigation, regardless of whether it is old or new, should contribute E2000 to E2400 to dam construction costs, regardless of how much total water is used for whatever irrigation purpose. Forestry should pay E170-E205/ha; the Electricity Board must pay E1300-E3000 per MW generated, also very cheap.

The next analytical step is to cater to the assumption that SIS, while obliged to contribute henceforth, should not really be charged as much as for each hectare of new irrigation. Table II-A-8 indicates the results of allowing only 20 percent of total future dam and dam system costs to redound to SIS (and other modest current users). Thus, proportionately, they are paying much less--they will have 50-60 percent of the total irrigated area but are asked to pay only 20 percent of dam water development costs. Under those (probably) politically viable assumptions, SIS water charges are 12.2-18.3 percent of those levied on new irrigation enterprises. Clearly that should be subject to review at some point, but probably not to start.

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Table II-A-7: Dam Costs Calculated on Total Use Pre-Project Use Plus Post-project Use

	I (Minimum)	II (Moderate)	III (Maximum)
Current Utilization (MCM)	192	192	192
New Use Contemplated- (MCM)	112	127	158
Total area in Swaziland post-system development (6 dams) (MCM)	304	319	350
Of which : %			
Irrigation	276	276	318
Forestry	26	39	26
Thermal	3	4	6
% of 3 above: Irrigation	90.3	85.5	90.9
Forestry	8.6	12.2	7.4
Thermal	0.9	1.3	1.7
Total Dam Cost (E million) (Share @ 5 above)	39.3	44.6	55.0
Of which :			
Irrigation	35.7	38.6	50.0
Forestry	3.4	5.4	4.1
Thermal	0.4	0.6	0.9
Resource applied:			
Irrigation (ha)	18,300	18,300	21,300
Forestry (ha)	20,000	30,000	20,000
Thermal (MW)	150	200	300
Dam Costs Applied to Resources:			
Irrigation E/ha	1951	2109	2347
Forestry E/ha	170	180	205
Thermal E/MW	1333	3000	3000

Source: Devres Staff Estimates, August 1985

Table II-A-8 : Per Hectare Water Charges Assuming SIS Provided Major Exemption from Full Duties

	Economic Use Scenarios		
	I (Minimum)	II (Moderate)	III (Maximum)
Total cost of water for irrigation (E million)	29.5	29.4	44.6
Twenty percent only to SIS (E million)	5.9	5.9	8.8
Eighty percent to new irrigation (E million)	23.6	23.5	35.2
Charge per hectare on SIS (12,300 ha) (E)	480	480	715
Charge rest of new system (E) (per hectare)	3933	3917	3911
Line 4 as % line 5 (%)	12.2	12.3	18.3

Source: Previous Tables

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Thus, it is now possible to speculate on the water cost per hectare or per MW of power by examining the number of M^3 needed (annually) and then multiplying by the "equity" cost of providing that water viz. E0.351/M^3. Taking, for example, the Scenario I, the "minimum" scenario, one has:

E0.351 x 276 MCM - irrigation	= E96,876,000	divided by 18,300 ha	= E5293/ha
x 26 MCM - forestry	= E 9,126,999	divided by 20,000 ha	= E 456/ha
x 3 MCM - thermal	= E 1,053,000	divided by 150	= E7020/MW

However, in the case of this most conservative scenario, as an example only, the total water needed is still the same (now plus new), some 304 MCM. But if one applies to this only the cost of E39.3 (Phase I costs as calculated), then the average M^3 of water drops to E0.129/M^3.

Under that unit price assumption, Table II-A-9 suggests M^3 costs per unit of all associated resources used and supplied with water in the Basin. There is no change in forestry and thermal power data since these activities are currently absent. But spreading new dam costs over all hectares irrigated--pre-dam plus post-dam--drops the average M^3 dam cost from E0.351 to E0.129-E0.157. This brings the dam cost which must be recovered from the irrigation users (old and new) down to E1,945-E2,343 per ha; clearly, over an extended period, the annual cost per hectare to contribute to dam investment would be very modest. Each hectare would have to pay, over on a 30 year basis, say, E70-E80 annually. That can be doubled for interest payments. The "need" analysis thus suggests an annual water charge/ha of perhaps E150-E300, a very modest charge from a E4,000-E4,500 gross margin/ha.

Another way of approaching the matter is to assess the "ability to pay" of current and potential irrigation water users. The analysis of both the smallholder and the nucleus estate budgets would suggest that even an annual water charge (against the dam) of E400/(at full development) would not be too difficult to manage. The three economic use scenarios would be contributing the following annually at full development.

	I	II	III
-- No. of Hectares Irrigated	18,300	18,300	21,300
-- Volume of Annual Water Charge (E million) @ E400/ha	7.3	7.3	8.5
-- Volume @ E250/ha (E million)	4.6	4.6	5.3

Purely as a rule of thumb, since it is not really worth calculating in detail at this point, it would only take about 15-18 years, allowing for interest, to retire the dam cost at E250/ha annual charge. At E7.3 million annually, it would of course take even less time, perhaps 10-11 years, to retire dam costs and their interest charges.

Table II-A-9: Unit Cost of Resources Used Under Different Economic Use Scenarios

	Economic Use Scenarios		
	I (Minimum)	II (Moderate)	III (Maximum)
Total Water Used Current and Possible Future (MCM)	304	319	350
Total Cost (E million)	39.3	44.6	55.0
Cost per M^3 (E)	0.129	0.140	0.157
Cost by Sector/Unit (E million)			
Irrigation	35.6	38.6	49.9
Forestry	3.4	5.5	4.1
Thermal	0.3	0.5	1.0
Unit Cost per Resources Used (E)			
Irrigation (ha)	1945	2109	2343
Forestry (ha)	170	182	205
Thermal (MW)	2000	2500	3333

Source: Previous Tables

ANNEX 7

MULTIPLE ECONOMIC OBJECTIVES FOR

SMALLHOLDER SETTLEMENT ON THE PROJECT

APPENDIX 7

Multiple Economic Objectives for Smallholder Settlement on the Project

A. Introduction

The Government of Swaziland, as a matter of development policy, has decided that the provision of assistance for small farmers ranks as a priority for planning and investing. The recent RDA programme is evidence of that committment. A critical future component of small farmer development is the increasing use of water for agriculture in the lowveld. Large (and smaller) estates on private lowveld arable soils have established beyond doubt that, technically and agronomically speaking, a range of both summer and winter crops can be grown successfully.

Numerous studies have been undertaken in the lowveld areas of parts of Swaziland in the effort to identify areas of soil and water availability appropriate to smallholder irrigation farming. Simultaneously, however, it has been recognised that some land and water for future irrigation development must be devoted to larger scale cropping, particularly of crops for export. For a variety of reasons, the concept of combining smallholder development with estate developments--a joint venture, has evolved. It has already taken one particular form in the Vuvulane Project where smallholders grow sugarcane, on their own plots for the nucleus estate, yet also have land available, under irrigation, for their own private cropping. A nucleus estate/smallholer project of 4,500 ha was assessed for the Big Bend area of the Usutu Basin by the Tate and Lyle consulting team.

That work suggested a 4 ha irrigated plot for smallholders, annual crops (not tree crops), and crops for the domestic market only; some, such as maize, would be foreign-exchange saving, however, substituting for imports. It was also assumed that the holding would be large and active enough to require the labour of the entire household and that extra labour to meet seasonal peaks would be needed--no labour was to be available to work on the nucleus estate itself.

This is a perfectly sensible model, and rests upon a host of assumptions, some of which are spelled out in the report. What is missing, however, is a more rigorous examination of the objectives of smallholder settlement, and the strategies required to achieve them. As well, new smallholder projects under contemplation presumably should be designed to obviate or mitigate the problems and issues which retard or preclude satisfactory progress in analogous schemes elsewhere in sub-Saharan Africa. There is little directed attention to this matter either e.g. the role of livestock in the project area.

While the following discussions is not intended to be completely definitive on these matters, it does suggest nonetheless the sorts of criteria and objectives considered by this study team in its selection and use of the 2 ha small farmer model. All discussion must naturally be conditioned by the realisation that the world in which the project could find itself will be different from today--what is realistic and sensible in mid-1985 may be less so, even quite unsuitable, 7-10 years from now. And vice-versa; an option or alternative considered of a lower priority now may be highly germane one decade down the road.

Five settlement objectives are discussed here, with brief comments on each. Some are quite compatible with one another, others are rather incompatible. The selection when the time comes will be a matter of policy. Given the size of these modules--Irrigation Development Units--at least 3 of them at 1,000 ha each, it is naturally conceivable that one or two objectives can be sought on one IDU, then other objectives on subsequent IDU's. Or the pattern desired on the first IDU may not sit comfortably, and larger and/or different types of settlement patterns used on subsequent IDU's.

B. Maximising the Net Return to Each M^3 of Additional Water

Already a reasonably scarce resource, net additions to Swaziland's water supply will become more and more costly to acquire. Even then a maximum supply will be reached in any one Basin, then there just isn't any more. It make sense therefore to design water use systems, cropping patterns, land use, etc. to not only not waste water, but also to obtain the greatest economic return for that increment. The study team made an effort to assess the net returns which might be obtained by applying an additional M^3 in a variety of places, and which gave the greatest return.

The data base would not support such an analysis at this time. There are a number of fairly obvious relationships, however. Gross and net financial returns may be quite high for some crops e.g. rice, sugarcane. Because they consume so much water, however, the returns per M^3 can be very modest. Conversely, though gross and net financial returns may be low for some field crops, especially when yields/ha are not high, the returns per M^3 used can be quite high. This is particularly the case where small farmers are unaccustomed to irrigation water avalability and tend to underwater--even doubling the water on a crop will rarely double the yield; the yield increment may be small so that the average yield per/M^3 at the margin goes down quite quickly.

Ideally, any given irrigation area (a 2 ha plot, a 1,000 ha IDU, the 50,000ha in a region or nation) should be cropping in such a manner as to always provide a net increase in value for each additional M^3 of water, and that curve should still be rising when the point is reached when additional water is no longer available. Since, however, the assessment of net returns is of course subject to changes in prices (costs and revenues), the "ideal" cropping mix would be achieved but rarely.

This objective is seldom given much consideration in the earlier years or decades of irrigation development; other objectives such as employment creation or the earning of foreign exchange take precedence. Nor is it given

much thought when water is plentiful. It came as a major shock to Egyptians in recent times, for example, when they learned that even Mother Nile was limited in supply and that any new use would be at the cost of an existing use. Thus, while water in Swaziland as a whole is not particularly short, it is already becoming so in some watersheds/basins. This objective of attempting to maximise net returns per additional M^3 of water thus must be given increasing attention in the coming period for the nation as a whole as well as in specific projects.

C. Maximising the Net Return per Each New Hectare Irrigated

Similar logic applies to this objective. Given the growing pressure on good land by rapidly expanding human populations (and, in some areas, of stock), new land of high quality for irrigation will be in cumulatively short supply. The "eyes" have been picked out already in most basins. It thus behoves planners to establish cropping patterns and rotations on smallholder plots which maximise value added for the nation per hectare. This process may not be consistent at all times with optimising financial returns for the farm family. It probably, however, would be consistent with the objective of maximising foreign exchange earnings.

D. Maximise Recoverable Values to Permit the Repayment of the Project's Debt

Smaller and poorer nations such as Swaziland tend to incur reasonably heavy international debt loads. To maintain international creditworthiness it thus behoves Swaziland to demonstrate that it can attempt to earn the foreign exchange necessary to repay its loans and interest on loans. In principle, each development project should at least pay for itself since much of the capital investment is imported in a typical project, and a share of the recurrent costs or inputs may also require foreign exchange e.g. some agricultural chemicals, equipment parts and spares, fuel. Thus, smallholder plots should emphasise export crops, or crops which are substitutes for imports.

As well, however, many of the investment and recurrent costs of an irrigation project such as this one are from government's domestic funds. So revenues must be generated to cover these additional disbursements.

In short, the right sorts of incomes must be developed on the smallholder farms but they must be recoverable as well--taxable in a convenient way. There is little point in encouraging maximum output for local markets, for example, if government has no institutional means to cream off a reasonable share of the revenues generated. The same for export crops; crops and products must therefore move through systems where records are kept and taxing may occur e.g. cooperatives, marketing boards, processing facilities, and the like. Water and O and M charges at the project level can also contribute to making the project more financially sound. Cost recovery is discussed at more length in Annex 6, this Volume II.

E. Maximise the Net Returns to the Family Unit

Another common objective for smallholder irrigation farming is of course to provide the family with a decent and reliable income. A secure family food supply is perhaps the dominant objective of many Swazi farmers. The availability of such food on a reliable basis can also help attract any labour force required. Crops selected, crop rotations, and farm size can all be considered in this light, recognizing that farm size in particular will also be guided by other considerations e.g. family labour available for the farm, and as paid labour on the nucleus estate.

It is thus customary to establish "target" income levels for the family unit. Depending upon crops available, production costs, and farm-gate prices, net revenues are generally targetted at levels consistent with alternative wage employment. In Swaziland this is usually considered the equivalent of a worker's take home (or send home) pay were he to be employed in the RSA and could range from E2,500 to E5,000 annually, usually after the family's basic food supply is allowed for from the "home" farm.

Several basic factors are involved here. One is the gross income earned. another is the costs of producing that gross income. These generally are of two kinds. One is the series of payments the farmer makes to the nucleus estate/organisation for required services and input, including water; many of these supplies/services may be compulsory in the interest of maintaining at least minimum levels of productivity. Secondly, there are those expenses which are discretionary to the farmer, particularly those on extra labour.

Thus the agronomist and the economist must "tinker" with alternative holding sizes, crops, crop rotations, price ranges (inputs and outputs), and the like to achieve that target income. Farm management skills needed should not exceed those available certainly in the early learning years, nor should labour requirements. If, however, labour is needed on the nucleus estate from this household, then pressure is downward on farm size and net income. Conversely, income per adult worker equivalent must be sufficient to preclude householders simultaneously maintaining their traditional farms off the irrigation project.

6. Maximise Settlement Densitites/Employment

One stated purpose of agricultural development in Swaziland is to provide higher levels of employment and income-earning opportunity. On both nucleus and on smallholder plots, the objective is to absorb as many people as possible. Thus there can be serious trade-offs. A lower incidence of machine technology can usually increase the need for more labour--cotton can be picked by many hands or by machine, even on smaller plots, for example. One can use a tractor and a gang plough, an ox plough, or a hoe.

Several conditioning factors must be taken into account here. Generally speaking the relatively greater the use of labour to accomplish any given task, the relatively greater the unit cost. It could be that production costs cannot stand being increased beyond a certain point because of the level of sales prices, especially in external markets where competition is keen.

Secondly, the average level of productivity per worker will normally fall under denser employee conditions; this must be related to incomes earned. Similarly for the family on the smaller farm. They may use more hand methods for a very wide range of tasks e.g., weeding, seeding, chemical application, etc. Or they can employ (usually by renting) a range of micro-technologies which cut down labour time per task by a very large factor. Not only is family-member productivity lower in the first case, but so may be yield since improved technologies normally ensure improved performances e.g. plant populations are more optimal with a small seeder than by hand.

Once again therefore, the agronomist, economist and extension agent should pursue the alternative packages of options available. In Swaziland's domestic markets, given the relatively greater distances from this Komati project to the main domestic markets (compared to Usutu suppliers), it is probably unlikely that farm gate prices will permit anything but the most effective technologies to keep unit production prices to their minimum.

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ECONOMIC STUDY OF POSSIBLE USES OF ADDITIONAL WATER ON THE KOMATI RIVER, SWAZILAND

VOLUME III : MARKETS AND MARKETING

VOLUME I : THE MAIN REPORT

VOLUME II : PRE-FEASIBILITY ANALYSIS OF THE KOMATI RIVER IRRIGATION PROJECT

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August 31, 1985

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CURRENCIES, WEIGHTS AND MEASURES, CONVERSIONS

CURRENCY EQUIVALENTS (END JUNE, 1985)

USA Dollar $1.00 = Emalangeni E1.85
Lilangeni 1 = RSA Rand 1

(Rand is also legal tender in Swaziland)

WEIGHTS AND MEASURES

The international system of units (SI) are used throughout this report. Base units for this system are:

Metre (M)	-	unit of length
Second (s)	-	unit of time
Kilogram (kg)	-	unit of mass/weight
Ampere (a)	-	unit of electric current
Celsius (c)	-	unit of temperature
Litre (ℓ)	-	unit of liquid volume
Hectare (ha)	-	unit of space

SI UNIT PREFIXES USED ARE AS FOLLOWS

Multiples & Submultiples	Prefix	SI Symbol
10^9	Giga	G
10^6	Mega	M
10^3	Kilo	K
10^{-3}	Milli	M

CONVERSIONS

The following conversions are offered:

From old Units	Multiply by (approx.)	To SI Units
Ft^2	0.0929	M^2
Acre	0.4047	ha
$Mile^2$	2.590	Km^2
lb/ft^3	16.018	kg/M^3
Ft^3/s	0.0283	M^3/s
gpm	0.0631	L/s
Mile	1.609	km

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Ft	0.3048	M
in	25.4	mm
Ton(long)	1.016	t,Mg
Ton(short)	0.907	t,Mg
lb	0.4536	kg
hp	0.746	kw
psi	6.895	kPa
Mile/h	1.609	km/h
Yd^3	0.765	M^3
Bushel	35.24	L
Gallon	3.785	L

MOST COMMONLY USED

1 hectare (ha)	=	2.47 acres
100 ha.	=	1 sq. kilometre
1 tonne (t)(MT)	=	1000 kg
1 kg	=	2.2 pounds (lb)
1 km	=	0.62 miles
1 metre (m)	=	3.28 feet (ft)

LIST OF ACRONYMS AND ABBREVIATIONS

ACP	Africa, Caribbean and Pacific
BLS	Botswana, Lesotho and Swaziland
CAP	Common Agricultural Policy
CDC	Commonwealth Development Corporation
CET	Common External Tariff
CI	Crop Intensity
CIDA	Canadian International Development Agency
CSO	Central Statistical Office
EDB	European Development Bank
EDF	European Development Fund
EEC	European Economic Community
EIRR	Economic Internal Rate of Return
FAO	Food and Agricultural Organisation (of the UNO)
FIRR	Financial Rate of Return
GOS	Government of Swaziland
GM	Gross Margin
GSP	Generalized System of Preferences
GDP	Gross Domestic Product
IBRD	World Bank
IDU	Irrigation Development Unit
IFAD	International Fund for Agricultural Development
IRR	Internal Rate of Return
ITC	International Trade Centre, UNCTAD/GATT
ITF	Individual Tenure Farms
JPTC	Joint Permanent Technical Committee
KOMAPRO	Komati Agricultural Products Marketing Authority
MAR	Mean Annual Runoff
MOAC	Ministry of Agriculture and Co-operatives
MSL	Mean Sea Level
NAMB	National Agricultural Marketing Board
NIDCS	National Industrial Development Corporation of Swaziland
NRLUE	Ministry of Natural Resources, Land Use and Energy
PY	Project Year
RDA	Rural Development Area
RDAP	Rural Development Area Programme
RSA	The Republic of South Africa
SAAGA	South African Avocado Growers Association
SACE	South African Citrus Exchange
SACU	South African Customs Union
SAMB	South African Maize Board
SAMGA	South African Mango Growers Association
SATS	South African Transport Services
SCB	Swaziland Citrus Board (Swaziland Cotton Board)
SI	Shortage Index
SIS	Inyoni Yami Swaziland Irrigation Scheme
SNL	Swazi Nation Land
STABEX	Export Stabilization Fund, EEC
TDF	Title Deed Farm

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TDL	Title Deed Land
TLTS (T AND L)	Tate and Lyle Technical Services
TOR	Terms of Reference
UK	United Kingdom
UNDP	United Nations Development Programme
USAID	United States Agency for International Development
USCOE	United States (Army) Corps of Engineers
VA	Value Added

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ECONOMIC STUDY OF POSSIBLE USES OF ADDITIONAL WATER ON THE KOMATI RIVER, SWAZILAND

Volume III: Markets and Marketing

EXECUTIVE SUMMARY

A. Introduction

This Volume III is a detailed supplement to the pre-feasibility analysis of the Komati River Irrigation Project (Volume II). Its development became an integral and iterative part of that project analysis assisting, by definition, with the basic discussions on crop selection, project phasing and timing, pricing and costing. Thus, it was a core ingredient in the process of determining project financial and economic feasibility levels; the project's overall attractiveness. As with other project analytical elements, basic examination concentrated on the 1,000 ha IDU level.

Subsequent sections will describe basic findings in markets and marketing for each crop, in packaging and transport, and in market shares/margins and foreign exchange earned.

B. Major Findings

1. Background

The Government of Swaziland's development policies include the need to switch away from capital intensive industries and give maximum emphasis to the improvement or expansion of smallholder agriculture. The effective implementation of this policy would reduce the country's dependence on food imports and move towards greater food self-sufficiency.\1 These objectives could be achieved by a major programme of irrigation agriculture in three defined activity areas:

- The Usutu River Basin which consists of 18,000 irrigable ha on the low and middle velds. The region includes the greater part of the national population and the two principal urban centers of Mbabane (capital city) and Manzini. Tate and Lyle studied part of this area on the Usutu;

\1 Development policies and objectives dealt with at length in Volume I, Chapter III and Volume II, Chapter II.A.

- The Rural Development Areas (RDAs) which comprise 50 percent of Swazi Nation Land of which 40,000 ha are already under irrigation, with 91 percent of this on Individual Tenure Lands; and

- The Komati River Basin which is located in the northern Swaziland lowveld and is scheduled for an irrigated agriculture project following the proposed construction of a dam at Maguga on the Komati River. This project is the subject of this present study as one of the alternative uses of an enhanced Komati water supply.

This major marketing study (Volume III) was launched to investigate the potential contribution of selected crops in the Komati project area when cultivated on the basis of a nucleus estate with satellite smallholder farmers. Production emphasis would be on tree crops, as well as some vegetables destined mainly for domestic and RSA markets. This brief presentation summarizes that more comprehensive study, which follows.

2. Markets and Marketing

A wide variety of prospective crops had already been examined and evaluated in a recent study commissioned by USAID.\1 Nine were selected from this list as suitable for cultivation in the lowveld project area, and having export and domestic market potential--citrus, avocado, mango, papaya, cotton, maize, cabbage, tomato, and potato.

Those tree crops are currently in demand in overseas markets between November and April, during the off-season in the Northern Hemisphere. Cabbage, tomatoes, and potatoes have established markets in Swaziland and neighbouring African countries. Maize is the most important ingredient in the Swaziland national diet, and a high priority item for import substitution. Cotton is in increasing demand by the RSA cotton spinning, textile and vegetable oil industries.

Overseas export markets in which Komati produce can generate significant foreign exchange earnings are identified in Western Europe, the Middle East, and Japan. In Western Europe, particularly attractive opportunities should exist in France, U.K., German Federal Republic and Scandanavia. The Middle East is already Swaziland's most important customer for citrus, and this provides a valuable bridgehead into the Gulf States.

Japan is now an important market for Swaziland grapefruit, and could become a regular importer of papaya (solo or pepio varieties only) throughout the year, and of mangoes and avocados during the off-season when high wholesale prices could cover air transport costs. Access to Japan's market would be subject to export produce satisfying the rigid plant protection laws, and the availability of direct transport. Since this presents no problem for grapefruit exports, the prospects for other produce would appear favourable also.

\1 See Annex 1, Volume II for details.

Domestic supply projections for fresh produce forecast 38,000 MT by 1994, when the Komati Irrigation Project's first IDU is scheduled to commence its first year of vegetable harvest.\1 Actual supply in 1982, however, was less than half IFAD had forecast for that year. Corrected projections from the 1982 data base indicate a shortfall of 13,000 MT on original estimates. Calculations by Ronco Consulting Corporation in 1983\2 pointed to a projected shortfall of 9,400 MT by 1990, requiring 670 ha additional irrigated land, equating to 926 ha by 1994 which conforms closely with the 1,100 ha of vegetables proposed by this project at full development (three IDUs). In the absence of alternative irrigated land, the Project would be well placed to make good the projected national shortfall.

The recent establishment of the National Agricultural Marketing Board (NAMB)\3 is a major step towards producing a steady market for smallholders on Swazi Nation Land. Appropriately staffed and equipped, it will be an indispensable channel for the distribution of produce from the project are to national markets. Moreover, the construction of the proposed new wholesale market at Mahlanya will provide ready access to the main markets of Matsapha and Mbabane.

Cabbage is selected for its important role in the national diet, its profitability in Swaziland between January and July, and for its competitive advantage in the RSA market between August and September. Tomatoes, too, are able to trade in the domestic and RSA markets according to comparative price advantage and use. The proximity of the tomato canning plant at Malelane provides an outlet for up to 3,000 MT of the Roma variety when RSA supplies cease during October and November. During this period, the Durban fresh produce market is undersupplied from RSA sources, and up to 1,000 MT is regularly sought by itinerant trucking companies.

Potatoes have been Swaziland's principle vegetable export for many years. In 1982, 2,000 MT, 64 percent of the potato production, was exported to RSA. During the period 1975 to 1981, RSA production consistently failed to satisfy RSA market requirements. It is estimated that RSA processors would have no difficulty absorbing 2,000 MT potatoes annually.

Exports of fresh vegetables to Europe, the Middle East and Japan are not economic as these countries are fairly well supplied across the years. Nor do market prices cover the cost the freight from Swaziland to those markets.

\1 IFAD, Smallholder Credit, ...

\2 M. Cassar, An Assessment of the Market for Swazi Nation Land Farmers (Washington, D.C.: Ronco Consulting, June 1983).

\3 Government of Swaziland (Bill No. 5 of 1985); see Annex 10 to this Volume.

The RDAP is designed to increase rainfed maize production on SNL. USAID is concentrating on research and extension, and IFAD is expected to fund a credit/marketing project within the structure of the newly established National Agricultural Marketing Board. Notwithstanding these actual and proposed programmes, it is estimated that maize imports of at least 50,000 MT annually will continue for several years.\1 Each project IDU provides for an average of 200 ha under irrigated maize cultivation throughout the life of the project with an annual output of 700 MT valued farmgate at E215,000 p.a.: Three IDUs would triple those values.\2

The crops selected for the first IDU were limited to those for which a ready demand has been identified. Opportunities are known to already exist, however, or to be developing rapidly, for many other fruits and vegetables including green beans, lychees, passion fruit (granadilla), guavas, macadamia nuts, green nuts, groundnuts, oil seeds and pineapple. These items will be cultivated in the project nursery to test their suitability for cultivation in the project area and later to test market potential in the domestic and export markets. Subsequent IDUs could then grow them.

3. Packaging and transport

a. Packaging for export

Swaziland has its own paper pulp industry, and cardboard cartons for two-color printing. Four and five kilogram fruit boxes at E0.50 per unit are 18 percent below Kenya prices. Competitors' prices from RSA should also be sought, however, in view of economies of scale through over-run of similar containers. Vegetable boxes of 3 kg and 5 kg are E0.25 and E0.45 respectively, which are competitive prices.

b. Export by air cargo

Jan Smuts Airport, Johannesburg, is the main air cargo port for South Africa with regular daily flights to the markets of Western Europe. As a member of the SACU,\3 Swaziland has access to this facility. Swazi produce is shipped there by road, a distance of some 450 km taking seven hours, using South African Transport Service (SATS) vehicles which also handle similar produce from Nelspruit and the RSA lowveld. Costs are E8.03 per kg by SATS, and E7.08 by fruit growers; small loads are E10.00 per kg.

\1 See discussion in Volume I, Chapter III; and Volume II, Chapter II.A.

\2 It is appreciated that the maize situation is rather more complicated than purely a production issue, e.g. comparative producer prices relative to those in RSA. The lowveld is particularly short of maize relative to its needs. See FAO, The Maize Industry of Swaziland (Rome: FAO, 1984).

\3 Southern African Customs Union, see details in Annex 3.

The commodity rate, as of July 1985, from Jan Smuts Airport to principal Western Europe air terminals is R0.99 (April-September) and R1.05 (October-November) per kg. Air cargo to the Gulf States is R6.05 per kg at straight freight costs. Commodity rates are not known but are normally around 25 percent = estimated R1.50 (at 40 percent straight rate = R2.42). Air cargo to Tokyo is R10.35 per kg at straight rates, and could be expected to be a minimum R2.58 and a maximum R4.14 per kg. Direct flights are not scheduled, however, and would not provide a basis for on-going exports to these markets.

Air charter services do not operate out of Johannesburg. Air Gambia operates a direct cargo service to Stockholm (Sweden) from Harare (Zimbabwe) at US$2 per kg. Air Gambia also have flights from Harare to Gulf States. Trade Winds, a leading British air cargo operator, quoted E1.04 per kg in 1984 for direct cargo flights from Matsapha Airport using the extended runway to take Boeing 707s on a twice weekly service to Europe (lifting 25 tonnes horticultural produce per aircraft). A decision has yet to be taken on this matter.

Until recently, export market wholesale prices, during the Northern Hemisphere off-season period, were high enough to absorb air cargo costs from RSA to Europe. With sea freight costs being around 88% less than air cargo, however, the prospect of increasing competition implies that products dependent upon air freight may need to make greater use of alternative carriers to compete effectively. Avocados, for example, are currently traded in Western Europe wholesale markets at $1.6 per kg. Continuing pressure could erode margins to a point where profitability will depend on containerized shipments by sea transport. By contrast, the greater margins resulting from sea transport will ensure that the Komati project area product is able to defend its position, at least with respect to prices. To this end, it is recommended that Komati exporters should collaborate closely with RSA exporters to secure the most economic rates from the shipping conference lines.

c. Export by sea

Fruit and vegetable exporters consider Cape Town more suitable, economic and faster than Durban and Maputo for perishable cargo destined for Europe. Fruit cargos are sent by road transport from Swaziland direct to Cape Town at E0.16 cents per kg. For large consignments, cool box containers are used as an alternative to normal containers. Cool boxes are fitted with a portable electric cooling unit which circulates cool air continuously through an elevated floor. Boxes (6m x 2.5 m x 2.5 m) are transferred to container vessels and connected to the ships' cooling system. Containerized transport would be essential for the Komati project area.

The composition of costs between farmgate and arrival at export destination are complex and vary according to each type of produce. The figures quoted have been obtained from farmers, fruit exporters in RSA, and shipping agents and may be taken as a reliable calculation base as of July 1985.\1

\1 These farmgate/FOB differentials are used in a final section of this report (Chapter IX) to assess marketing margins.

Sea freight costs from Cape Town - Europe, including port handling, documentation, wharfage, insurance and freight to European ports:

- o Mangoes E0.13 per kg;
- o Avocados E0.12 per kg; and
- o Papaya E0.12 per kg.

4. Domestic and export sales, and sales margin

a. Background

The market sales/margins analysis build upwards and outwards from the project farmgate values used in the project's financial and economic analysis. The end result in this marketing analysis is to provide, among other things, a much more precise estimate of possible project foreign exchange earnings. The analysis proceeded to delineate market percentage shares for each crop--domestic, RSA, and external. These of course varied for each crop and, in some cases, between smallholder and nucleus estate. Market prices (E, R, $) were then multiplied by these shares to calculate revenues or net sales (NS) and thence gross margins (GM) by subtracting farmgate values. Those amounts are destined to cover all marketing costs in-project. GM values are then expressed as percentages of NS values.

b. Selected findings

The field crops have the lowest GM/NS ratios, generally negative in the case of smallholders since a 30% output share has been assumed to be consumed on-farm, and their prices are almost farmgate and sometimes fixed (maize, cotton). Exported tree crops, however, usually have very high ratios, ranging from a low of 33% for citrus (shipped by sea) up to 90%-93% for avocado (shipped by sea)--ratios are slightly lower if the produce is shipped by air, since transport costs per tonne are higher.

A further set of assumptions was made to delineate foreign exchange earnings. For smallholders, it was assumed that 70% of the tree crops marketed in the Northern Hemisphere were sent by sea, and 30% by air. It was then assumed that 1/3 (33.3%) was lost due to spoilage, waste, etc. That dropped the $ figure to $7.5 million. The equivalent for the nucleus estate on one IDU was $23.7 million, a total of some $31.2 million annually at full development. The base project of 3,000 ha would naturally triple that figure in due course (nearing PY 28-30).

C. Recommendations

There are several recommendations:

1. Assuming the Komati Irrigation Project goes forward, it is not too early to start planning an appropriately sited citrus canning and juice processing factory. Such a factory could rely on other producers as well, e.g. SIS. A pre-feasibility study of such a plant would, most importantly, identify markets, market prices, and product selection.

2. For the evaluation and proper development of papaya, mango and avocado--production, handling, marketing--an on-going process must be institutionalized by which RSA activity may be monitored and acted upon as appropriate. There is no need, nor time for that matter, for Swaziland to re-invent the wheel.

3. For papaya and mango in particular, there will be the need for access to controlled atmosphere sea-freights (a la Brazil) since these products have highly reasonable market margins only under sea shipping conditions.

4. Also in the tranport field, work must begin on the matter of developing technologies for air shipping full air-freight loads (24 tonnes in a 747) of mixed products and crops, e.g. fresh and canned fruit and juices.

5. Probable domestic vegetable shortages: the differing sets of projections into the late 1990's suggest that there could be meaningful shortfalls of vegetables supplied to domestic markets. The IFAD project is designed to help allay this problem by assisting small irrigation farmers on SNL, and elsewhere. Nonetheless, there could be a shortfall sufficient to encourage planners to consider putting relatively greater shares of Komati Irrigation Project land to such cropping, certainly on a 4th or a 5th IDU.

Such advice is tendered subject to the need to examine the economics of such a cropping/land use/water use alternative with circumspection--the values "lost" by not planting tree crops could be very considerable.

6. The list of commodities is long for which Swaziland has considerable tariff advantages under the Lome Convention and the Generalised System of Preferences. These include, especially, and looking at the Komati Irrigation project, tree crop exports to the EEC under the former, and tree crop exports to Japan, Canada and the U.S.A. under the latter. It is not too early to begin inquiries as to the more precise manner in which Swaziland can maximize these opportunities.

7. The basic general recommendation must be to begin work with all deliberate speed on the institutional structure required for the marketing process in this Komati Irrigation project. Annex 2 to Volume II contains numerous recommendations as to initial staffing, training, and relationships to the new NAMB. The Terms of Reference for the next (design stage) study (Annex 3, Volume I) recommend strongly that an equivalent study to this Volume III be conducted when the full feasibility study is underway. It should begin 12-15 months before that final analysis is completed so as to provide the required financial inputs.

8. Meanwhile, the marketing section of the MOAC could commence these other activities. Included must be the establishment and deepening of the data base needed for proper project feasibility analysis and marketing operations. It would be most unsound to attempt a feasibility analysis of the Komati Irrigation project without an improvement in the grossly inadequate information base with which this pre-feasibility marketing analysis worked.

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I. INTRODUCTION AND BACKGROUND

A. Introduction

The Government of Swaziland's policy is to adjust the emphasis away from capital intensive industries to give greater emphasis to the improvement and expansion of smallholder agricultural production. This accords with World Bank recommendations that the effective implementation of such a policy would broaden the country's base, encourage new exports and reduce the heavy productive dependence on food imports.\1 To realize these goals, the Bank also recommended that high priority should be given to revitalizing the agricultural research programme so as to address important smallholder issues, which should include the development of crops suitable for more effective and cheaper processing.\2

These objectives could be attained by the development of agriculture in three areas:

- Irrigation from the Usutu River; its basin consists of 18,000 irrigable ha on the low, middle and high velds. The region includes the greater part of Swaziland's population as well as the two principal cities and markets--Mbabane and Manzini;

- The Rural Development Areas (RDAs) comprise about 50 percent of Swazi Nation Land (SNL) and produce mostly dryland crops. Currently, there are 40,000 ha under irrigation, of which 91 percent is on Individual Tenure Lands (ITL). The Rural Development Area Programme was devised to enhance such cropping, though it has not been remarkably successful; and

- The Komati River Basin, located in the northern lowveld and comprising 5,000 ha scheduled for irrigated agriculture following the proposed construction of a dam at Maguga on the Komati River. The implications and benefits of this projected scheme are the subject of this study.

B. Purpose and Scope

The market study investigates the potential for selected crops generic to Swaziland and suitable for commercial cultivation on a smallholder and nuclear estate basis in the Komati Basin lowveld. Particular attention is given to identifying export markets capable of generating incremental foreign exchange earnings, apart from domestic and cross-border opportunities in Swaziland and the Republic of South Africa (RSA) respectively.

\1 IBRD, Economic Review (of Swaziland), 1984 (Washington, D.C.: The World Bank, 1984).

\2 IBRD, Swaziland: Agricultural Sector Study (Washington, D.C.: The world Bank, 1983).

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The scope of the study was limited to the six-week period June 1st to July 14th 1985. Meetings were held with Ministries, government agencies, statutory bodies, processing plants and exporters in the private sector. Field work was carried out on the project site. Personal visits were made to transport operators, cargo handlers, commodity exporters and research organizations in the RSA, at Johannesburg, Pretoria and Nelspruit. Finally, discussions were held in Geneva (Switzerland) with the Market News Service, International Trade Centre UNCTAD-GATT.

Foreign trade statistics relating to Swaziland and selected external markets were either not available or out-of-date. Moreover, in the case of the fruits and vegetables identified for project development, imports/exports, even on a global basis, are not considered statistically significant to be individually classified in official foreign trade statistics. Nevertheless, they are important to the study and, together with authoritative information from in-market traders, provide orders of magnitude and valuable market indicators.

Studies have recently been carried out on behalf of the Government of Swaziland covering the selection of Swaziland fruits and vegetables for domestic and export markets. In order to avoid unnecessary duplication, certain information has been omitted from this report which is already set out in the following documents:

- Reconnaissance Study, Usutu and Ngwavuma River Basin (London: Tate & Lyle Technical Services Ltd, November 1982);
- Swaziland Smallholder Credit and Marketing Project (Rome: IFAD, September 1982);
- The Potential for Establishing an Air-freighted Horticultural Export Industry in Swaziland. (Geneva: International Trade Center, July 1984); and
- A Preliminary Study for Possible Agricultural Aid Projects for Swaziland (Draft report to USAID) (Johannesburg: East African Technical Services. April, 1985).

C. Swaziland's Balance of Trade and the Need for Increased Exports

Swaziland's domestic market is limited to about 640,000 persons, with modest average disposable income. The area of the Komati River Basin, by comparison, is only a fraction of the country in both geographic and socio-economic terms. Consequently, any development programme within the project area can affect, or be affected by, trends and events at the national level. This is especially true in regard to foreign trade.

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With so small a domestic market, establishing a viable and continuing export trade; and, second, searching for economic local alternatives, are both crucial to future agricultural development. The deteriorating situation is evident in the accelerating growth of the annual foreign trade deficit (Table III-1) which rose by 50 percent between 1981 and 1983.\1

Moreover, the contribution by agriculture to total exports dropped from 56 percent in 1980 to 48 percent in 1982, due to, a priori, reduction of 16 percent in the value of sugar exports. More than half of the agricultural contribution to GDP was attributable to estate agriculture on individual ITL and 26 percent derived from agro-industries. Smallholder production on the SNL stood at 21 percent GDP.

The continuing increase in exports of citrus and canned fruits underlines the growing importance of fruit and processed fruits and juices, the exports of which have more than doubled during the past four years (Table III-2). With the addition of cotton products, 30 percent of export earnings are currently derived from non-sugar products, compared to 14 percent in 1980. Furthermore, with the possible exception of citrus, all fruits and vegetables listed are being, or can be grown by smallholders.

Given a reasonable level of assistance and supervision in cultivating suitable new varieties, and backed by an adequate marketing support structure, traditional smallholders could make a significant contribution to augmenting Swaziland's foreign exchange revenues, reducing the foreign trade deficit and achieving food self-sufficiency.

The national trend thus identified has an important bearing on the selection of crops for export and the formulation of appropriate cropping patterns in the Komati River Basin project.

D. Crop Selection and Recommendations

1. Criteria

Crops are selected for cultivation to the extent that they satisfy at least two criteria:

- Pre-harvest: Agronomic, climatic, soil and associated factors (covered in Volume II); and
- Marketing criteria which include: Export and domestic market potential; profitability to the grower; and impact on the country's foreign exchange reserves through incremental export earnings and/or import substitution.

\1 Further discussion of deficits in Volume I, Chapter III.A, and Volume II, Chapter II.A.

SWAZILAND: ECONOMIC STUDY OF POSSIBLE USES OF ADDITIONAL WATER ON THE KOMATI RIVER, SWAZILAND

Table III-1: Visible Balance of Trade, 1980-1983 (000s E)

Item	1980	1981	1982	1983
Imports	468,513	519,711	562,845	609,046
Domestic Exports	279,157	318,152	331,929	323,689
Re-Exports	7,656	22,128	19,865	15,206
Visible Balance	181,700	179,431	211,051	270,151

Source: Central Statistical Office (CSO).

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SWAZILAND: ECONOMIC STUDY OF POSSIBLE USES OF ADDITIONAL WATER ON THE KOMATI RIVER, SWAZILAND

Table III-2: Value of Agricultural Exports 1979 - 1983 (000s E)

Commodity	1979	1980	1981	1982	1983
Foodstuffs and Tobacco					
Live animals	285.1	379.6	1,200.2	485.8	391.4
Meat and meat products	8,029.6	7,060.7	3,733.0	5,276.0	4,263.8
Butter and butterfat	1.7	0.6	0.2	-	-
Paddy rice	73.5	35.0	-	-	-
Other cereals, peas and beans	-	-	-	-	-
Citrus fruit	9,436.8	7,646.0	9,156.4	15,625.0	14,900.8
Other fruits	5.2	-	-	-	-
Canned fruit and juices	9,193.9	9,364.5	12,652.4	17,979.3	22,455.0
Sugar	70,992.0	128,445.5	125,799.0	109,157.1	122,802.1
Honey	-	-	-	-	-
Molasses	2,225.7	3,666.4	4,372.7	4,406.6	3,780.9
Other farm produce	216.2	640.9	668.1	6,335.1	3,650.6
Chocolate and sweets	-	-	-	-	-
Tobacco unmanufactured	236.7	333.2	248.1	103.4	83.1
Beer and spirits	305.9	199.8	231.0	48.3	-
Raw Materials					
Hides and skins	732.1	306.3	404.9	485.4	497.8
Blood. bone and carcass meal, horns, hooves and tallow	293.1	189.0	87.9	72.7	54.2
Wood and wood-products	10,803.4	13,050.3	15,943.0	11,403.0	11,435.0
Unbleached wood-pulp	28,153.6	36,850.8	46,360.0	46,518.4	44,800.0
Wool and mohair	-	-	-	-	-
Seed cotton	1,675.2	-	3,417.7	4,011.9	4,011.9
Cotton lint	5,955.2	5,462.4	12,176.8	4,121.3	4,121.3
Cotton seed	743.8	507.1	1,326.0	237.9	237.9
Minerals					
Chrysolite asbestos	17,557.7	15,590.0	17,771.3	14,374.8	19,548.5
Iron ore	5,265.0	1,892.3	-	-	-
Coal	2,791.7	2,689.3	3,080.0	2,948.4	2,006.1
Other minerals	8.7	-	-	95.9	105.6
Chemicals					
Insecticides	-	-	-	-	-
Other chemicals	9,976.0	23,670.0	36,577.1	55,237.4	42,723.7
Manufactures					
Misc. Engineering products	154.0	145.9	239.1	759.4	7,774.4
Clothing and textiles	523.7	1,653.4	3,062.6	495.5	2,084.3
Handicraft	87.6	76.8	23.1	5.1	3.8
Other manufactures	10,880.2	19,301.0	23,029.3	31,745.9	11,956.5
TOTAL, of which to	196,593.8	279,156.8	318,151.5	331,929.4	323,688.7
South Africa	45,432.6	82,697.8	108,389.4	122,527.6	104,937.3
United Kingdom\a	52,259.5	56,294.3	49,674.8	25,554.0	71,591.0
Other Countries	98,901.7	140,164.7	160,087.3	183,847.8	147,160.4

\a Total exports to United Kingdom exclude canned fruit, as the data are not available. They are included with Other Countries.

Source: CSO

2. Recommended crops

The following crops are judged to satisfy the above criteria and therefore recommended for production in the Komati Basin project area:

- Maize;
- Cotton;
- Cabbage;
- Tomatoes;
- Potatoes;
- Citrus;
- Papaya;
- Mangoes; and
- Avocados.

E. Proposed Export Markets

1. Introduction

Export markets will be primarily those located in the Northern Hemisphere where the off-season for fruits and vegetables coincides with Swaziland's peak harvesting season. "Off-season" products are defined as those which cannot generally be grown during the winter and are therefore imported from abroad. Actual off-season months vary with the specific produce but for the purpose of this report the period covers October to April.

The following markets are identified as offering good opportunities for Komati Project products:

2. Western Europe

There is increasing EEC production and intra-EEC trade in avocados, oranges, green peppers, mandarins and clementines, bananas, grapefruit and melons following the admission of Greece into the community. This will be further extended after 1986 when Spain and Portugal join the EEC. It is not yet known whether current tariff concessions to EMENA-7 will be reduced as a result. It is certain that the increased competition and promotional activity to secure a major share of the market for these products will also have the effect of expanding year round demand.

However, EEC, EMENA and ACP (Africa, Caribbean and Pacific) countries located in the Northern Hemisphere are unable to satisfy demand during the period October through May, thus providing specific opportunities to suppliers from the Southern Hemisphere which, in the absence of EEC reference price systems during that season, provides minimum tariff access to EEC markets. The situation favours Brazil and South Africa, Swaziland and Kenya.

As a signatory to the Lome Convention, Swaziland has duty-free or preferential access to the markets of the ten member states (Annex 1). Preferential access is also offered to Swaziland by non-EEC countries through the Generalized System of Preferences (GSP) (Annex 2).

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3. Middle East and Gulf States

Generally, there is no or little acknowledged trade between Middle East countries and the RSA for political reasons. During the Mediterranean and European off-season, therefore, fruit and vegetable importers in the Middle East look to the Southern Hemisphere for sources of supply, and especially to Southern Africa, including Swaziland, and South America. Already Swaziland citrus fruits have established a strong presence in the Gulf States, which provides a ready-made base on which to introduce a further range of off-season fruits and vegetables.

4. Japan

There could be unexpected opportunities for marketing highly priced tropical fruits in Japan provides that Swaziland produce satisfy Japan's sanitary requirements for imports of fresh produce. Japan's schedule of non-importable items classifies most countries in South East Asia and the Indian subcontinent as "prohibited districts." Southern Africa countries are not so classified. Of particular significance has been the exclusion of the Philippines for papaya, with the result that approximately 92 percent of all pawpaw imports into Japan are supplied by Hawaii. On the basis of current costings (1985), Swaziland could compete effectively in this market (valued at US $6.3 million [3,267 t]) and could supply mangoes from October to February.

5. Republic of South Africa

As a member state of the South African Customs Union (SACU), Swaziland has duty-free or preferential access to the markets of member states with free movement of goods and common transport rates within the area, and common access to ports (Annex 3). There is a potentially large market for Swaziland products subject to market acceptance in terms of quality, price and delivery.

II. CITRUS (APRIL TO SEPTEMBER)

A. Production: General

Citrus is grown in the lowveld by six commercial growers. They normally produce about 65,000 t annually from 650,000 trees on 2,500 ha. Grapefruit and oranges account for 93 percent of total production. The remaining 7 percent is exotic varieties of soft, easy to peel fruits. An additional 250 ha of grapefruit and oranges, was planted in 1983. Smallholder citrus growing is minimal, and only for household or local consumption. The citrus harvesting season, April to September, comprises two distinct phases: grapefruit, April to June, and oranges, June to September.

Production remained fairly steady between 1976 and 1981, but 1982/83 exports fell due to shipments of unacceptable small fruits to overseas markets. The problem was compounded in the following year (1983/84) by production losses due to cyclone damage (Table III-3). Because of these "abnormal" factors affecting the pattern of citrus production and distribution, a schedule of "citrus production under normal conditions" has been prepared by the Swaziland Citrus Board (Table III-4) which is the basis of reference for this analysis.\1

1. Grapefruit (April to July)

Annual production of 33,000 t represents 51 percent of Swaziland citrus production and, significantly, about 40 percent of total grapefruit production in Southern Africa. Exports of 23,720 tonnes represent 72 percent, of which South Africa takes 3 percent. There are three principal varieties.

- Marsh White (April to July) is the most important variety and accounts for 26,000 t (78 percent total grapefruit). Smaller white fruits are particularly accepted in Western Europe, especially the juicy varieties. As a rule, the more fruits to the carton (15 kg) the better the export prospects; and

- Rose (May to June) and Star Ruby (June) are red flesh varieties and especially popular in France. Production of 7,000 t represents 12 percent of all grapefruit.

2. Oranges (June to September)

Annual production of 27,000 t is 37 percent of the country's total citrus crop. Exports of 18,000 t represent some 50 percent of production, and comprise five varieties:

- Valencia (July to September). This is the most important variety and accounts for 23,800 t (87 percent of orange production); and

- Tomango, Protea, Shamouti and Clanors (May to June). These four varieties provide a further 3,000 t annually.

\1 A discussion of the impact of the dry years--1981 to 1983--on citrus production can be found at Volume I, Chapter V.

Table III-3: Estimated Swaziland Citrus Production, 1975/76 - 1984/85

Year	Quantity (t)	Total Value (E)	Average Price (E/t) \a	% Change in Quantity	% Change in Average Price
1974/75	53,344	5,730	107		
1975/76	74,358	5,356	72	+39.4	-32.7
1976/77	64,903	5,341	82	-12.7	+13.9
1977/78	61,894	8,703	141	-4.6	+72.0
1978/79	62,450	9,717	156	+0.9	+10.6
1979/80	57,442	9,158	159	-8.0	+1.9
1980/81	66,011	9,832	149	+14.9	-6.3
1981/82	58,492	8,760	150	-11.4	+0.6
1982/83	53,435	10,634	199	-8.6	+32.7
1983/84	48,087	9,185	191	-10.0	-4.1
1984/85\b	42,968	16,384	271	-10.6	+41.9

\a Producer prices.

\b Estimated on basis of current foreign exchange rates.

Source: Swaziland Citrus Board.

Table III-4: Swaziland Citrus Production\a under Normal Conditions
(tonnes)

Type and Variety	Harvesting Season	Total Production	Market Distribution: Fresh Export	Fresh Local	Processed	Non-Marketable
Grapefruit						
Marsh White	April/July	26,000	18,500	1,500	6,000	-
Rose	May/June	5,900	4,500	1,200	-	200
Star Ruby	June	1,000	720	250	-	30
TOTAL		32,900	23,720	2,950	6,000	230
Oranges						
Valencia	July/Sept	23,800	15,700	2,100	6,000	-
Tomangos	May	2,500	1,400	100	1,000	-
Shamouti	June	730	680	25	25	-
Protea	May	260	210	25	25	-
Clanors	June	27,290	17,990	2,250	7,050	-
TOTAL						
Soft Citrus (exotics)						
Tambor	July	3,000	2,700	300	-	-
Minneola	June	1,410	1,200	210	-	-
Clementine	April	55	5	50	-	-
Ellendale	July	39	26	13	-	-
TOTAL		4,504	3,931	573	-	-
TOTAL CITRUS		64,694	4,561	5,77	13,050	230

\a The 6 producers are Ngonini Estates and Tambuti Estate (United Plantation Group), Inyoni Yami Swaziland Irrigation Scheme (Commonwealth Development Corporation), Tambankulu Estates, Crookes Plantations, and S.D. Citrus Estates.

Source: Swaziland Citrus Board, 1985.

3. Soft citrus (April to July)

This category includes the easy-to-peel varieties characterized by a soft, thin skin similar to the tangerines. Export traders consider this the fastest growing citrus sector. Principal varieties are Tambour and Minneola which, together with Shamouti, are well suited to lowveld production. All three have been included in the Swaziland Irrigation Scheme (SIS) new plantings. Present production is 4,500 t.

- Tambour (July) is distinguished by its reddish-orange colour, which gives the fruits good promotional and display impact at the point-of-sale in export supermarkets. The red juice is not acceptable to the canning industry, however. Tambour annual production is around 3000 t of which 90 percent is exported.

- Minneola (June) has a highly-rated flavour and the appearance of a large tangerine. It is sometimes too large for overseas markets but is much in demand in South Africa, regardless of size. It has the bottleneck problem of maturing very rapidly coupled with a one-month harvesting season (June) necessitating post-harvest storage at 2o--3o C in order to bridge the three/four month selling season. The SIS has evaluated several varieties for adaptation to Swaziland lowveld conditions. Meantime transport tests are being carried out to determine impact of long road hauls on product and packaging. Tambuti Estate has already shipped out 70,000 cartons (1,000 t) in Dufalyte packing (3-layer polyurethane honeycomb).

B. Production: Komati River Basin Project Area

Based on varieties satisfying the agronomic requirements of lowveld production, and export marketing criteria, indications point to grapefruit (Marsh White, Rose and Star Ruby) and orange/exotics (Shamouti, Tambour and Minneola) as appropriate crops for the irrigation project--see D. below for project details.

C. Market Opportunities and Access

1. Introduction

Prior to 1983 Swaziland's principal citrus export markets were the Middle East (38 percent), Western Europe (38 percent) and Japan (12 percent), with oranges going to the Gulf States and grapefruits destined for Europe and Japan (Table III-5). Due to the 1983 increases in rail costs for the long haul from Swaziland to Cape Town, exports of grapefruit were priced out of the Japanese market. Neither Maputo nor Durban have adequate cold storage capacity to hold the required tonnage for the six-week period of cold sterilization required by the Japanese authorities. All grapefruit exports were immediately switched to EEC countries. However, exports to Japan were resumed in May 1985, following the fall in the foreign exchange rate of the Emalangeni/Rand.

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Table III-5: Citrus Exports by Country of Destination, 1981-1983

	1981		1982		1983	
	Quantity (t)	Value (000s E)	Quantity (t)	Value (000s E)	Quantity (t)	Value (000s E)
Citrus Fruit	48,219	9,156.4	51,748	15,625.0	47,318	14,900.8
of which						
United Kingdom	18,476	3,871.3	-	-	-	-
Europe, Other	-	-	15,949	7,160.4	26,838	8,225.1
Middle East	21,069	4,267.3	19,191	7,540.8	16,627	5,857.3
Japan	5,573	860.2	5,735	1,794.6	-	-
South Africa	3,101	137.6	9,640	652.2	3,853	818.4
Rest of World	-	-	1,223	477.0	-	-

Source: CSO, Annual Statistical Bulletin, 1982 and 1983.

2. Western Europe

As a signatory to the Lome Convention Swaziland enjoys duty free access into EEC markets for grapefruit, and a tariff of only 5 percent on oranges. Moreover, Swaziland citrus is exported to Europe during the off-season for the Mediterranean crop. The market is virtually static, however, with Brazil representing the principal competition. The product mix is changing, as already mentioned, with growing emphasis on red-flesh grapefruits and easy-to-peel orange varieties.

3. Middle East

In 1978 citrus accounted for 64 percent of all fruit imports into the Middle East\1. Principal importers are Saudi Arabia, Kuwait, the United Arab Emirates and Bahrain, all of whom have been historically supplied by neighbouring Turkey, Jordan and Lebanon. During the Mediterranean off-season importers look to the Southern hemisphere where Swaziland is an established major supplier of oranges under the brand name "Golden Land." In a market which is steadily expanding, Swaziland's share (20 percent in 1976) has diminished, although export volume has been steady. This implies a problem of supply rather than promotion or acceptability and contributes to the justification of the inclusion of citrus in the Komati River Project.

4. Japan

Excellent opportunities exist for exports of grapefruit during the Northern hemisphere off-season. But Japan's strict plant protection laws are rigorously applied. Currently, Swaziland citrus exports destined for Japan must be subjected to six-weeks cold sterilization at port of shipment. The Japanese Fruit Importers Association (NISSEKYO) continues to urge government to modify the law on the grounds that it is not strictly applied to the USA. It is believed, however, that behind the legislation is the citrus lobby, fearful of competition at any time. With the impending prohibition of fumigation by EDB (ethio-di-bromide) and world pressure on Japan to remove protectionist policies, there is a possibility that the existing sanitary regulations will have been revised by the mid-1990s.

5. Distribution, processing and packaging

The Swaziland Citrus Board is the sole marketing agency for citrus exports, which in turn are marketed by the South African Cooperative Citrus Exchange through its network of panelists in overseas markets. This body defines the marketing policy and handles the physical distribution, promotion and sale of citrus in South Africa and overseas under the "OUTSPAN" or "Golden Land" labels depending on market requirements\2. Discussions with the Exchange have established that they will provide all technical assistance and services required in the setting up of a citrus component in the Komati river project, including guidance on varieties to be grown on a commercial basis.

\1 B. Lacroix and I. Mathews, Swaziland--The Potential for Agro-Industrial Development (Washington, D.C.: The World Bank, 1981).

\2 "Golden Land" labels allocated to Swaziland and Mozambique.

Non-export grade citrus is sold on the local market or to Swaziland Fruit Canners (Pty) Limited, Malkerns. The opening up of the Komati river area to subtropical fruit production by irrigation will make a stron case for the establishment of a canning and juice processing factory. Fo example the Malkerns canning factory took 88 percent of non-export citrus (21,450 t) in 1981, thus taking up the slack period following pineapple processing.

Citrus pieces are packed in corrugated board cartons, 15 kg for palletsisation and/or containerization. Grapefruits are packed in 8.6 kg packets units and oranges in 10 kg packets/units when destined for the RSA market and Swaziland. DUFAWYTE cartons consisting of three-layer polyurethane honeycomb packing are in use with Minneola variety citrus.

D. Marketing Contribution--Citrus

Citrus is classified as an export crop in the range of the fruits selected but all revenues are received in RSA Rands, due to the fact that Swaziland is a supplier of citrus into the South African marketing system in the first instance. Komati project orchards will commence flowering in project Year 7. Annual yields and revenues, combined estate and smallholder, are shown in Table III-6.

Based on a current average market price of approximately R.406 per t, the incremental gross margin/net return ratio is 33 percent. Citrus sales are predicted to contribute 7 percent to project annual revenues from all sources in Year 10 and thereafter. Three IDU's at full development would triple these figures. Full margin analyses are at Chapter IX below.

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Table III-6: Projected Citrus Production and Export Values on the Komati Project, First IDU

Project Year	Tonnes	Rand (1985 base)
7	1,813	461,825
8	2,125	862,750
9	4,687	532,875
10 et seq.	5,000	2,030,000

Source: Devres Staff Estimates, August, 1985.

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III. PAPAYA\1 (JANUARY TO DECEMBER)

A. Introduction

This fruit has been largely ignored by consumers and exporters alike until very recent years, with one notable exception--Japan. The underlying reason is that importers, being handling agents rather than producers, are not interested in investing in the promotion of new products where there is no guarantee of immediate profit. Moreover, since importers compete amongst themselves, joint promotion is out of the question. Similarly, an individual producer country will only promote a fruit if it has a good chance of dominating the market. This has been the case with avocados which were marketed into Western Europe by Israel guaranteeing constant size, colour, flavour and price for a product which was irregular in shape, unripe in appearance, bland in texture, neutral in flavour and virtually unknown. Mangoes too were unknown until heavy immigration into Western Europe from the Caribbean and the Asian subcontinent during the past thirty years created a demand which has broadened its base and increased heavily as the result of promotion.

Papaya is the melon-like fruit of the melon tree Carica papaya which grows extensively in tropical and subtropical countries. For the most part, fruit weighs between 1 kg and 6 kg and grows to 700 mm in length. For table purposes the normal size is around 1 kg and 200 mm length. Sizing has been a fundamental export problem which is now being resolved with the introduction of new small varieties of around 550 grams and one which forms the basic argument of this section of the report.

B. Production

Estimated world production of papaya (Table III-7) remained static between 1981 and 1983 at around 1.95 million t, with Brazil (23 percent), Indonesia (15 percent), India (13 percent) and Mexico (13 percent) accounting for 64 percent of total production by eighteen countries. Brazil jumped from 9 percent of world production to 23 percent in 1981 retaining No. 1 producer status since then. It may not be coincidental that this spectacular increase of 321,000 t occurred at a time when Brazil's exports of papaya began to penetrate overseas markets backed by substantial promotional support in subsequent years.

Although Swaziland is well suited to the cultivation of papaya, existing planting is done mostly by smallholders for home consumption. There are no large commercial growers and supplies reaching the market place are from small growers. In the absence of reliable data in Swaziland, the RSA experience should be monitored carefully since papaya is mainly cultivated in the Eastern and northeastern Transvaal lowveld and at the agricultural research station at Nelspruit, where conditions replicate those of the Komati project.

\1 Papaya is known as "Pawpaw" in southern Africa. The term "Papaya" is used in this report as it conforms to official nomenclature and common usage in export markets.

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Table III-7: Estimated World Production of Papaya

Country	1974/76	1981 ('000 t)	1982	1983	% Change From 1974/76-1983	% of Total\a 1974/76	1983
Brazil	129	450	460	460	+357	8.9	23.2
Indonesia	220	312	300	310	+ 41	15.3	15.6
India	257	270	270	270	+ 5	17.8	13.6
Mexico	220	226	201	230	+ 5	15.3	11.6
Zaire	165	156	156	156	- 6	11.4	7.9
Philippines	64	104	105	110	+ 72	4.4	5.5
China	36	75	70	75	+208	2.5	3.8
Peru	64	47	48	49	- 23	3.4	2.5
Mozambique	35	38	38	40	+ 14	2.4	2.0
Cuba	27	32	35	38	+ 41	1.9	1.9
Venezuela	32	33	33	34	+ 6	2.2	1.7
U.S.A.	19	43	38	33	+ 74	1.3	1.7
Columbia	43	27	30	31	- 28	3.0	1.6
R.S.A.\b	20	25	25	25	+ 25	1.4	1.3
Ecuador	20	24	24	25	- 14	2.0	1.3
Bangladesh	19	25	25	25	+ 32	1.3	1.3
Other	63	70	72	71	+ 13	4.4	3.6
TOTAL	1,442	1,956	1,928	1,982	+ 37	100.0	100.0

\a May not add up due to rounding.

\b R.S.A.= Republic of South Africa.

Source: East African Technical Services, A Preliminary Study of Possible Agricultural Aid Projects for Swaziland (Mbabane: April 1984).

At present, only two RSA commercial producers of small export quality papayas are known to have begun operating. Both are located in the Transvaal lowveld and combined exports in 1984 amounted to around 200 t out of a production level of 2,000 t. Marketing experience with pioneering production of papino (similar to the solo variety) is not readily divulged, beyond the fact that the loss of winter leaf cover resulted in sun blemishes and that prices obtained in the EEC were higher than fruit from Brazil's. The fact that the highest prices in the RSA produce markets in 1984 were R 620/per t compared to lowest Brazilian wholesaler prices in the EEC at equivalent R 3,400 suggests that, after allowing for freight and intermediate costs, other undisclosed factors would need to be accounted for. Moreover, since papaya exports from the RSA represent no more than 1 percent of all papaya marketed, and since the RSA is still in the early stages of export market development additional experience is necessary to ensure marketability by the time the Komati project becomes operational.

C. Komati River Basin Project Area

Papaya is recommended for estate cultivation on the pre-condition that the quality standard specifications will be as follows:

- Variety: Hawaii solo;
- Configuration: Full round pear/bell shape;
- Colour: Warm yellow bell tapering to green (minimum 30 percent yellow in skin colour);
- Maturity: 60 percent (maximum 70 percent) at shipment date allows 10 days transit and shelf life;
- Weight: 560 grams normal;
- Brix: 9-10. Strong smell/taste not acceptable;
- Fiber: Minimum fiber content; and
- Measurement: Length 11cm, Width 9cm.

Papaya has been chosen because it is potentially viable in its fresh and processed form. Major market related reasons are:

- The fruit, and its products, probably have high coefficients of income elasticity in export markets, thus favouring sale in high income sectors with rising incomes;
- Papaya is not seasonal, thus year round operations are possible;

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- The fruit is versatile. The small Solo variety is firm-ripe and better suited to shipment and market handling than the normal large varieties;

- Export market sales in Western Europe and Japan are known to be expanding following substantial promotion and exports by Brazil and Hawaii respectively; and

- Up to the present time transport has been limited to air-freight. As of September 1984 Brazil has been shipping large consignments by fast sea-freight (controlled atmosphere) to the leading German importers, Scipio Fruchtvertrieb KG in Bremen, for distribution direct to central buyers and supermarkets. Prospects for Swaziland and the RSA should be excellent when similar shipping facilities are available.

D. Market Opportunities and Access

1. Introduction

In contrast to Brazil, the RSA, although possessing some of the most efficient produce marketing bodies in the world (viz., citrus, deciduous fruits, groundnuts, etc.), has produced no more than about 25,000 t annually of papaya in the past ten years and has yet to penetrate her traditional overseas markets where steady growth is now foreseeable.

2. Western Europe

Although quantities imported did exceed 1,250 t by 1982 and were well below that up to 1983, current information provided by the International Trade Centre, Geneva, is that the market has expanded considerably since 1984. That is the year Brazil switched from air-freight to fast regular shipments by sea in atmosphere controlled vessels, a method hitherto not considered feasible for papaya.

The principal markets in 1982 (Table III-8) were the United Kingdom (38 per-cent), West Germany (20 percent) and France (18 percent), with an average market price ECU of $2,145/t. Notable increases are recorded during the seven-month period November 1984--May 1985 when wholesale market prices for Brazil papaya (lows) were $1,800/t and (highs) $2,640/t, or approximately E 3,600 and E 5,280 respectively.\1

Scandanavian markets are important to Swaziland given their reluctance to trade with the RSA. Sweden particularly could provide a good market for air-freighted papaya trucked to Harare and then by direct SAS flight to Stockholm, or air charter for larger loads. Lowest wholesale prices in 1984/85 were $2,500/t (E 5,000/t). Other markets currently importing from Brazil are Switzerland, Austria and Norway.

\1 Marketing Advisory Service, ITC-UNCTAD/GATT, Geneva.

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Table III-8: Quantity\a and Value of Papaya Imports into the EEC 1980 - 1983

Importing Country	1980 QTY (t)	1980 PRICE/t (ECU)	1981 QTY (t)	1981 PRICE/t (ECU)	1982 QTY (t)	1982 PRICE/t (ECU)
West Germany	105	1,486	103	2,068	250	2,080
France	175	2,280	216	1,907	235	2,328
Italy	48	2,500	57	2,158	126	2,325
Netherlands	64	1,703	65	1,923	96	1,927
Belgium/Luxembourg	39	1,821	41	1,732	67	1,388
United Kingdom	218	1,716	300	2,117	474	2,192
Denmark	1	2,000	1	1,000	1	2,000
TOTAL	650	1,894	783	2,018	1,249	2,145
Country of Origin						
Brazil	436	1,780	621	2,147	1,203	2,180
U.S.A.	107	1,925	-	-	-	-
Ivory Coast	68	2,676	-	-	-	-
Other	39	1,718	162	1,525	46	1,239
TOTAL	650	1,894	783	2,018	1,249	2,145

\a Excludes re-exports within EEC

Source: EUROSTAT - Analytical Tables.

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3. Middle East

Papaya is not a listed item in market data but the rapid growth in imports of other subtropical fruits suggests that importers of air-freighted produce are keen to supply a wide range of products to this market. An important factor is the existence of a sizeable Asian population of 750,000 in the Gulf region. Bahrain is the entrepot centre of the Gulf and the main market for expensive high-quality air-freighted food products. The possibility of exporting full air-freight loads (24 t) of mixed products (fresh and canned fruits and juices) should be studied.

4. Japan

Japan is entirely dependent upon imported papaya. As shown in Table III-10, Hawaii is the dominant supplier accounting for around 95 percent of total 1981 imports of 3,267 t. This represented an increase of 300 percent in six years. There is general agreement in the trade that the market should grow annually by 10 percent, and that a fall in prices would result in significant growth\1. In 1973 retail prices were US $3 per piece ($5 per kg) in supermarkets and US $7 ($13 per kg) in specialty fruit outlets.\2

The market has been opened up and developed during the past fifteen years exclusively by Hawaii as the only supplier (Annexes 6, 7, and 8), and by Del Monte, Blue Seal and Diamond Head in particular. Not suprisingly the Hawaii Solo variety is the standard with which all other varieties must conform. Therefore, the export potential for the Komati project area will be in the development and marketing of varieties that satisfy Japanese consumer requirements such as Hawaiian Solo.

Shipments are traditionally by aircargo. Brazil's recent dominance in Western Europe, however, is based on fast sea shipments of Hawaii Solo variety papaya which, due to small size and other favorable characteristics, make it a viable product for controlled atmosphere vessels. Consignments could be consolidated with Swaziland citrus between May and October.

5. Packaging specifications (Annexes 7-8)

On the assumption that the Komati project adopts the Hawaiian Solo variety, 560 g per piece, standard packaging specifications should be as follows:

- Measurements: 6" x 10" x 13"--four flap enclosure;
- Contents: Weight 4.5 kg. Average No. pieces: 8;
- Vertical reinforcement: By cornerposts if required;

\1 Japan, Japan Fresh Fruit and Vegetable Imports--Managerial Association (NISSEIKYO).

\2 I. Matthews, Export Market for Papaya and Mango to Japan, 1983.

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Table III-9: Projected Papaya Production and Export Value on the Komati Project, First IDU

Project Year	Tonnes	$ Value\a (000s)	$ (1985 base)
5	825	1,000	700
6	1,962	2,289	1,602
7	3,125	3,598	2,519
8	3,437	3,866	2,709
9	3,750	4,134	2,894
Total IDU No. 1	18,049	20,093	14,065

\a Conservative estimate based on air-freight costs. Add 28 percent to obtain approximate $ earnings by sea. Personal Communication, K. Morimoto, President, Karin Trading Co. Ltd., Tokyo, 1985. Wastage 30 percent assumed.

Source: Devres Staff Estimates, August, 1985.

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Table III-10: Mango Imports into Selected West European Countries, 1975-1984 (Actual and Estimated)\a
(tonnes)

Country	1975	% of Total	1976	1977	1978	1979	1980 \b	1981 \b	1982 \b	1983 \b	1984 \b	% of Total\c
United Kingdom	1347	46.1	1211	1162	1893	2768	3044	3349	3729	4102	4512	38
France	607	20.8	733	913	1387	1859	2268	2388	2781	2906	3196	26
Netherlands	539	18.4	673	831	1569	1534	1660	1324	1597	1960	2156	18
Germany Fed.Rep	231	7.9	213	294	678	947	968	742	746	1136	1250	11
Belgium	86	2.9	94	215	309	322	354	389	428	471	518	4
Switzerland	71	2.4	70	107	173	237	260	287	315	347	382	2
Sweden	27	0.9	27	50	38	44	48	53	58	64	70	1
Denmark	14	0.5	na\c	34	14	13	14	16	17	19	21	
TOTAL	2922		3021	3606	6061	7724	8616	8548	9671	11005	11645	100

\a Above statistics include imports of guavas and mango steens (usually 1-2 of total) with the exception of the Federal Republic of Germany, which relates only to mangos.

\b 1980-1984 estimates for countries 1 and 5-8; assume similar growth trend to countries 2, 3, and 4 where 1980-1983 figures are obtained from national statistics namely 10% p.a. 1984 estimates and + 10% 1983.

\c na = Not available.

Source: ITC, UNCTAD/GATT.

- Ventilation holes: Not essential for papayas;

- Printed: Top and sides brand name and graphics (2 colours).
  Printed both ends: Ripeness 75/50/25/MG.
  Count 8/9/10/11/12/13; and

- Protection: Paper shredding, poly-foam (as for fragile products) or newspaper.

E. Marketing Contribution--Papaya

The fruit has the advantage of a short germination period and can be harvested almost continuously throughout the year. First production on the first IDU is scheduled for project year 5, with projected annual yields and foreign exchange earnings, estate and smallholders combined, as shown in Table III-9.

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V. AVOCADO (MARCH TO SEPTEMBER)

A. Introduction

Estimated world production of avocados is 1.55 million t but only a small percentage is traded internationally. In common with mangoes, avocados grow in tropical and subtropical regions the world over. The major market is Western Europe and the principal supplier is Israel followed by California, South Africa and Martinique. Minor suppliers include Kenya, Swaziland, Cameroon and Ivory Coast.\1 Northern Hemisphere countries, led by Israel, supply the market between November and March (winter). Southern Hemisphere countries supply between March and September. Swaziland has an important seasonal advantage, with main competition from South Africa and Mexico, and to a lesser extent from Israel's extended season. California, Australia and New Zealand are also active especially in the Japanese market.

B. Production

Although Swaziland is well suited to avocado production, smallholders grow for family consumption or local sale and only little reaches the market place in Manzini and Mbabane. Only one producer, a TDL farmer in Nhlangano is known to be exporting avocado on a commercial basis. Exports were reported to be 64 t in 1983 with plans for 200 t in 1986.

The RSA is a major commercial [illegible]r, producing 15,000 t in 1984, of which 8,500 t were exported and 6,500 t sold on the local market (Table III-15). Conse-quently, the RSA's experience in export marketing merits careful examination when planning any marketing strategy for the Komati River Basin project area. Between 1975 and 1983 RSA avocado production increased 63 percent, and export values increased by over 700 percent to R10.4 million f.o.b. A 16 percent fall in exports in 1984 was entirely due to the effects of the drought and the lack of supplementary irrigation water.

The total number of producing avocado trees in the RSA, both commercial and domestic, stood at 963,594 in 1981, with an estimated potential yield of 24,000 t in 1984. Output is predicted to double by 1990 and reach 55,000 t by 1994 (Table III-16). The most popular varieties in export markets are Fuerte and Hass which combine to extend the total export season. Plantings are geared to maxi-mize the off-season advantage in order to evenly balance production of Fuerte/ Hass which at present are in the ratio of 8:1. The ratio is forecast to change to 2:1 by 1990 and to be even by 1994.

C. Komati River Basin Project Area

Western Europe is the largest and fastest growing export market in the world and it is fortunate that the bulk of shipping and aircargo services from ports nearest to the Komati project region are to European ports. Markets are predicted to more than double by 1990 with Israel alone accounting for 100,000 t. The main thrust will clearly come from producers in the Northern Hemisphere with the result that corresponding increases in demand from off-

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\1 ITC, UNCTAD/GATT.

Table III-15: RSA: Avocado--Annual Production, 1975-1984
(tonnes)

Year	Production	Local Market	Export Market
1975	13,547	8,747	4,800
1976	14,761	8,641	6,120
1977	14,324	7,888	6,436
1978	15,350	8,070	7,280
1979	16,425	7,149	9,276
1980	18,259	6,627	11,632
1981	16,974	7,586	9,388
1982	21,333	10,209	11,124
1983	21,957	11,781	10,176
1984	14,900	6,400	8,500

Source: SAAGA.

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Table III-16: Avocados: Varietal Plantings and Projected Yields, 1983-1984

	Tree Plantings				Estimated Production		
	1973		1981				
	No.	%	No.	%	1983	1989 (T)	1994
Fuerte	336,206	71.0	702,557	73	15,973	25,183	19,642
Hass	50,668	10.7	79,661	8	1,797	11,902	20,987
Edranol	13,259	2.8	116,173	12	2,332	7,609	8,018
Other	73,397	15.5	61,007	7	898\a	4,721\a	6,360\a
TOTAL	473,530	100.0	963,594	100.0	21,000	49,415	55,007

\a Related only to the plantings of Ryan estimated to be 42,963 trees in 1981 which represents 70% of "other" trees planted in 1981.

Source: RSA, Avocado Tree Census 1981, SAAGA.

season suppliers will have to be met, inter alia, from the RSA and Swaziland with Mexico as a probable contestant. The prospects are especially important for the Komati project area because producers could have an important seasonal advantage with harvesting commencing one month ahead of the RSA.

Swaziland produce would have an important competitive edge over the RSA and Mexico under the Lome Convention's duty-free access to EEC markets when compared to the 15 percent tariff applicable to the RSA and Mexico. Similar benefits will accrue on exports to Switzerland, Scandinavia and Austria under the General System of Preferences (GSP) (Annex 2). Finally, at least for the foreseable future, the current currency exchange rates remain favourable to RSA and Swaziland exporters.

Avocados are recommended for estate and smallholder cultivation with the prerequisite that selected varieties be tested for acceptance in the Western European market. First indications are that Fuerte, Hass and Edranol are the most likely candidates. Particular care will be needed to ensure through controlled irrigation techniques, that the trees are free from Phytophtera which results in poor root development from critical changes in water supply. It is estimated that 80 percent of avocado trees in the RSA are affected by this problem.

D. Market Opportunities and Access

Consumption of avocados in the Northern Hemisphere has increased rapidly during the past ten years and is still growing.

1. Western Europe

Imports of avocados into Western Europe in 1983 totalled 69,645 t. By far the largest importer is France, accounting for 51,000 t representing 73 percent of all imports. The U.K. is second, with 11,000 t and accounting for 15 percent of total imports. Of the remaining 8,000 t, the German Federal Republic takes one-half. France is the fastest growing market having more than doubled avocado imports since 1980. The U.K.'s imports have increased by 61 percent (see Table III-17 for these data in detail).

During the European winter France and the U.K. import approximately 86 percent of their avocado requirements from Israel. On the other hand, between May and September, the RSA supplies 85 percent of imports into France and 89 percent of imports into the U.K. Wholesale prices in France and the U.K. during May 1985 were around $1.60/kg or US $1,600 per t. Assuming equivalent prices in 1985, the RSA's combined exports of 10,000 t to France and the U.K. would be valued at US $16 million.

Table III-17: Avocado Imports by Selected West European Countries, 1975-1983
(tonnes)

Country	1975	1976	1977	1978	1979	1980	1981	1982	1983
United Kingdom	4,331	3,441	4,222	4,937	6,633	6,535	10,674	9,310	10,709
Germany Fed. Rep.	1,297	1,241	1,749	2,230	2,421	1,612	1,880	2,470	3,956
Netherlands	511	586	905	818	944	1,277	1,737	1,485	2,044
Belgium	501	555	805	850	940	969	1,307	1,205	1,437
France	14,704	15,853	19,773	23,970	28,932	24,030	30,202	40,141	50,790
Switzerland	570	520	770	865	1,010	NA\a	NA	NA	NA
Sweden	628	560	767	714	921	NA	NA	NA	NA
Denmark	221	NA	407	417	606	481	698	794	709
Norway	54	NA	69	60	68	NA	NA	NA	NA
Austria	NA	NA	NA	136	283	NA	NA	NA	NA
TOTAL	22,817	24,732	34,874	34,997	42,758	34,904	46,498	55,405	69,645

\a NA = Not Available

Source: ITC, UNCTAD/GATT.

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Monthly imports into France (1983) are set out in Table III-18. In the absence of similar data for the U.K., annual exports have been weighted on the French base. The data indicate average monthly imports of around 2,400 t to France and 600 t to the U.K. totalling 3,000 t monthly during May-September, compared to an average of 5,600 t monthly in the European high season. The imbalance between the two seasons points to a factor of undersupply rather than falling demand. Avocados are consumed cold and in salads. Therefore, more are appropriate for consumption in the European summer season. Consequently, any anxieties about the import of extended seasons by Israel and Spain should be considered in the context of reducing shortfall. In short, the prospects in Western Europe for avocados from the Komati project must be considered to be very good.

2. The Middle East and Gulf States

Typically the population mix of the Gulf States appreciates sweet, juicy fruits; this is reflected in all published data on fruit and vegetable consumption in the region.\1 Test consignments were shipped from Kenya in 1982 but were discontinued due to lack of consumer response. As in the case of Western Europe, the market may respond only to sustained promotion, which may be beyond Swaziland's ability to support.

3. Japan

Information provided by KT Co. Tokyo, in June 1985, confirms that there is a fast-growing market for avocados in Japan. California supplies between April and November. New Zealand also supplies small quantities of the Hass variety. As in the case of papaya, very high prices are paid.

Clearly, there is an opportunity for Swaziland to take advantage of avocado shipments with a view to consolidating them with grapefruit consignments.

4. Packaging specifications

Although there are no statutory quality standards, the RSA has established stringent market requirements:

- Variety: Fuerte, Hass, Edranol, Ettinger;
- Configuration: Pearshape (Fuerte is standard);
- Colour: Bright green or dark purple warty skin. Fruit must be free from disease, bruising and blemishes;
- Maturity: 70 percent at shipment date and slightly unripe on arrival;

\1 Particular reference is made to FAO, Major Markets, op cit.

Table III-18: France - Avocado Imports by Country of Origin, 1983
(tonnes)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	TOTAL
Israel	5,798	5,410	6,134	2,909	2,037	-	-	-	-	1,215	4,556	7,048	35,107
R.S.A.	4	-	28	841	1,177	1,658	734	681	335	7	-	-	5,465
Spain	443	278	236	163	58	52	-	-	237	1,059	373	878	3,777
U.S.A.	5	-	15	319	365	818	451	207	94	258	5	7	2,544
Martinique	-	-	-	-	-	-	8	1,167	877	185	-	-	2,237
Mexico	22	16	5	-	-	-	-	-	36	45	267	124	515
Kenya	1	3	14	114	49	123	28	31	13	4	-	-	380
Ivory Coast	-	-	-	28	55	133	75	54	13	-	-	-	358
Cameroon U.R.	-	7	11	22	29	50	7	-	-	-	-	-	126
Morocco	20	16	15	3	-	-	-	-	-	22	4	24	104
Brazil	1	-	4	3	5	3	3	-	13	8	-	-	40
Other	4	-	4	8	2	47	4	40	19	9	-	-	137
TOTAL	6,298	5,730	6,466	4,410	3,777	2,884	1,310	2,180	1,637	2,812	5,205	8,081	50,970

Source: Statistiques de Commerce Exterieur de la France.

- Weight: 270 g to 330 g;
- Texture: Large or loose stones not acceptable; and,
- Packing: Weight 4 kg per carton; counts 14, 16 and 18 pieces, accurately size graded. Fruits must be individually wrapped in tissue paper or polythene and packed in single layer fiberboard cartons with adequate ventilation holes to prevent heating.

E. Marketing Contribution--Avocado

Avocado exports are predicted to account for 46 percent of foreign exchange earnings by Project Year 10 (40 percent, if by aircargo). The principal market open to Swaziland during the Northern Hemisphere off-season would be Western Europe and, subject to transport availability, Japan. First production is scheduled for Year 7 due to germination lead time. Projected annual yields and foreign exchange earnings, estate and smallholders combined, are shown in Table III-19. Three IDU's would triple those figures.

Table III-19: Projected Avocado Production and Export Value on the Komati Project, First IDU

Project Year	Tonnes	$ Value	$(1985 base)\a
7	1,320	1,755	1,229
8	3,140	2,595	1,816
9	5,000	4,065	2,846
10	5,500	4,368	3,058
11 et. seq.	1,500	908	636

\a After wastage of 30 percent.

Source: Devres Staff Estimates, August, 1985.

VI. COTTON

A. Introduction

As a successful crop in Swaziland, cotton is included in the Komati River basin project for both estate and smallholder cultivation. Cotton growing is mostly labour intensive, but its various sub-products form the basis of other industries with additional employment potential, import substitution or foreign exchange earning capability.

B. Production

Currently, Swaziland's total cotton output is sold directly or indirectly to South Africa through the South African Cotton Board. In 1983/84, total sales of 17,900 t amounted to E11.5 million, consisting of 9,308 t seed cotton and 6,265 lint. There are approximately 4,000 smallholders, mostly in the lowveld, producing cotton on 1-2 ha, who account for 60 percent of Swaziland's total cotton production. The remainder is produced by 30 large plantations of up to 550 ha, and 350 intermediate-sized farms with from 30 to 40 hectares.\1

The principal variety is the short staple Albacala. Seed cotton production doubled between 1975 and 1980. Since then, drought conditions have resulted in inferior quality and reduced quantities. Between 1980/81 and 1983/84, total production fell by 62 percent from 24,883 to an estimated 9,300 t (Table III-20). As a result of these adverse conditions, only one ginnery is still in operation, Swaziland Cotton Ltd, with a capacity of 20,000 of seed cotton annually. The other ginnery, Swaziland Oil Seeds Ltd, has been closed down. Adding to cash flow problems, apparently, has been a series of credit over-extensions to farmers.

C. Marketing Opportunities and Access

Cotton produced in the Komati project could be marketed through the existing channels, namely, Swaziland Cotton Ltd. Lint and seed could be sold to South African interests through the South African Cotton Marketing Scheme on the basis of an agreement between local and South African ginners and spinners regarding crop take-in, lint and seed-cotton allocations, quality standards, and pricing policy. Producer prices in 1985 are in line with the RSA, between E0.82 and E0.86/kg according to grade. The Cotton Industry Commission in the RSA is responsible for the regulation of marketing for establishing minimum and maximum prices for the coming season. The tendency is for harvesting levels to follow the rise or fall in price, even though price is not announced prior to planting.

Cotton growers in the Komati project area, in line with the country in general, would benefit from Swaziland's membership of the ACP group of countries, through the STABEX agreement of the Lome Convention which compensates for loss of crop failure in respect of uncombed cotton and seed cotton. Swaziland received E3 million in 1983 and E7 million in 1984. To date, 1985 cotton production is well below the quota mark and no STABEX pay-out is expected.

\1 Swaziland Cotton Board.

Table III-20: Swaziland Seed Cotton Production, 1975 - 1983
(tonnes)

Year	ITF	SNL	Total
1975/76	6,145	6,013	12,158
1976/77	7,255	7,400	14,655
1977/78	10,414	11,866	22,280
1978/79	6,529	9,505	16,097
1979/80	9,255	13,981	23,236
1981/82	5,810	8,445	14,255
1982/83	4,107	5,020	9,127
1983/84\a	4,000	5,300	9,300

\a Estimates

Source: Swaziland Cotton Board, July 1985.

The Swaziland Cotton Board is satisfied with the technical and marketing assistance provided by the South African Cotton Board in guaranteeing prices and market access. Over-production in the past has been accommodated without difficulty, and should a situation arise in the future, a ready market would be assured, since the land which can be allocated to cotton production in the RSA is limited. Even if the cotton production in the RSA and Swaziland should amount to 400,000 bales by the year 2000, together with a further 50,000 bales imported specialty cotton, the South African Cotton Board estimates that there would still be a shortfall of 86,000 bales.

D. Processing Opportunities

It will be advantageous for Swaziland to set up a cotton spinning mill in the long run. In 1978, GOPA, a West German firm of consultants carried out a Study for NIDCS, the findings of which suggest that a prerequisite would be a cotton production level of around 40,000 t annually.

E. Marketing Contribution--Cotton

Sales of cotton crop represent a local currency contribution to project justification commencing in Project Year 2. Projected annual yields and Emalangeni earnings are as at Table III-21 at an assumed price of E820/tonne. Three IDU's would produce triple those values.

Table III-21: Projected Cotton Production and Export Value on the Komati Project, First IDU

Project Year	Tonnes	Value (E'000)
2	150	123
3	337	276
4	537	440
5	350	287
6	350	287
7	350	287
8	350	287
9	350	287
10 et seq.	350	287

Source: Devres Staff Estimates, August, 1985.

VII. VEGETABLES

A. Introduction

From published data on production and consumption, it is evident that cabbages, tomatoes and potatoes are Swaziland's most important in terms of local, central market and export sales. These three vegetables account for an estimated 78 percent of the total vegetable area under cultivation in the country and 88 percent of total sales.\1

B. Production

1. The impact of the export ban

Swaziland imposed a ban on imports of all South African fresh fruits and vegetables in October 1980 because of an outbreak of cholera in the Eastern Transvaal. The status of the ban is at present obscure because it applies to imports of produce where there is no record of cholera. Moreover, although it is still in force, restrictions no longer apply to the imports of fresh produce which are not available in Swaziland, i.e., grapes, apricots, etc. Due to the relatively free flow of traffic across the border, there seems to be little to prevent the movement of produce, especially apples, from the RSA to the Mbabane and Manzini markets.

The ban on vegetables resulted in a 44 percent increase in 1981 prices at the trader level and a 71 percent increase at retail level. Cabbages, tomatoes and onion prices had retail markups of over 100 percent. In fact, retail margins increased from 66 percent in 1980 to 110 percent in 1981; wholesale margins fell from 57 percent to 36 percent.

Between 1981 and 1982, fruit and vegetable prices increased by 16.4 percent, followed by a further 26.3 percent rise in April 1983.\2 Between 1982-1983, producer prices for potatoes, tomatoes and cabbages remained steady at E266, E450 and E170/t, respectively--see Tables III-22, III-23, and III-24. Price evolutions for 1984 are shown in tables in subsequent sections dealing specifically with potatoes, tomatoes and cabbages.

2. Production and consumption projections

The data base for production estimates is poor and few accurate statistics are available. The calculation base for the projected demand shown in Table III-25 at 1994, is that used by IFAD (op cit), and assumes a population growth of 3 percent annually, and estimated demand increasing by 5 percent per annum. Projections assume that relative production volumes would remain constant, and that future demand would be met by increased local production, with the Komati River Basin project making partial or incremental contributions

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\1 Cassam, An Assessment of the Market.

\2 Market Advisory Unit, MOAC.

Table III-22: Cabbages: Average Prices in Mbabane and Manzini Markets, 1982-1984 (E cents)
(All prices in Emalengeni)

		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Producer Price	1982	0.13	0.14	0.14	0.15	0.17	0.19	0.19	0.18	0.16	0.17	0.14	0.16
	1983	0.18	0.15	0.21	0.15	0.16	0.16	0.15	0.20	0.14	0.20	0.19	0.16
	1984	0.18	0.15	0.23	0.19	0.13	0.15	0.14	-	0.10	0.08	0.08	0.04
Trader Price	1982	0.15	0.16	0.23	0.21	0.21	0.25	0.25	0.24	0.21	0.19	0.21	0.21
	1983	0.22	0.23	0.24	0.21	0.22	0.23	0.21	0.21	0.21	0.24	0.21	0.23
	1984	0.26	0.25	0.24	0.27	0.25	0.21	0.15	0.13	0.20	0.16	0.14	0.11
Retail Price	1982	0.48	0.47	0.52	0.55	0.59	0.53	0.45	0.52	0.53	0.48	0.52	0.59
	1983	0.50	0.51	0.50	0.49	0.53	0.46	0.43	0.52	0.44	0.58	0.59	0.34
	1984	0.52	0.44	0.49	0.38	0.38	0.30	0.23	0.24	0.56	0.44	0.43	0.44
Trader Margin	1982	0.02	0.02	0.09	0.06	0.04	0.06	0.06	0.06	0.05	0.02	0.07	0.05
	1983	0.04	0.08	0.03	0.06	0.06	0.07	0.06	0.01	0.07	0.04	0.02	0.07
	1984	0.08	0.10	0.01	0.08	0.12	0.06	0.01	0.13	0.10	0.08	0.06	0.07
Retail Margin	1982	0.33	0.31	0.29	0.34	0.38	0.28	0.20	0.28	0.31	0.29	0.31	0.38
	1983	0.28	0.28	0.26	0.23	0.31	0.23	0.22	0.31	0.23	0.34	0.38	0.11
	1984	0.26	0.19	0.25	0.13	0.13	0.09	0.08	0.11	0.36	0.28	0.29	0.33

Average Prices:

	1982	1983	1984
Producer	0.16	0.17	0.13
Trader	0.21	0.22	0.20
Retail	0.52	0.49	0.40

Average Margins:

	1982	1983	1984
Trader	0.05 (31%)	0.05 (29%)	0.07 (53%)
Retail	0.31 (147%)	0.27 (122%)	0.20 (100%)

Source: Market Advisory Unit, MOAC.

Table III-23: Tomatoes: Average Prices in Mbabane and Manzini Markets, 1982-1984
(E)

		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Producer Price	1982	0.62	0.65	0.50	0.53	0.59	0.59	0.45	0.36	0.26	0.29	0.41	0.50
	1983	0.50	0.53	0.58	0.51	0.52	0.49	0.50	0.37	0.33	0.35	0.37	0.39
	1984	0.71	0.48	0.45	0.45	0.27	0.31	0.31	0.29	0.44	0.57	0.61	0.36
Trader Price	1982	0.67	0.71	0.72	0.66	0.66	0.66	0.61	0.37	0.37	0.39	0.54	0.68
	1983	0.71	0.70	0.75	0.71	0.71	0.69	0.64	0.53	0.41	0.44	0.53	0.66
	1984	0.72	0.67	0.69	0.68	0.63	0.58	0.57	0.56	0.68	0.64	0.64	0.34
Retail Price	1982	0.94	0.91	1.02	1.00	0.97	0.97	0.95	0.74	0.63	0.64	0.68	0.66
	1983	0.97	0.98	1.01	0.96	1.01	0.86	0.78	0.74	0.70	0.90	0.82	0.81
	1984	0.98	1.04	1.20	0.98	0.87	0.65	0.76	0.73	1.11	1.19	1.18	1.18
Trader Margin	1982	0.05	0.06	0.22	0.13	0.07	0.07	0.16	0.01	0.11	0.10	0.13	0.18
	1983	0.21	0.17	0.17	0.20	0.19	0.20	0.14	0.16	0.08	0.09	0.16	0.27
	1984	0.04	0.19	0.24	0.23	0.36	0.27	0.28	0.27	0.19	0.07	0.03	0.83
Retail Margin	1982	0.27	0.20	0.30	0.34	0.31	0.31	0.34	0.37	0.26	0.25	0.14	-0.02
	1983	0.26	0.28	0.26	0.25	0.30	0.17	0.14	0.21	0.29	0.46	0.29	0.15
	1984	0.23	0.37	0.51	0.30	0.24	0.07	0.17	0.17	0.48	0.55	0.54	0.74

Average Prices:

	1982	1983	1984
Producer	0.48	0.45	0.44
Trader	0.59	0.62	0.62
Retail	0.84	0.88	0.99

Average Margins:

	1982	1983	1984
Trader	0.11 (23%)	0.17 (38%)	0.18 (41%)
Retail	0.26 (42%)	0.26 (42%)	0.38 (60%)

Source: Marketing Department, MOAC.

Table III-24: Potatoes: Average Prices in Mbabane and Manzini Markets, 1982-1984 (E)

		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Producer Price	1982	0.28	0.24	0.23	0.25	0.31	0.35	0.34	0.33	0.28	0.29	0.29	0.3
	1983	0.34	0.36	0.34	0.37	0.38	0.40	0.46	0.38	0.35	0.35	0.34	0.3
	1984	0.43	0.23	0.28	0.24	0.23	0.21	0.24	0.25	0.22	0.25	0.25	0.2
Trader Price	1982	0.32	0.25	0.29	0.36	0.35	0.41	0.38	0.39	0.35	0.34	0.36	0.4
	1983	0.45	0.39	0.42	0.47	0.44	0.55	0.57	0.50	0.44	0.42	0.43	0.4
	1984	0.42	0.37	0.35	0.33	0.33	0.33	0.33	0.32	0.43	0.37	0.37	0.3
Retail Price	1982	0.55	0.68	0.69	0.74	0.66	0.72	0.65	0.57	0.52	0.51	0.64	0.6
	1983	0.66	0.53	0.52	0.49	0.51	0.66	0.71	0.71	0.70	0.76	0.78	0.7
	1984	1.49	0.86	0.62	0.65	0.72	0.58	0.74	0.77	0.92	0.78	0.80	0.
Trader Margin	1982	0.04	0.01	0.06	0.11	0.04	0.06	0.04	0.06	0.07	0.05	0.07	0.1
	1983	0.11	0.03	0.08	0.10	0.06	0.15	0.11	0.12	0.09	0.07	0.09	0.1
	1984	0.01	0.14	0.07	0.09	0.10	0.12	0.09	0.08	0.21	0.12	0.12	0.1
Retail Margin	1982	0.23	0.43	0.40	0.38	0.31	0.31	0.27	0.18	0.17	0.17	0.28	0.2
	1983	0.21	0.14	0.10	0.02	0.07	0.31	0.27	0.18	0.17	0.17	0.28	0.2
	1984	1.07	0.49	0.27	0.32	0.39	0.25	0.41	0.45	0.49	0.41	0.43	0.3

Average Prices:

	1982	1983	1984
Producer	0.29	0.37	0.26
Trader	0.35	0.46	0.36
Retail	0.64	0.65	0.81

Average Margins:

	1982	1983	1984
Trader	0.06 (20%)	0.09 (24%)	0.10 (38%)
Retail	0.28 (91%)	0.19 (41%)	0.44 (125%)

Source: Market Advisory Unit, MOAC.

Table III-25: Swaziland: Vegetables - Projected Demand at 1994 on 1°30 Base
(tonnes)

	1980	1981	1982	1982 ACTUAL	1983	1984	1985	1994
Cabbage	4096	4272	4486	4000	4200	4410	4630	7182
Tomatoes	5802	6092	6397	6500	6825	7166	7524	11672
Potatoes	4974	5223	5484	3580	3759	3947	4144	6429
TOTAL Vegetables	14845	15587	16367	14080	14784	15523	16298	25283\a
Population	550,000	566,000	582,000	582,000	598,000	615,000	632,000	825,000

\a Note: IFAD projection on 1980 base: 1985, 24,821 t.
1994 (extension) 38,505 t.

Sources: 1980-1982. IFAD "Integrated Smallholders Credit and Marketing Project," 1980.
1982. Ministry of Agriculture and Cooperatives.
1983-1985. Calculation base IFAD as at 1980-1982.
1994. Projection from above calculation base.

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from Project Year 2 onwards. Thus, projected achievement of 25,000 t by the time the Komati IDU No 1 is in production would still represent a shortfall of 13,000 t on the IFAD projected requirement.

From a different calculation base, the Ronco Consulting Corporation Report (1983) estimated a shortfall of 9,400 t in 1990, requiring 670 ha of incremental irrigated vegetable land which would be equivalent to 926 ha for the 13,000 t implied in this report. This corresponds with an actual area planned for vegetable cultivation in the Komati Project first IDU, namely 1,000 hectares.

The recent establishment of the National Agricultural Marketing Board (see Annex 9) is a major step forward, as it will be empowered and equipped to base Swaziland's horticultural product marketing operations on sound commercial principles. Indeed, the Board should make an invaluable and vital contribution to increasing the volume of vegetables produced and reducing the extremely high prices that are current in the Central Area (Mbabane and Manzini). To meet the consumer demand identified in the original objectives, in fact the Komati Irrigation project may need to revise its vegetable export estimates until such time as the National Agricultural Marketing Board is able to increase the area under irrigation and utilize the production resources of the smallholder farmers.

In view of the substantially increased potential demand, both domestic and cross-border (RSA and Mozambique), the level of vegetable cultivation proposed for the Komati project area is believed to be realistic.

Table III-26 summarizes the market outlets in 1978, which are taken as indicating the present and future situation. Key pointers are that 37 percent of all vegetables produced were consumed in the local region (4,434 t), 34 percent were exported to the RSA (4,043 t) and 29 percent were sold in the Central Area (3,471 t), the latter comprising the two markets of Mbabane and Manzini, and located in the most densely populated area in the country.

C. The Komati River Basin Project Area

The distance from the project area near Bordergate to the Manzini and Mbabane markets is approximately 110 km and 140 km respectively. Consequently, the impact of transportation costs and delivery times becomes a significant factor when marketing produce competitively, especially with growers in the Malkerns region. Moreover, with the improved marketing and distribution facilities vested in the proposed NAMB, smallholders nearer to the markets, but at present without adequate transport facilities, will eventually provide substantial additional vegetable supplies.

Consequently, vegetables have been selected which are known to have potential outlets in Swaziland and across the border in the markets of Johannesburg and Durban, notably cabbage, tomatoes and potatoes. Maize is

Table III-26: Market Outlets for Selected Vegetables
(tonnes)

Produce	Local Sales	Central Area	Exports	Totals	%
Potatoes	490	473	1,971	2,898	24.3
Cabbage	1,467	1,473	456	3,396	28.4
Tomatoes	1,724	1,344	1,199	4,267	35.7
Green Maize	753	217	417	1,387	11.6
TOTAL	4,434	3,471	4,043	11,948	100.0
Percentage	37	29	34	100	--

Source: IFAD, 1980.

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accorded a very high priority as being basic to the national diet and essential to the achievement of national food self-sufficiency.\1

1. Cabbage

Cabbages are in general oversupply between August and December when winter cabbages are available, with average producer prices at E7.5/kg and wholesale prices at E14/kg. During these months, average wholesale prices in Johannesburg (1984), however, were R35/kg which, even allowing for transport costs, provides a profitable alternative outlet. Conversely, during January to July, the central market in Swaziland is undersupplied and average producer prices rise to E16/kg, peaking at E23/kg, (Table III-22) whilet the RSA prices are lower (Table III-27). Consequently, growers in the Komati project area should be able to trade in both markets throughout the year. Table III-26 suggests a breakdown of markets for cabbage of 43 percent local Komati sales, 43 percent Central Area market and 14 percent for the RSA.

2. Tomatoes

a. Production

Tomatoes are the most profitable of vegetable crops with ready markets when harvesting, collecting and packing are systematically coordinated. The two main categories are the medium-sized salad variety and the smaller, round "Roma." The latter are cultivated primarily for processing. Lowveld climatic conditions in the project area are especially suitable for winter production from July to November.

b. Market access and opportunities

There is a market window in the RSA during October and November when farmers in the Transvaal and Natal clear the land for summer cotton. During this period the cannery at Malelane, Transvaal (only 60 km from the Komati project area), is in need of 3,000 t of Roma variety tomatoes due to the halt in Transvaal supplies. Roma tomatoes are at present shipped across the border in trucks by the Entonjieni Cooperative Union. The cannery's proximity would be a unique advantage to the Komati project growers in terms of both price and delivery.

In addition to the 3,000 t required by the cannery, there is a market for at least another 1,000 t during this period in the Durban fresh market. This 4,000 t was equal to 62 percent of Swaziland's tomato crop in 1982. In fact, 1982 cross-border exports amounted to 300 ts, of which 67 percent went to the Malelane Cannery and 33 percent to the Durban market.

\1 It must be recognized, however, that these field crops are not as financially or economically viable as the tree crops. Their modest areas on the Komati Irrigation project are satisfying requirements such as smallholders' and local food supplies;, spreading production risks; and conservation/soil objectives.

Table III-27: Swaziland: Monthly Wholesaler/Trader Prices for Cabbages, Tomatoes and Potatoes--Swaziland (SWD), Johannesburg (JHB), Durban (DBN), January - December, 1984. (E)

		Cabbages	Tomatoes	Potatoes
JAN.	SWD	0.26	0.75	0.42
	JHB	0.22	0.37	0.20
	DBN	0.14	0.38	0.21
FEB.	SWD	0.25	0.67	0.42
	JHB	0.22	0.40	0.18
	DBN	0.14	0.49	0.23
MAR.	SWD	0.24	0.77	0.32
	JHB	-	0.44	0.27
	DBN	0.34	0.40	0.25
APR.	SWD	0.28	0.71	0.38
	JHB	0.40	0.42	0.24
	DBN	0.41	0.42	0.33
MAY	SWD	0.25	0.63	0.33
	JHB	0.43	0.38	0.20
	DBN	0.27	0.43	0.28
JUN.	SWD	0.21	0.58	0.33
	JHB	0.27	0.43	0.26
	DBN	0.36	0.45	0.25
JUL.	SWD	0.15	0.39	0.38
	JHB	0.26	0.40	0.24
	DBN	0.36	0.42	0.28
AUG.	SWD	-	0.72	0.40
	JHB	0.30	0.37	0.73
	DBN	0.15	0.30	0.36
SEP.	SWD	0.20	0.68	0.38
	JHB	0.30	0.45	0.20
	DBN	0.18	0.44	0.83
OCT.	SWD	0.16	0.64	0.30
	JHB	0.30	0.45	0.10
	DBN	0.20	0.55	0.31
NOV.	SWD	0.14	0.64	0.37
	JHB	0.35	0.45	0.23
	DBN	0.16	0.32	0.36
DEC.	SWD	0.11	0.39	0.33
	JHB	0.53	0.23	0.15
	DBN	0.23	0.37	0.28

Source: Market Information Services, MOAC.

Table III-27 lists comparative average wholesale prices in Swaziland's markets, Johannesburg and Durban monthly from January to December, 1984. The data could imply that there was no advantage in exporting to the RSA at any time during 1984 because local prices were around 40 percent higher than the RSA markets. Reference to Table III-26 reveals that wholesalers have nearly doubled their margins between 1982 and 1984, from 23 percent to 41 percent. The fact is that export potential in the RSA and Mozambique could provide unique opportunities for tomatoes from the Komati project area. Particular attention will need to be given to quality inspection in the field and proper grading and quality control on the packing lines.

3. Potatoes

Potatoes are mainly grown under irrigation in the lowveld during the winter months on land that is used for cotton in the summer. At present, the bulk of the crop (75 percent) is produced by TDL farmers, with Vuvulane smallholders growing most of the remainder on SNL.

Potato production has been on the order of 3,000 t annually since 1978 rising to 3,600 t in 1982. They are Swaziland's main vegetable export chiefly because they are available only between August and November when local production far exceeds demand and a ready market exists in Durban and Johannesburg. A substantial quantity has also been taken up by the Simba Chips processing plant in the RSA. In 1982, 2,000 t were exported to the RSA, representing 64 percent of production and 50 percent of all vegetable exports. TDL farmers accounted for virtually all exports. Only about 1,000 t were sold locally.

The overall picture points to both the risks and opportunities in exporting. However, the risks are considerably reduced when export is managed on an efficient commercial basis. The Ronco Consulting Corporation study points out that South African demand for processed potatoes is rising, and water shortages have already limited any increase in winter potato hectarages. Future RSA production will have to come from increased yields and/or imports. In fact, RSA production between 1975 and 1981 averaged around 720,000 t with no growth evident. In this context, even if the Komati project 3 IDU's should export the total planned production of 6,600 t annually, there would be no difficulties in finding a ready market with the RSA processors.

4. Maize

Maize is the principal food crop grown in Swaziland. The area under maize has shown a downward trend during the last fourteen years. In 1969/70, the area was nearly 100,000 ha but official estimates for 1983/84 indicate a 30 percent reduction to 70,000 ha with production at 97,000 t. During the same period, imports of whole maize equivalent have risen by 60 percent from 21,000 t in 1971 to 51,000 t in 1983. The Government views this growing lack of self-sufficiency with concern, and a number of programmes have been undertaken during the past five years, the latest and most comprehensive being by the FAO.\1

\1 The status of maize is discussed at further length in Volume I, Chapter III.A.

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The Swaziland producer price for maize is a function of the RSA domestic and export prices. Farmgate price is based on the import parity principle which in turn is dictated by the economic framework of the SACU. Government exercises some control over the price of maize and maize products in Swaziland. Guaranteed floor prices are set according to grade, but producers may sell higher if a buyer can be found. The price is effective from May to the following April, and is announced during May. The current price is E21.60/kg bag or E308.57 per t (Table III-28).

Government policy is aimed at achieving maize self-sufficiency through a variety of means. The RDAP is directed towards increasing maize production in rainfed areas. USAID is concentrating on research and extension. IFAD is expected to fund a credit/marketing project within the structure of the recently established National Agricultural Marketing Board which will include extension, credit, storage and transport components linked to 14 collection centers. However, import levels of at least 50,000 t may continue for some time to come.

The Komati Irrigation Project 1st IDU provides for an average of 200 ha under irrigated maize cultivation throughout its life, both as a main crop and in rotation with cotton. The crop will be grown partly on the nucleus estate and partly by smallholders. Annual output would be 700 t valued at E215,000 per annum. For three IDU's in the base project of 3,000 ha, output will be 2,100 tonnes with a farm-gate value of E645,000.

IX. DOMESTIC AND EXPORT SALES AND SALES MARGINS

A. Introduction

This section's purpose is to present summary results of selected marketing analyses. For both the project's smallholders and the nucleus estate, the first step was to calculate those farmgate values, viz:

(1) Total Area (ha) x Estimated Yield (T/ha) = Total Yield (T)

(2) Total yield (T) x Producer Price (E/T) = Farmgate Value

These total yields and values are the same as those found in the project's financial and economic analyses in Volume I.

B. Market Shares

There the complete similarities end, however, in that the search here is for values achieved in the market place. Thus, instead of using the farmgate price to evaluate revenues, perfectly justified in an economic analysis, final market prices are used in this analysis. For those products which sell in numerous markets, there could be up to three different prices, e.g. in the domestic market (E), in the South African (RSA) market (R), and outside ($). The differences between the farmgate price and the estimated market price is the cost of transport, handling, insuring, brokerage, storing, merchandising, and so on, and any and all mark-ups. Tomatoes, for example, have a domestic farmgate price of E347/tonne while their market price in RSA is R415/tonne. The equivalent prices for potatoes are E200/tonne and R390/tonne.

For exports to Europe and Japan, the tree crops, the margins will be greater. Papaya, for example, has a farmgate price of E400/t. If shipped by sea, this achieves $1690/t in Europe; if by air, then $1225/tonne (or E845/t and E613/t). For papaya, mango, and avocado, margin calculations were effected for both air and sea shipments since both are considered possible under differing sets of marketing institution and timing assumptions.

In addition to calculating the value of sales in the three different markets, it was of course necessary to decide what proportions of cash crop would get to each market. For the nucleus estate, the following assumptions were made for field crops:

- Cotton and maize: 100 percent domestic sales;
- Cabbage: 86 percent domestic; 14 percent export to RSA;
- Tomato: 73 percent domestic; 27 percent export to RSA; and
- Potato: 35 percent domestic; 65 percent export to RSA.

Tree crops are 100 percent to the Northern Hemisphere.

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Table III-29: Net Sales (NS), Gross Margins (GM), and GM % NS, Smallholders and Nucleus Estate one IDU at Full Development

(E'000)

Smallholder (400 ha)	Net\a Sales (NS)	Gross Margin (GM)	GM % of NS
Cotton	164	internal	0
Maize	77	(33)	(43)
Cabbage	174	(26)	(15)
Tomato	257	(91)	(35)
Potato	631	71	11
Field Crop Total	1,303	(78)	(6)
Papaya - Sea	2,958	2,458	83
- Air	2,144	1,644	76
Mango - Sea	838	549	66
- Air	545	256	47
Avocado - Sea	3,724	3,372	90
- Air	2,422	2,070	85
Citrus - Sea	508	169	33
Total PY 10 - Sea	9,329	8,655	93
- Air	6,921	6,247	90

Nucleus Estate (600 ha)			
Cotton	123	internal	0
Maize	132	internal	0
Cabbage	276	56	20
Tomato	429	12	28
Potato	453	173	38
Field Crop Total	1,412	241	17
Papaya - Sea	8,450	7,450	88
- Air	6,125	5,125	82
Mango - Sea	2,394	1,816	78
- Air	1,557	980	63
Avocado - Sea	10,640	9,936	93
- Air	6,920	6,216	90
Citrus - Sea	1,523	506	33
Total PY 10 - Sea	23,019	18,550	80
- Air	17,537	13,068	74

\a Sales in domestic, RSA, and external markets all reduced to E'000

Source: Devres Staff Estimates, August 1985.

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SWAZILAND: ECONOMIC STUDY OF POSSIBLE USES OF
ADDITIONAL WATER ON THE KOMATI RIVER, SWAZILAND

Table III-30: Gross Value of Sales by Type of Market (E, R, $), Smallholder and Nucleus Estate, one IDU up to Full Development

(currencies in 000s)

	Smallholder				Nucleus Estate			
PY	Local (E)	RSA (R)	External ($)	Total in E	Local (E)	RSA (R)	External ($)	Total in E
2					894	519		1,412
3					1,900	1,297		3,197
4	674	628		1,303	1,900	1,297		3,197
5	674	628		1,303	894	519	s. 1,394	4,201
							a. 1,011	3,433
6	674	628	s. 370	2,042	894	519	s. 2,789	5,889
			a. 536	1,839			a. 2,021	5,455
7	674	628	s. 739	2,781	894	854	s. 6,376	14,498
			a. 536	2,374			a. 4,461	10,670
8	674	755	a. 1,696	4,820	894	1,128	s. 8,454	17,630
			a. 1,185	3,800			a. 3,813	13,648
9	674	882	s. 2,619	6,795	894	2,041	s. 10,742	23,019
			a. 1,814	5,784			a. 7,301	17,537
10	674	1,009	s. 3,189	8,062	894	2,041	s. 10,742	23,019
			a. 2,000	6;052			a. 7,301	17,537
11\a	674	1,136	s. 3,760	9,329	894	2,041	s. 10,742	23,019
			a. 2,554	6,921			a. 7,301	17,537
Total	5,393	6,246	s.12,373	36,435	10,889	11,788	40,497	96,062
			a. 8,359	29,376			a. 23,908	93,623

\a Annual values thenceforth over project life.

Source: Devres Staff Estimates, August 1985.

To be conservative with respect to foreign exchange ($) earned, however, it would be prudent to make a further set of assumptions. For smallholders, it was assumed that:

70 percent of total by sea	=	$ 8,661,211
30 percent of total by air	=	2,598,363
	=	$11,259,574
Further, wastage 33.3 percent		7,510,135
add E/R total (in $ x .50)		5,844,715
Total	=	$13,354,850

Using similar calculations for the nucleus estate, we arrive at $23.7 million after wastage and, after adding in the E/R total (@ 0.50) the total is $34.9 million. Actual dollar earnings are thus $31.2 million after wastage ($7.5 + $23.7 million) at full IDU development. That is a very reasonable E31,200/ha (remembering that all costs past the farm gate must still be deducted from that figure). If the project was doing all of its own marketing, and some 70 percent of that E31,200 was cost, it would still leave a healthy E9,369/ha as "profit." A 3,000 ha base project (three IDUs) would of course gross three times these amounts.

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Annex 1

The Lome Convention

Market opportunities for Swaziland in the EEC through the Lome Convention

The Lome Convention is a trade and aid agreement between the 10 member states of the EEC and the 65 African, Caribbean and Pacific states comprising the ACP group. The first Lome Convention agreement was signed in 1975 with a five-year duration expiring in March of 1980. Lome II was was signed in October 1979 and expired in March 1985. Lome III was signed on 8th December 1984, and will expire in March 1990.

The aid package for Lome III is US$7.2 million compared to US$4.3 million for Lome II: an increase of 67% in current terms. In real terms, however, the increase is negligible. In the meantime the number of ACP member countries has risen from 46 to 57. The financing vehicles for aid are the European Development Fund (EDF) and the European Development Bank (EDB).

Swaziland, as a member state of the ACP Group, is a full beneficiary of Lome III. Moreover, the country derives additional benefits and is accorded special treatment because of her "least developed and land locked ACP status". The Lome Convention guarantees free access to the EEC for 99.5% of ACP exports. The 0.5% are products covered by the Common Agricultural Policy (CAP).

Importance is attached to trade promotion for which financial and technical assistance are made available.

Notwithstanding the free access granted to ACP members, one sector of the EEC economy, agriculture is so heavily protected as to be virtually impenetrable to all outside suppliers. The instrument of protection is the Common Agricultural Policy (CAP) under which 70% of agricultural products benefits from a system which guarantees both market and price. For the principal cereals, sugar, dairy products, beef, veal and sheepmeat, an intervention price is applied to acquire, store and resell products in the market. In the case of pork, certain fruits, vegetables and table wines, market support takes the form of storage assistance, produce withdrawals, aid for distillation, etc.

About 25% of produce withdrawals, i.e. certain fruits, vegetables, flowers, some wines, eggs and poultry, is subject to an external protection system.

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For certain products such as animal feeds, e.g. maize and soya, tropical products, and out-of-season produce, Europe is reliant upon outside suppliers. Imports are regulated by lowering the tariff rates and introducing quotas in specific instances during certain times of the year. The system is especially favourable to ACP countries.

Free to the CAP sector by ACP countries is on the basis of quota established by the EEC and allocated to selected ACP countries where exports of the specific products represent a significant component in their national economy. Special provisions of importance to Swaziland cover pineapple, beef and sugar.

The price advantage accruing to ACP states over non-EEC members is in theory equivalent to the Common External Tariff (CET) applicable, subject to certain adjustments according to product demand. The full list is not relevant here. The following CET are of interest to Swaziland, however, and this project; pineapple 20%, potatoes 10%, cabbage 17%, carrots and turnips 17%, cucumbers 17% to 20%, peas 10%, lentils 7%, onions 20%, preserves 8%-15% according to season; citrus: oranges 15-20%, grapefruits 12%; sugar 26% (Swaziland has a tariff-free quota of 116,400 tons p.a.), avocado 8%; mango 6%; strawberry 14%-16%; tropical fruit juice/pulp 19%-23%--these tree crop CET's are especially attractive.

Seasonal variations in the CET may negate partially some of the apparent preferential access countries. During the European winter season, for instance, the external tariff on citrus is temporarily lowered. That is precisely the time, however, that both Swaziland and the RSA ship their citrus to Europe. Swaziland's competitive advantage for citrus exports to the EEC, with respect to shipments from the RSA due to its ACP status, is by and large nullified by this seasonal tariff reduction.

Rules of origin are laid down in Protocol No. 1 of the Lome Convention. In principle rules of origin are the criteria used to determine whether goods are indigenous to the exporting country, or are being trans-shiped by a third country. Few problems exist in establishing the country of raw materials origin. The main difficulties arise in the context of processed and semi-processed products. In these cases the qualification is that the imported ingredients in the processed product must have the effect of classifying the product under a tariff heading which is different than the heading of the original ingredient. Additional stipulations are that the product must contain a minimum local added value of 50% to 60%. This includes value-added by ingredients or components imported from the EEC or from other ACP states. In some cases part of the processing must take place in the country of origin.

The criteria are classified under two headings: List "A" and "B", and cover 488 items. List "A" refers to operations carried out on imported materials which change the tariff heading, without conferring the status of "originating" product. List "B" refers to operations which, when applied to imported materials, do not change the tariff heading, but qualify the resulting product as "originating" product. The rules of origin and the related topic of minimum added value for processed products are sufficiently complicated to warrant a case-by-case analysis of any process or product contemplated for export to the EEC.

STABEX is the system for guaranteeing the stabilization of export earnings derived from ACP states' exports to the EEC. The system is applied only to products on which their economies are highly dependent and which are affected by fluctuations in price, quantity, or both. To qualify for STABEX the minimum earnings of the schedules product must not be less than 7.5% of total export earnings. By virtue of her classification as a least developed, landlocked country, Swaziland qualifies for two important additional benefits:

-- minimum earnings for any one product qualifying for STABEX are reduced from 7.5% to 6.5% of total export earnings, and

-- export earnings may be derived from all sources, and may represent nil exports to the EEC. For instance, Swaziland can qualify for STABEX on exports confined to the RSA.

Article 147 of the Lome Convention lists 48 products covered by STABEX of which the following are potentially important to Swaziland, generally, but not necessarily of great relevance to the Komati project:

cotton, not carded or combed; cotton linters; wood sawn lengthwise; cotton seeds; oil cake; beans; iron one; raw hides and skins; bovine cattle leather; sheep and lamb-skin leather; goat kid skin leather.

Under the Sugar Protocol, the EEC undertakes to purchase, at guaranteed prices, specific quantities of cane sugar, raw or white, which originate in the ACP member states. The quantities referred to are as follows:

Barbados	49,300 m. tons
Fiji	163,600 m. tons
Guyana	157,700 m. tons
Jamaica	118,300 m. tons
Kenya	5,000 m. tons
Madagascar	10,000 m. tons
Malawi	20,000 m. tons
Mauritius	487,200 m. tons
Congo	10,000 m. tons
Swaziland	116,400 m. tons
Tanzania	10,000 m. tons
Trinidad & Tobago	69,000 m. tons
Uganda	5,000 m. tons
Total:	1,300,000 m. tons

Annex 2

Generalized System of Preferences (GSP)

The GSP is a system whereby industrialized countries grant special treatment to imports from developing countries, in the form of concessions, reductions or duty free access for their products. The GSP is a non-reciprocal scheme.

As far as Swaziland is concerned the GSP is replaced by the ACP/EEC Lome Convention for the 10 member countries of the EEC. Consequently, Swaziland would benefit from the GSP preferences applied by USA, Japan, Norway, Switzerland, Sweden, Canada, Austria and certain Comecon countries.

GSP benefits are not automatically conferred upon developing countries and Swaziland exporters should make a point of checking whether goods destined for the USA, Japan and Canada, for example, are eligible for special concessions.

Special conditions govern the quantity of goods that are granted access under GSP. Annual tariff ceilings and quotas are imposed on the GSP schemes of the USA and Japan. Definition of rules of origin vary according to the GSP donor country.

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Annex 3

The Southern African Customs Union (SACU)

A. Background

The Southern African Customs Union Agreement comprises four states: The Republic of South Africa, the Republic of Botswana, the Kingdom of Lesotho and the Kingdom of Swaziland. The Customs Union has been in operation since 1910; but the current agreement was renegotiated in 1969 and modified in 1976. The main positions can be summarized and highlighted as follows:

Article 2. Free movement within area.

There are no quantitive restrictions or duties on the free movement of goods within the Customs Union.

Article 5. Changes in Tariffs and Duties.

The Republic of South Africa will consult with the BLS states before changing the structure of tariffs and duties. This will not apply to changes which the Republic may effect for fiscal purposes or as interim measures to assist local industry.

Article 6. Infant industries.

An infant industry is defined as one which has not existed for more than eight years. In order to protect a new or infant industry, BLS states may impose additional duties and quantitative restrictions on goods imported by individual members subject to prior consultation with other members. The protection period shall not exceed eight years.

Article 15 and 16. Transport.

There will be no discrimination in transport rates throughout the area of the customs union; there will be freedom of transit for all goods within the area.

B. The SACU Common Revenue Pool

All customs, excise and sales taxes collected within the Customs Union are paid into a common Revenue Pool administered by South Africa. Out of this pool a distribution is made among the member states according to a special formula. Payments into the Pool are made quarterly, and distributions from the Pool are made annually to BLS. Total distributions to the BLS states are proportional to each states' imports and are based on 142% of total collections in the Pool as compensation for the disadvantages of belonging to a customs union with a more developed partner, i.e. with the RSA. These disadvantages include the "price raising effect" of protective tariffs, the "polarisation of development effect" and the "loss of fiscal discretion".

The objective of the revenue sharing formula is to relate BLS revenue to imports of goods into each BLS state and to the trade in taxable products within its borders. The assumption is made that, if BLS where not SACU members, they would have imposed duties on their own imports and on the trade in taxable products. A hypothetical tax rate is therefore applied to the total value of BLS imports and to the trade in taxable products, in order to compensate for revenues lost through membership of the Customs Union.

C. The impact of the South African Customs Union on industrialization and export development in BLS

The potential impact of SACU on industrialization and market development, largely will depend upon BLS states' assessment of the benefits of continued membership versus the alternative of leaving the Customs Union. Member states are free to opt out at will. Any one member state could presumably do this if it considered that membership had already prevented, or could inhibit, the growth of its industry and trade. The various elements of gain and loss which could accrue to a member state on secession from the Customs Union naturally have been discussed in some detail in recent times. Results of these discussions suggest that BLS states would gain modestly from secession under optimistic assumptions but might lose substantially under pessimistic assumptions.\1

The impression gained by the Devres mission during the course of its (admittedly cursory) investigations is that the government of the RSA is eager to assist the BLS states by all positive and visible means, not least in order to emphasize to other African states the benefits to be gained from closer economic ties with the Republic.

With respect to SACU's importance for Swaziland, the following factors appear to be relevant:

1. It is improbable that the RSA would risk alienating those countries who are considered friendly, by taking retaliatory action designed to cripple the landlocked economies of extremely poor countries, should BLS opt out.

2. Secession from the SACU might deny Swaziland the opportunity to establish industries whose viability would depend upon unimpeded access to the RSA market in the first instance. Many such industries are already faltering in the current recession.

3. The costs and benefits of secession would take some time to materialize. As a result, short-term sacrifices would be incurred, without any real guarantee of long-term benefits.

4. There are no records of complaints since 1969 of South Africa hindering the establishment of industry designed primarily to serve BLS domestic markets. For example, the maize and wheat mills in Lesotho, as well as that

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\1 See, for example, Jonathon Popper, "The South African Customs Union Revenue Sharing Formula," undated mimeograph; and Paul Mosley, "The South African Customs Union: A Reappraisal," World Development, Vol. 6, 1978.

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country's egg and potato production in times of domestic oversupply, receive assistance in the form of import prohibitions for competing products. Thus Lesotho can assert its economic sovereignty in spite of SACU.

5. Attention should be given to developing industries with potential market opportunities outside the RSA taking advantage of preferential access to EEC markets under the Lome Convention, and to Middle Eastern markets and to other African markets, with particular reference to the proposed African Preferential Trade Area.

D. Marketing Swaziland and Komati Project Products

Full advantage should be taken of the technical facilities and marketing expertise offered by the RSA in those areas of duplicated resources. Specific commodities in which the RSA has advanced technology and marketing experience include citrus, sugar, wool, tobacco and coal. For these the RSA already has established worldwide export markets. Where the RSA has statutory boards, e.g. the Citrus Board, Deciduous Fruit Board or Tobacco Board, the advantages of using these boards outweigh the disadvantages for the BLS states. The latter's domestic production is too small to justify setting up a local marketing organization. SACU and cooperation with the RSA let the BLS states partake of the benefits accruing from the RSA's strong negotiating position in regard to many matters of international trade, such as shipping, insurance, payments, freight rates, etc.

The disadvantage lies sometimes in the loss of national branch or label identity, which makes it impossible for the BLS states to profit from preferential or politically motivated access to the EEC or to most markets in Arab countries. Conversely, where label identity exists, such as citrus from Swaziland, preferential or politically motivated access to certain markets may be used to boost similar products from the RSA. A symbiotic relationship is thus clearly extant.

E. The South African Customs Union Common Revenue Pool

Based on the Customs Union Agreement No. R 3914, published in the Republic of South Africa's Government Gazette No. 2584 of 12 December 1969, the BLS states' share of customs revenue came to be calculated according to the formula:

$$R = \frac{(i + p)}{(I + P)}(C+E+S)\ (1.42)$$

Where :

R	=	Revenue received by BLS state
I	=	Total value of imports into SACU
i	=	Total value of imports into BLS state
P	=	Total value of dutiable goods produced and consumed in SACU
p	=	Total value of dutiable goods produced and consumed in BLS state
C+E+S	=	Total collection of customs, excise and sales duties within the Customs Union.

In May 1976 it was formally agreed that the coefficient of 1.42 in the formula would be increased to 1.43, and that revenue "R"would not be allowed to exceed 23% or fall below 17% of the BLS states' indirect tax base (i+p).

Annex 4

Proposal for a UN/EEC Standard for Mangoes

This draft standard was sent to the Working Party on Standardization of Perishable Produce by the secretariat of the OECD for the International Standardization of Fruit and Vegetables. The original draft was prepared by the International Trade Centre (UNCTAD/GATT) and was revised and finally adopted at the thirty-first session of the Plenary Meeting of the Scheme (OECD), held in Paris from 11 to 13 December, 1984.

DRAFT STANDARD

concerning the marketing and commercial quality control of

MANGOES

moving in trade between and to European countries

I. DEFINITION OF PRODUCE

This standard applies to mangoes' fruit of varieties (cultivars) from Manguifera indica to be supplied fresh to consumers, mangoes for industrial processing being excluded.

The name of accepted varieties are fixed by a national list.

II. PROVISIONS CONCERNING QUALITY

The purpose of the standard is to define quality requirements for mangoes at the dispatching stage, after preparation and packaging.

A. Minimum requirements

In all classes, subject to the special provisions of each class and the tolerances allowed, the mangoes must be:

-- intact

-- firm

-- fresh in appearance

-- sound; produce affected by rotting or deterioration such as to make it unfit for consumption is excluded

-- clean, practically free of any visible foreign matter

-- free of marked bruising

-- free from damage caused by insects and/or other parasites

-- free of damages caused by low temperature

-- free of abnormal external moisture

-- free of foreign smell and/or taste

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Mangoes must have been carefully picked at the stage of complete ripeness and in a state of maturity which enables them:

-- to ensure a continuation of the ripening process until they reach the appropriate degree of ripeness corresponding to the varietal characteristics;

-- to withstand transport and handling, and

-- to arrive in satisfactory commercial condition at the place of destination.

In relation to the evolution of maturing, the color may vary according to variety.

B. Classification

Mangoes are classified into two classes defined below:

1. "Extra" class

Mangoes in this class must be of superior quality. Shape and coloring must be characteristic of the variety.

They must be free from defects, with the exception of very slight superficial defects provided that these do not affect the general appearance of the fruit, the quality, the keeping quality or the presentation in the package.

2. Class 1

Mangoes in this class must be of good quality. They must be of shape and color characteristic of the variety. However, the following slight defects may be allowed provided that these do not affect the general appearance of the produce, the quality, the keeping quality or their presentation in the package:

-- slight defect of shape;

-- slight defects of skin due to rubbing, healed punctures or sunburn, with the reservation that they do not exceed a total of 10 cm2 for surface defects and 10 cm for defects in length.

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III. PROVISION CONCERNING SIZING

Sizing is determined by the weight of the fruit. Mangoes are sized according to the following scale:

Weight scale in grams	Code size
200 g. to 250 g	A
250 g. excluded to 300 g.	B
300 g. " 350 g.	C
350 g. " 400 g.	D
400 g. " 450 g.	E
450 g. " 500 g.	G
500 g. " 550 g.	H
550 g. " 600 g.	J
600 g. " 650 g.	K

The minimum weight of fruits must not be less than 200 g.

IV. PROVISION CONCERNING TOLERANCES

Tolerances in respect of quality and size shall be allowed in each package for produce not satisfying the requirements for the class indicated.

A. Quality tolerance

"Extra class": 5 per cent by number or weight of mangoes not satisfying the requirements of the class but meeting those of Class 1 or, exceptionally coming within the tolerances of that class.

Class 1: 10 per cent by number or weight of mangoes satisfying neither the requirements of the Class nor the minimum requirements, with the exception of fruit affected by rotting marked bruising of any other deterioration rendering it unfit for consumption.

B. Sizing tolerances

For all classes: 10 per cent by number or weight of mangoes satisfying the size immediately below or above the size concerned with a minimum of 180 gr. for mangoes classified in the smallest size (200/250 gr.).

V. PROVISION CONCERNING PRESENTATION

A. Uniformity

The contents of each package must be uniform and contain only mangoes of the same origin, variety, class and size, subject to the tolerances admitted.

B. Packing

Mangoes must be packed in a single layer in such a way as to protect the produce properly.

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The material used inside the package must be new, clean and of a quality such as to avoid causing any external or internal damage to the fruit. The use of materials, particularly paper or labels bearing trade specifications, is allowed provided that the printing or labelling has been with non-toxic ink or glue.

Packaging must be free from all foreign matter.

VI. MARKING

Each package must bear the following particulars, in letters grouped on the same side, legibly, indelibly marked, and visible from the outside.

A. Identification

Packer and/or Name and address of official despatcher issued or accepted trade mark.

B. Nature of the produce

-- "Mangoes", if the contents are not visible from the outside;

-- name of variety.

C. Origin of the produce

Country of origin and, optionally, district where grown or national, regional or local place name.

D. Commercial specifications

-- class;

-- size expressed according to the coding set out in Section III (provisions concerning sizing);

-- number of fruits.

E. Official control mark(optical)

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Annex 5

Mango: Export Varieties Recommended for Komati River Basin Project Area

i) Zill

-- Harvest	Early season crop
-- Weight/Size	300-500 grams
-- Brix	High
-- Color	Crimson blush (50%) with yellow
-- In-mouth	Flesh juicy; Low fiber
-- Shelf Life	Two weeks plus
-- Rating	Recommended

ii) Irwin

-- Harvest	Early season crop. As for (i)
-- Weight/Size	350-500 grams
-- Brix	High
-- Color	Ruby red (50%) with yellow
-- In-mouth	Balanced slightly acidic
-- Shelf Life	Two weeks plus
-- Rating	Recommended

iii) Tommy Atkins

-- Harvest	Mid-season
-- Weight/Size	280-410 grams. Smaller than (i), (iv) and (v)
-- Brix	Medium; Low
-- Color	All over crimson (70%) with greenish yellow
-- In-mouth	Flesh less juicy than (i); Low fiber; Good flavor; Seed small
-- Shelf Life	Two weeks
-- Rating	Recommended

iv. Kent. (Mexico)

-- Harvest	Middle/Late season crop
-- Weight/Size	420-620 grams. Size as (i)
-- Brix	High
-- Color	Green (70%) with red, finally turning yellow and red
-- In-mouth	Flesh juicy. Fiberless, subacid, soft, very good flavor, small seed, with more flesh, can be easily removed for serving as popular dessert with ice-cream filling.
-- Shelf Life	Three weeks
-- Rating	Highly recommended

v. Keitt. (Mexico)

--	Harvest	Late season crop
--	Weight/size	300-410 grams. Small
--	Brix	Medium
--	Color	Yellow with pink blush
--	In-mouth	Flesh firm. Fiberless, good flavor, seed small
--	Shelf Life	Seven days
--	Rating	Recommended to extend season after Kent (iv) crop.

Annex 6

Japan - Factors Affecting Imports of Fresh Fruits and Vegetables

(Extracts from "Access to Japan's Import Market" JETHRO 1980.)

Due to the Japanese Plant Protection Law, there are at present a number of import-restricted fruits. If those countries producing and exporting tropical fruit want such restrictions to be lifted, it will be necessary for their governments to heighten their standards of export inspections, as well as to actively improve their shipping environment.

Exporters are required to adjust related standards and regulations and keep quality standards, as well as to adhere rigidly to the shipment times prescribed in their contracts with importers. This requirement is particularly important for developing countries. It is also advisable for exporting countries to encourage their exports by regarding tropical fruit as a precious export item.

Through awkward consultation with Japanese importers, it is essential for exporters to understand that what is wanted in the domestic market is not necessarily what the Japanese want.

Quality tropical fruit as a gift item should be in greatest demand during the mid-year (June-August) and year end/new-year (December-January) seasons (customary exchange of gifts centers around these seasons in Japan).

It must be remembered that too strong a smell or taste will not gain general acceptance among the Japanese customers.

It is necessary for developing countries to endeavor to study more actively and willingly in order to better cope and compete with those advanced nations with adequately prepared export systems.

Exporters are requested to further improve packaging and design techniques so that their merchandise may increase in added value and that damages may decrease during conveyance.

Exporters are also advised to thoroughly study and always be prepared to cope with the related laws, regulations, and standards of Japan.

Annex 7

Packaging of Avocados, Mangoes and Papaya for Air Transport

A. General

In the case of avocados, mangoes, papaya and fruit and vegetables in general, reference should be made to OECD document 85, published in 1967 and entitled Recommendations on the international standardization of packaging for fruit and vegetables. The document gives detailed recommendations for various types of packaging materials and package design from the standpoint of dimensions, quality and mechanical strength.

Since the document was drafted with rail or sea transport in view, in which palletization is increasingly used, some adaptation is needed, the concern here being with air transport. To begin with, a number of the recommended types of packaging have to be discarded either because of their form (e.g. packaging without a lid) or construction (e.g. wooden crates, which are too bulky and heavy).

In addition to the types of packaging required for air transport (i.e. strong and light), the main point to be noted in the OECD document is the range of dimensions recommended in Europe. Their use is often required, if not by regulations, then at least by importers. The choice of dimensions suitable for palletization is strongly recommended in view of the terminal rail or road journey between the airport of destination and the place of sale.

B. Form of Packaging

The following types of fiberboard box could be used:

(a) Telescopic box with flaps, No. 0320 in the FEFCO code (the photographs on pages 62 and 64 of the OECD document should also be consulted); Obtainable from the Organization for Economic Co-operation and Development, 2 rue Andre Pascal, Paris 16e, France.

(b) Telescopic box No. 0301 in the FEFCO code;

(c) Telescoping box consisting of case No. 0422 for the bottom (or for the lid) and of case No. 0423 for the lid (or for the bottom) (see photograph on page 45 of the OECD document referred to above);

(d) Box with flaps, No. 02012 in the FEFCO code (see photograph on page 48 of the OECD document).

The last-mentioned box could be used only for products which are not fragile or for short-distance shipments.

The telescopic box with flaps should be used either for not very fragile fruit which is packed loose or preferably, for fruit which is placed in cell-trays (of moulded cellulose, for example) similar to the one shown in the photograph on page 62 of the OECD document.

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Whatever the constituent material (e.g. moulded cellulose, paper, plastics), the cell-trays should be adapted to the size of the fruit and should not cause irritation or damage.

Telescopic boxes (b) and (c) with internal heights of not more than 6 inches (15 cm) should be used for fruits which are fragile or need to be well displayed, either in a single layer with or without a cell-tray or in not more than two layers with a cell-tray.

C. Quality of the Material

Telescopic boxes (a), (b) and (c) referred to in the previous section should be in double-face corrugated fiberboard. In the case of fruits and vegetables, it would be preferable to determine the mechanical resistance of packagings according to the principles set out on pages 91 et seq. of OECD document 85 instead of specifying the quality of the papers to be used for the manufacture of the corrugated fiberboard or the properties of the corrugated fiberboard itself.

Day-to-day experience shows that "good" packaging cannot be obtained with mediocre materials but "bad" packaging can, unfortunately, be obtained with good quality materials. If the conditions under which the board is manufactured are unsatisfactory, the results will be disappointing whatever the raw materials used.

Satisfactory results will be obtained by using all-kraft liners of at least 220 g/m weight for boxes of double-face corrugated fiberboard. Liners, also of kraft, for boxes of double-face corrugated fiberboard should each have a minimum weight of 200 g/m.

4. Ventilation

In order to allow gaseous exchanges with the atmosphere, packages should be provided with perforations in an opening, as described below.

The ends of the package, i.e. the small vertical sides, should each have a lengthwise perforation of about 3 inches by 1 inch, rounded at the ends and situated in the center of the top third of the panel. These two orifices would serve the double function of ensuring ventilation and providing a hold to facilitate handling. In the case of telescopic packaging, it is obvious that the perforations in the bottom and the lid must coincide. This type of perforation is illustrated on pages 2 and 3 of the FEFCO code.

The faces of the package, i.e. the two large vertical sides, should be provided either with two perforations in a line or with four perforations in a square, each approximately 1/2 inch in diameter.

The top outer flaps of boxes with flaps need not meet but could be spaced about 1/2 inch apart to provide for ventilation from above without allowing the contents to escape.

E. Closure

Boxes (b) and (c) referred to above do not usually need a closure if lids and bottoms fit sufficiently closely. It is recommended, however, that strips of adhesive tape should be affixed to the bottom lid joint. If these are printed with the exporter's trade mark, they can, in addition to sealing the package, provide evidence that it has not been opened during transport.

The same remarks apply to boxes (a), but they, like boxes (d), must have a closure for the flaps. The use of gummed paper tape is not recommended in order to avoid blocking the air vents. The flaps should preferably be closed by stapling, as shown on page 5 of the FEFCO code.

Annex 8

Japan - The Launch of Hawaiian Papaya--1969

Hawaiian papaya (Solo variety) was first imported into Japan in 1969, after an inspector had been sent to Hawaii from the Ministry of Agriculture, Forestry and Fisheries. The Hawaii Administrative Committee, consisting of major Hawaiian growers and exporters who had previously shipped most of their papaya to the American mainland, and University research groups (primarily from the University of Hawaii), was formed for the purpose of working with various Japanese related organizations to promote exports to Japan. Long-time efforts in research and preparations have been expended to this end. In particular, the improvement of species with slight fragrance, good taste and good shape-that is, those species most suited to what we may call the Japanese taste-has been actively encouraged.

Meanwhile, the Japan Air Lines has been extending its aid to the Hawaii Administrative Committee. The American government has also been actively involved in working for the promotion of exports to Japan.

When the papaya was first introduced into the Japanese market, Japan Air Lines participated in a campaign based upon the use of television spots, posters, etc, they promoted Hawaiian tourism, souvenirs and specialty products, in order to formulate and establish .pa a product image for the papaya on the Japanese market. In this way, direct public relations' efforts directed towards the consumer were extended.

At the same time, cooperation in the area of distribution routes has made possible the research and preparation of long-term sales channels and studies on fair pricing; efforts have been made to establish low profit margins and to set prices at a level the average consumer can comfortably afford to pay. In order to help the consumer in this area, a great deal of research and attention has gone into packaging designed to prevent injury to the outward appearance of the fruit, while such aspects as package design and instruction labels have also been approached with much thought and ingenuity.

Conducted along with these sales-boosting image campaigns, Hawaiian dancing shows and papaya campaigns were held three times every year at major department stores and supermarkets across the nation. Efforts were made to spread information about the product, such as how to best prepare it to yield tasty results. Furthermore, preparation and cooking methods have been exhaustively and carefully taught to those in charge of cuisine at famous restaurants and hotels all over Japan, with every endeavor being made towards the spread of accurate product information.

The above series of constructive sales promotion efforts has made it possible to achieve a steady yearly increase in consumption of about 20%, rising to 3,267 tonnes in 1981.

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(b) eight members appointed by the Minister as follows:

(i) one person who shall represent the Ministry of Commerce, Industry, Mines and Tourism;

(ii) one person who shall represent the Central Cooperative Union;

(iii) one person who shall represent retailers of fruits and vegetables;

(iv) three persons who shall represent farmers; and

(v) two persons with such qualifications and who shall represent such organizations as the Ministry may determine.

(c) a public officer designated by the Minister to be the Executive Officer and secretary of the Board who shall not have the right to vote.

(2) member of the Board who is not a public officer shall hold office for such period not exceeding three years and on such other terms and conditions as the Minister may determine and shall be eligible for reappointment.

Functions of the Board

5. In exercise of its powers under section 6 and subject to any directions of a general nature which may be given to it by the Minister under section 7, the Board may--

(a) register wholesale distributors, importers and exporters of scheduled products;

(b) facilitate in such manner as it may consider appropriate, the production, processing, storage, transportation, distribution and sale of scheduled products;

(c) where required to do so, advise the Government in all matters related to the availability of and demand for scheduled products;

(d) perform such other functions as may from time to time be determined by the Minister.

Powers of the Board

6. In the exercise of its function under section 5, the Board may--

(a) require any person wishing to or engaged in importing and exporting scheduled products to register with and obtain a permit from the Board;

(b) nominate and empower any person or body to import or export scheduled products;

(c) determine the quantity, quality, grade or class of scheduled products that shall be subject to control and designate the place and manner of distribution of scheduled products;

(d) require from any person information relating to the source, type, grade, quantity and price of scheduled products;

(e) prescribe and collect permit fees and impose such levy as may be appropriate on the value of scheduled products.

Power of the Minister

7. The Minister may give directions of a general nature to the Board relating to the performance of its duties and the Board shall comply therewith.

Appeal to the Minister

8. A person aggrieved by any decision of the Board not to grant a permit to import or export scheduled products may, within thirty days of his being informed of such decision, appeal to the Minister in writing whose decision thereon shall be final.

Procedure of the Board

9. (1) The proceedings of the Board and other matters relating thereto shall be governed by the provisions set out in the Schedule hereto.

(2) The Minister may, by Notice in the Gazette, amend the Schedule.

Funds and assets of the Board

10. The funds and assets of the Board shall consist of--

(a) all moneys or property that may from time to time be donated, lent or granted to the Board;

(b) all property and investments required by or vested in the Board and all money earned arising therefrom;

(c) all moneys raised or borrowed by the Board;

(d) all other moneys or property that may in any manner become payable to or vested in the Board in respect of any matter incidental to its powers and functions.

Borrowing powers of the Board

11. The Board may, with the approval of the Minister, borrow such sums as it may require for meeting its obligations or exercising or performing its functions.

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Financial year

12. The Financial year of the Board shall run from the 1st January, to the 31st December in one year:

Provided that the first financial year may be shorter or longer than twelve months if the Board so determines.

Accounts and audit

13. (1) The Board shall cause to be kept books of account in proper form as well as all necessary records in connection therewith.

(2) The accounts of the Board shall be subject to an annual audit by an auditor appointed by it and approved by the Minister.

(3) The Board shall within six months after the end of each financial year--

(a) report to the Minister in such form as the Minister may direct on the performance of its functions;

(b) deliver to the Minister a copy of its accounts audited in accordance with subsection (2).

(4) The Minister shall lay before Parliament copies of all audited accounts as soon as practicable after he has received them.

Offenses and penalties

14. A person who fails to comply with instructions issued under section 6(a) and (d) or who fails to pay a fee or levy imposed under section 6(c), shall be guilty of an offense and liable on conviction to a fine not exceeding five hundred Emalangeni or imprisonment for three months.

Regulations

15. The Minister may make Regulations prescribing scheduled products and generally giving effort to the provisions of this Act.

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SCHEDULE (Section 9)

RULES OF PROCEDURE OF THE BOARD

1. The Board shall meet at least once every three months.

2. The Chairman of the Board shall convene and preside at all meetings of the Board.

3. In the absence of the Chairman, but subject to the quorum, the Board shall appoint an Acting Chairman from among the members present to preside at a meeting of the Board.

4. The quorum for a meeting of the Board shall be five members.

5. All decisions of the Board shall be made by a majority of the votes of the members present and in the event of an equality of votes, the Chairman or Acting Chairman as the case may be, shall have a casting vote in addition to his deliberate vote.

6. Subject to the Act and this Schedule, the Board may regulate its own proceedings.

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