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DEPARTMENT OF WATER AFFAIRS

SOUTH WEST AFRICA

PRELIMINARY FEASIBILITY REPORT

ON THE

IRRIGATION POSSIBILITIES ALONG THE LOWER ORANGE RIVER

SECRETARY OF WATER AFFAIRS
PRIVATE BAG 13193
WINDHOEK
9000

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1. INTRODUCTION

The Orange River forms the southern border of South West Africa and is one of only five perennial rivers of the country. The land alongside the Orange River therefore has an important advantage because it has access to an assured source of water. This fact alone gives these lands an advantage and opportunities not enjoyed by many other places elsewhere in the country. In this respect it should be noted that large areas of land alongside the Orange River is cultivated and has been for many years.

The agricultural potential of these lands and unutilized lands could therefore be of great significance to the country in the struggle to reduce imports. Furthermore, the agricultural sector has great potential for employing large numbers of people. Therefore it is important that the development possibilities of the land along the Orange River be seriously examined and its potential determined.

It is within this context that the request from the Infrastructure Committee in 1981 should be seen. The committee had requested the Department of Water Affairs to investigate the practical and economic feasibility of irrigation development along the South West African side of the Lower Orange River. The items of reference were that the study should be confirmed to the three largest tracts of irrigable land. Further, the question of the legal position of the international border between South West Africa and the Republic of South Africa, the hydrology of the Orange River and the availability of water, need not be covered by the report.

The purpose of the investigation carried out, and detailed in this report are:

- **to indicate the areas of potentially irrigable land and which of these could be considered for development;**

- to determine whether irri= gation agriculture would be economically feasible at the three areas mentioned above;

- to determine what employ= ment opportunities could be created by the development;

- to determine the effect on food production;

- to indicate the capital funding requirements of the development;

- to identify the critical parameters affecting the economic viability of any proposed development.

The results of this study are to be made available to the Agronomy Committee appointed by the National Assembly. It would thus become an input into determining the overall development priorities and possiblities of the country.

Due to the limitations of time and budget this report is basically a desk study. However a reconnaissance trip to the area was made as part of the work.

2. GEOGRAPHICAL DETAILS

2.1 LOCATION

The Lower Orange River, over its last 600 km, forms the southern border of South West Africa. Refer to ANNEXURE 1 for a location map. At 20° longitude the River becomes the southern border of South West Africa and before this point it flows through the Republic of South Africa.

2.2 TOPOGRAPHY

The lower part of the Orange River flows through a very dissected and mountainous area. Due to the incision of the Orange River in the landscape, agricultural soils are scarce and mostly limited to narrow strips alongside the river.

From South West African territory the Fish River contributes the only large tributary flow to the Orange River.

2.3 CLIMATE

The Lower Orange River region has an arid climate. East of the 18° longitude is a summer rainfall region whilst the area to the west receives rare, intensive rain showers throughout the year. The average annual rainfall decreases gradually from about a 100 mm in the east to less than 50 mm in the west. The annual average number of days with rain varies for the region between 10 and 20. A summary of the rainfall data for Noordoewer and Oranjemund is given in TABLE 1.

TABLE 1: RAINFALL FIGURES FOR NOORDOEWER AND ORANJEMUND

GAUGING STATION	PERIOD OF RECORD	RAINFALL (mm)		
		ANNUAL MEAN	ANNUAL MAXIMUM	ANNUAL MINIMUM
Noordoewer	1972/73 to 1984/85	74	180	4,2
Oranjemund	1948/49 to 1984/85	50	122	8,5

Mean daily maximum temperatures for the hotest month is less than 31°C at Oranjemund. This increases gradually to more than 40°C at Noordoewer. Mean daily minimum temperatures for the coldest month is 7°C for Oranjemund and 3°C at Noordoewer.

The region along the Orange River from Noordoewer to Sendelingsdrif and Oranjemund receives only mild frost in winter and certain areas are virtually frost-free.

Mean annual gross "class A" pan evaporation along the Lower Orange River gradually increases from 2 540 mm at Oranjemund to 3 400 mm at the 20° longitude. For Noordoewer this mean is 2 918 mm and an estimate of the annual maximum is 3 400 mm.

2.4 VEGETATION

Two major vegetation types occur along the Lower Orange River. From the 20° longitude westwards to the Haib River, the vegetation type is classified as Dwarf Shrub Savanna and from here further westwards up to Oranjemund, it is classified as Desert and Succulent Steppe.

The Dwarf Shrub Savanna is dominated by Karoo shrubs and grasses. In some parts "Aloe dichotoma" is quite common and dominates the landscape.

In the western parts of the Desert and Succulent Steppe area, near the coast, fairly large barren desert plains with sand dunes are encountered. Further inland the stony hills and mountains are fairly densely covered by succulents of different families. Further to the east, where some rain also falls during summer, the perennial vegetation becomes denser. Trees and shrubs are confined to river courses.

2.5 GEOLOGY

For the area along the Orange River from the 20° longitude up to Noordoewer and again from the Gamkab River up to the border of Diamond Area No 1 the geology consists of intrusive rocks of the Mokolian period and Orange River volcanic rocks of the Haib group.

Between Noordoewer and the Gamkab River, smaller areas of different rock types follows each other; sandstones and shales of the Karoo sequence, Nama sandstones and shales of the Damara sequence, post-Damara granites, Orange River volcanic rocks of the Haib group and sandstones and shales of the Karoo sequence.

Further westwards, into the Diamond Area No 1, various rocks of the Gariep complex are found and lastly this is followed by the sand sea of the Namib Desert.

2.6 LAND USE

From the country's eastern border at 20° longitude to the 18°4' longitude, the land adjacent to the river is divided into large farms which are owned by private farmers. The dominant land use here is irrigation on the riparian irrigable soils and sheep farming on the rest of the farmlands.

At Noordoewer and Aussenkjer irrigation is practised.

All other riparian ground is State land, unused except for the Diamond Area No 1. This area is held by concession under control of the firm C D M (Pty) Ltd. The town Oranjemund has developed as a result of the diamond mining at the mouth of the Orange River.

Other mining activities near to the river are the Rosh Pinah mine where lead, zinc and silver are mined and two smaller mines on the farms Ysterputs 254 and Border 155 in the Karasburg district where blue agate and rose quartz are mined respectively.

2.7 IRRIGABLE SOILS

In 1979 a reconnaissance survey of irrigable soil along the Orange River between Augrabies and Alexander Bay was carried out by the Soil and Irrigation Research Institute of Pretoria (Ref. 1). The results of the reconnaissance survey are used in this irrigation feasibility study.

The reconnaissance survey was done on both sides of the river up to a height of 50 metres above the river's "flood line". At some places where irrigable soil extended further inland, these were also identified. The different soil types were identified and classified according to their suitability for irrigation.

Reduced copies of the maps showing the irrigable soil classes are given as ANNEXURE 2.

The total areas of each soil class in the region under discussion are given in TABLE 2 below.

TABLE 2: SUMMARY OF AREAS SUITABLE FOR IRRIGATION UP TO 50 m ABOVE THE FLOOD LINE OF THE RIVER

PHYSICAL IRRIGATION SUITABILITY CLASS	DESCRIPTION	GROSS AREA (ha)	
		R S A SIDE	S W A SIDE
I	Suitable for irrigation	11 430	7 820
II	Conditionally Irrigable	13 470	15 810
TOTAL		24 900	23 630

The Class I soils are mainly restricted to thin corridors along the river, as can be seen from the maps in ANNEXURE 2. Most of the present irrigation is being practised on the Class I soils.

Class II soils are classified as conditionally irrigable because one or more of the physical soil properties do not comply with the criteria used in evaluating the suitability of the soil for irrigation.

Currently however, irrigation is practised succesfully on certain types of the Class II soils namely the Dundee B and Dundee C soils. At Aussenkjer and Hakiesdoorn there are large areas of these soils under lucern. At Noordoewer and Komsberg various crops are grown on an experimental basis with good success on small areas of these soils.

Soil analyses have been done on the Class II soils at Aussenkjer by the Oenological and Viticulture Research Institute, Stellenbosch. These indicated that it is virtually impossible to degenerate the physical structure of these soils by tillage practises, or to inundate them by incorrect irrigation practises. The courser gravellike top layer of the soil serves to retard moisture evaporation from the soil. A disadvantage of the soil is however its low water retaining capability. Thus it is concluded that these soils are

suitable for irrigation with proper irrigation and management. This feasibility study therefore assumes that Dundee B and Dundee C Class II soils can be cultivated successfully.

2.8 WATER RESOURCES

The Orange River is the major and most important water resource of the region under consideration. According to the Water Act the river falls under the jurisdiction of the Republic of South Africa although a dispute exists in this regard. However, certain water rights have been granted to farmers on the northern bank, in South West Africa, by the Republic. The whole matter of water rights and allocations is being discussed between the respective governments of South West Africa and South Africa and therefore it is not intended in this report to discuss the subject.

Neither is it intended to discuss the hydrology of the river. It is assumed that water for irrigation development discussed in this report can and will be made available as required.

3. SOCIO-ECONOMIC FACTORS

3.1 HISTORICAL BACKGROUND

During the precolonial stages most of what is now known as the Karasburg District was occupied by a Nama group, called the Bondelswarts. The German colonisation began at the end of the 19 th century and by 1903, some farmland along the River had been awarded to private farmers. South West Africa was entrusted to the Union of South Africa as a Class C Mandate in 1919. All land rights of private chartered companies were then cancelled and the settlement of White farmers was stimulated.

The Noordoewer settlement had its origin during the depression and drought years of the early 1930's.

The history of the diamond mining on the west coast of South West Africa dates back to April 1908 when the first diamond was found at Kolmanskop near Luderitz. In September 1908 the first Diamond Area was established by the German Government.

3.2 POPULATION

3.2.1 General

The population figures according to the 1981 Census for Oranjemund, Rosh Pinah, Noordoewer and the riparian farms on the South West African side of the Orange River are given in TABLE 3 below.

TABLE 3: POPULATION OF ORANJEMUND, ROSH PINAH, NOORDOEWER AND ORANGE RIVER RIPARIAN FARMS

NO	LOCATION	1981 CENSUS POPULATION FIGURES					
		WAMBO & KAVANGO	NAMA	COLOUREDS	WHITES	OTHER	TOTAL
1	Oranjemund	1 296	7	59	2 720	30	4 112
2	Rosh Pinah	235	15	57	256	8	571
3	Noordoewer	57	82	188	111	49	487
4	S.W.A Orange River Riparian Farms	82	135	158	45	22	442

3.2.2 Manpower

Unskilled labour is available in large numbers in South West Africa and experience obtained to date has indicated that the ability of these labourers is excellent. Thus no problems are foreseen in recruiting unskilled or semi skilled workers.

As far as farm management is concerned current practice is that the resident farmer does this himself. Only in a few instances in the area are farm managers or assistants employed. Obtaining suitably skilled persons to manage and work on any irrigation development may be a difficulty.

3.3 PRESENT IRRIGATION DEVELOPMENT

3.3.1 Irrigated areas and irrigation methods

The areas of Orange River riparian land under irrigation in South West Africa and the irrigation methods used are summarised in TABLE 4, based on figures supplied by the farmers themselves in 1985.

TABLE 4: APPROXIMATE AREAS PRESENTLY UNDER IRRIGATION ON THE SOUTH WEST AFRICAN SIDE OF THE ORANGE RIVER AND THE IRRIGATION METHODS BEING USED

	LOCATION	IRRIGATION METHOD	POWER SOURCE	AREA PRESENTLY UNDER IRRIGATTION (ha)
1.	PRIVATE FARMS			
1.1	Khomsberg (Eastern Section)	Flood	Diesel	25
1.2	Khomsberg (Western Section)	Flood and Sprinkler	Diesel	43
1.3	Stolzenfells (Eastern Section)	Flood	Diesel	5
1.4	Stolzenfells (Central Section)	Flood	Diesel	55
1.5	Stolzenfells (Western Section)	Flood	Diesel	30
1.6	Beenbreek (Eastern Section)	Flood	Diesel	15
1.7	Beenbreek (Central Section)	Flood	Diesel	30
1.8	Beenbreek (Western Section)	Flood	Diesel	15
1.9	Khaais	Flood	Gravity Flow In Private Canal	100
1.10	Velloorsdrif	Flood	Diesel	8
1.11	Keimasmund	Flood	Diesel	10
1.12	Pella Drift	Flood and Sprinkler	SWAWEC Electricity	140
1.13	Houmsrivier	Flood	Diesel	22
1.14	Gaidip	Flood	Gravity Flow In Private Canal	41
1.15	Ramansdrif (Central Section)	Flood	Diesel	5
1.16	Ramansdrif (Silverstroom)	Flood	Diesel	20
1.17	Hakiesdoorn	Sprinkler and Centre Pivot	SWAWEC Electricity	315
1.18	Aussenkjer	Sprinkler	Diesel	400

	LOCATION	IRRIGATION METHOD	POWER SOURCE	AREA PRESENTLY UNDER IRRIGATTION (ha)
2.	NOORDOEWER			
	(Part of the Vioolsdrif irrigation scheme)	Flood	Gravity Flow In Scheme Canal	373*
3.	DIAMOND AREA:			
	DABERAS	Flood	SWAWEC Electricity	76
	TOTAL			1 728

* Of the 373 ha under irrigation at Noordoewer only 283 ha is officially scheduled, for 21 farmers.

3.3.2 Crop production

Up until 1965 lucern cultivation was practiced almost exclusively. Since then with the opening of the Cape Town Fresh Produce market farmers have diversified their production base. Now only 60% of irrigated land is under lucern. Other crops grown are cotton, tomatoes, musk-mellon, beans, peas, pumpkin and gem squashes. Some farmers also grow wheat and maize and a few have citrus orchards and vineyards. At places, dates, mango and paw-paw are grown, mainly on the lower potential soils.

Typical yields obtained for some of the crops grown reported by the farmers at Noordoewer and Aussenkjer are given in TABLE 5.

TABLE 5: REPORTED AVERAGE CROP YIELDS

CROP	YIELD (ton/ha)
Lucern	15 - 22 per year
Cotton	3,5
Tomatoes	50
Musk-mellon	18
Dry beans	1,4
Dry peas	2,4
Pumpkin	10
Gem Squashes	20
Wheat	3,5 - 4,5
Maize	6,5

Lucern is sold either to the nearest agricultural co-operative or on contract to large consumers in the Cape Province and to a lesser extent directly to local sheep farmers. Lucern produced at Daberas is supplied to the dairy farm there.

Cotton, beans, peas and maize are sent to Upington whilst wheat is milled at Kakamas.

Fresh vegetables and fruit are mainly grown at Noordoewer and Aussenkjer. Most of the Noordoewer vegetables and fruits are sold on the Cape Town market. Those produced at Aussenkjer are also delivered on contract to fruit and vegetable outlets in South West Africa and to the military.

3.4 INFRASTRUCTURE

In general, land along side the Orange River is poorly provided for in terms of infrastructure, as will be discussed below. Whilst the area is not isolated from the rest of the country it is remote and partly served. The implication for development and especially irrigation is that this will increase operating and maintenance costs and pose significant marketting and manpower problems.

3.4.1 Railways

The nearest railway line to the Orange River is the Luderitz - Aus - Seeheim - Karasburg - Ariamsvlei-Upington line. From Seeheim the railway also branches off to Keetmanshoop and the rest of South West Africa.

3.4.2 Roads

There are only three road bridge crossings over the Orange River. They are at Oranjemund, Noordoewer and Onseepkans. A number of pontoon crossings also exists.

East of Noordoewer a network of proclaimed roads connect all riparian farms with towns in the interior. There is, however, no road stretching all the way along the river.

From Noordoewer westward, there is a dirt road on the South West African side along the river up to the pontoon bridge near Sendelingsdrif. From here the road continues to Alexander Bay on the South African side of the river.

3.4.3 Electricity

A 330 kV SWAWEC electrical power line from Karasburg to Aggeneys crosses the Orange River at the farm Gaidip. There are no offtakes for any consumers at the Orange River.

Places currently supplied with electricity are:

Oranjemund;
Dabaras;
Rosh Pinah;
Hakiesdoorn;
Pella Drift.

The electricity to these places is supplied from the Republic of South Africa. The cost of electricity supplied for irrigation in TABLE 6 below.

TABLE 6: COST OF ELECTRICITY SUPPLIED FOR IRRIGATION

IRRIGATION FARM	AREA PROVIDED WITH ELECTRICAL DISTRI= BUTION LINES (ha)	COST OF ELECTRICITY (c/kWh)
Daberas	392	16
Hakiesdoorn	315	8,4
Pella Drift	250	10

Negotiations between ESCOM/SWAWEC and the Farmers Cooperative at Noordoewer to provide Noordoewer with electrical power are in progress. Vioolsdrif, just across the river, will shortly be supplied with ESCOM electrical power.

In other words electricity supply in the region along the river currently is not controlled by the South West African authorities.

3.4.4 Communications

All the farms, settlements and towns along the Orange River enjoy a telephone service. Postal services are available at Oranjemund, Rosh Pinah, Noordoewer, Warmbad and Ariamsvlei.

3.4.5 Other Communal Services

There are primary schools at Oranjemund, Rosh Pinah, Noordoewer, Warmbad, Karasburg and Ariamsvlei. The secondary school nearest to the Orange River in South West Africa is at Karasburg.

There are hospital facilities at Oranjemund and Karasburg and there is a clinic at Noordoewer.

The regional police headquarters is in Karasburg whilst local police stations are at Oranjemund, Noordoewer, Warmbad and Ariamsvlei.

3.4.6 Discussion

The infrastructure has a very important bearing upon the ability of the area to support development. If development takes place many services will be required, some of which are not currently catered for. Some will have a direct bearing upon development such as transport services; the need for good roads, repair services, spare parts, workshops etc. Others will have a social impact; the need for community services such as schools, clinics and the like. The financial burden of providing such services will have to be planned for and borne. With the present infrastructure this aspect will tend to restrict any development to those places currently catered for in terms of services.

The current infrastructure also has an influence upon what crops could or should be grown. For example fruit and vegetables can be sold on the Cape Market due to its relative proximity and large consumer market. Staple foods such as maize and wheat could be marketted in South West Africa.

3.5 MARKETS FOR ACRICULTURAL PRODUCE

Three potential markets have been identified for agricultural produce from the lower Orange River. These are;

Cape Metropolitan Market Area;
South West Africa;
International Export.

In terms of size and ability to absorb products, the Cape Market is the most important. It is expected that fruit and vegetables grown along the Orange River would compete favourably with produce from other regions. This would be the major market. The Western Cape also provides a ready market for lucern especially for dairy and horse breeding concerns.

The local South West Africa market is in comparison small and dispersed. Only Windhoek offers a market of any size for fruit and vegetables. On the other hand most agricultural produce is imported at present. Therefore the

potential for staple products grown locally should not be ignored. Hence produce from the area could reduce imports especially if preferential treatment were to be given to local products.

Lastly there is the international market. The potential of this market for South West African produce is thought to be small. It may be that certain fruits could be exported as long as the quality, price and timing are correct.

4. GENERAL ECONOMIC MODEL FOR IRRIGATION

4.1 INTRODUCTION

The purpose of the general economic model is to enable the economic feasibility for an irrigation scheme to be evaluated. The model requires that certain assumptions be made concerning the characteristics of an irrigation scheme to be analysed. Inputs to the model are in the form of costs.

A diagramatic description of the model is given on page 18 and in the subsequent sections there are brief explanations of the inputs.

Various values that emerge from the flowchart can be used to calculate a variaty of economic and other parameters, all of which are results obtained when looking from different angles towards the feasibility of irrigation.

A number of such economic parameters are:

* Total capital requirement for development
* Gross margin on crop production = B -C3
* Nett anual cash flow = B - C3 - C2
* Benefits mius cost = B - (C1 + C2 + C3)
* Benifits over cost = B1/(C1 + C2 + C3)
* Internal rate of return, which is that interest rate by which C1 (Capi= talized Annual Cost) becomes equal to B - C3 - C2 (Nett annual cash flow).

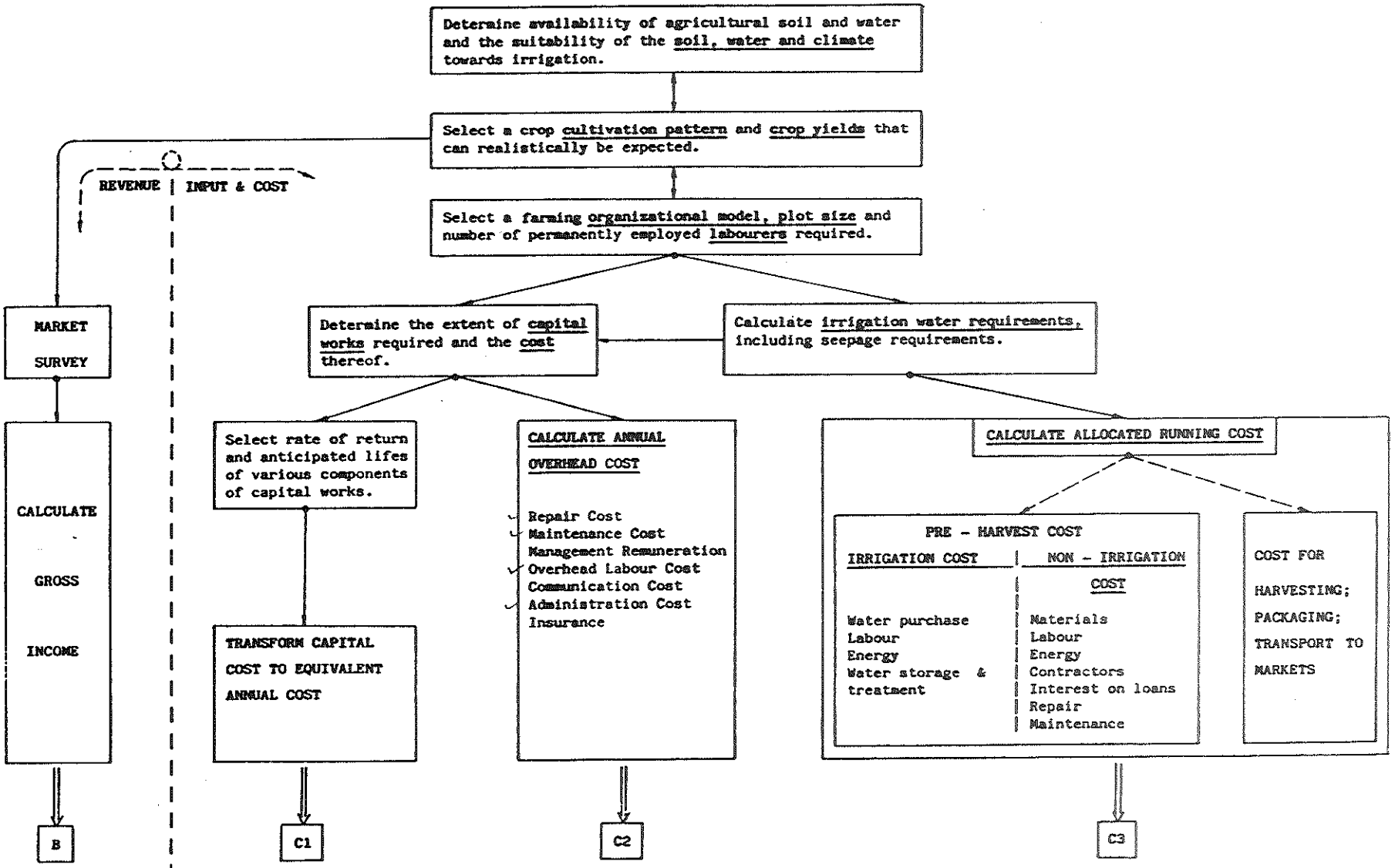
Some other usefull parameters are:

* Labour opportunity creatment
* Capital investment required per labour opportunity created
* Food import replacement

The general economic model is computerized on the computer system of the Department of Water Affairs. The software is available in the Departments computer library under the following labels: Disc 1: ORANGE RIVER, GENERAL, NOOR 23, AUSSEN and Disc 2: ORANGE RIVER, NOOR 1, FLOODE, FLOODD, DABIM

LOWER ORANGE RIVER IRRIGATION

THE MODEL USED FOR ECONOMIC EVALUATION : A FLOWCHART SUMMARY



ASSUMPTIONS

1. COMMERCIAL, OPERATION RUN BY A SINGLE FARMER PLUS FARM WORKERS. NO SUBSIDIES PROVIDED.
2. FARM SIZE : 200 ha
3. CROPS : MAIZE, WHEAT AND COTTON
4. IRRIGATION SYSTEM : HAND MOVED SPRINKLER
5. WATER SUPPLY : 7,8 m^3/h/ha
6. ENERGY SOURCE : ELECTRICITY, TO CENTRAL POINT AND RETICULATION BY FARMER

INPUT

EXPENDITURE

CAPITAL	R4700/ha
IRRIGATION SYSTEM	R 890/ha
WATER SUPPLY	R1850/ha
ELECTRICITY SUPPLY	R 330/ha
MECHANISATION	R 630/ha
FARM IMPROVEMENT	R1000/ha
MAINTENANCE	R 118/ha
CAPITAL WORKS	R 12/ha
EQUIPMENT	R 65/ha
MECHANISATION	R 46/ha
OPERATION	VARIABLE
MARKETING	VARIABLE
WATER	R0,0012/m^3
ELECTRICITY	VARIABLE
CONTRACT	VARIABLE
RUNNING	VARIABLE
INTEREST	VARIABLE

INCOME

COTTON	R2800/ha
WHEAT	R1655/ha
MAIZE	R1679/ha

COMPARISON

INCOME vs. EXPENDITURE

OUTPUT

BENEFIT / COST RATIO
BENEFIT - COST = NETT BENEFIT
TOTAL CAPITAL COST
INTERNAL RATE OF RETURN
NETT OPERATIONS CASH FLOW

4.2 ASSUMPTIONS

4.2.1 Commercial Operation

In order to develop the general model certain assumptions were made concerning the type of development. It has been assumed that the irrigation development will take the form of a commercial operation involving a single farmer assisted by a number of permanent and temporary farm workers.

4.2.2 Size of Irrigation Units

The size of irrigation unit has been taken as 200 hectares. This size has been chosen for a number of reasons. It can be managed by one person, for the type of crops to be grown. Mechanisation costs per hectare are significantly reduced as are capital costs. In arriving at the 200 hectares other, smaller, areas were looked into. However it was found that in most cases these were uneconomic. Hence it was decided to use 200 hectare units in the analysis.

Some of the short comings with this approach are that the size is influenced by the crops that can be profitably grown. It also depends upon the cost of energy, the degree of management skills available and subsidies. There is no optimum unit size as such a size will depend upon not only the above factors but many others. This is an aspect which could be researched further.

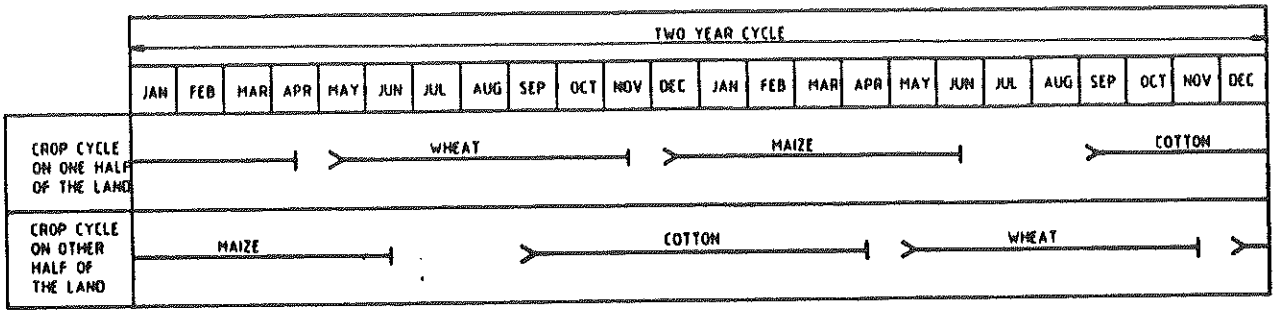
4.2.3 Crops

Three crops have been chosen for use in the model; cotton, wheat and maize.

Other crops, such as vegetables, were considered but not included. The reasons for not including them were that this was to be a general model and the market would not be able to absorb the volume of produce if all the farm units were to produce vegetables. In other words only a small area could be given over to vegetable production. There was also the price variations throughout the year to consider which would complicate the calculations.

For these reasons it was decided to concentrate upon three crops and accept that this would be the bottom line.

The cropping system adopted is the successive cultivation of the three crops on a two year cycle. The Diagram below demonstrates the concept.



NOTE : > DENOTES PLANTING DATE

4.2.4 Irrigation System

A semi permanent hand moved sprinkler system has been chosen as the most appropriate system.

The capacity of the system has been designed taking account of; the crop water demand, irrigation efficiency, peak requirements, the elevation of the irrigated lands and the pumping head required by the system.

Refer to APPENDIX A for more details.

4.2.5 Electricity Supply

It is assumed that an electricity supply is available at a central point. Distribution from this point to the consumer points on the irrigation units and provision of transformers is the responsibility of the farmer.

4.2.6 Farm Improvement Costs

Farm improvement costs such as land clearing and levelling, fencing, roads, buildings and mechanisation are borne by the farmer.

4.3 INPUTS

Inputs to the general model can be broken down into two broad catagories: expenditures and incomes. Expenditures can be further broken down into such items as capital, maintenance and operation costs. Income is derived from the sale of produce grown on the farm.

4.3.1 Income

The income generated from the sale of cotton, wheat and maize depends upon the yields and the selling price. TABLE 7 gives the expected income.

TABLE 7 : EXPECTED INCOME FROM SALE OF PRODUCE

CROP	YIELD tonne/ha	PURCHASE PRICE R/tonne	INCOME R/ha
Cotton	3,5	800,00	2 800
Wheat	5,0	331,14	1 655
Maize	6,0	279,89	1 679

4.3.2 Capital Expenditure

Capital expenditure is taken to include farm improvement costs, establishing the electrical distribution, purchase of irrigation equipment and the water supply system. The acquisition of plant such as tractors, planters, spreaders etc. is also included here.

4.3.2.1 Farm Improvement Costs

TABLE 8 gives the breakdown of Farm Improvement costs.

TABLE 8 : FARM IMPROVEMENT COSTS

DESCRIPTION	COST R	UNIT RATE R/ha
Building:		
3 N° Sheds @ R18 000 each	75 000 54 000	270
1 N° House/Office	150 000 50 000	250
Land Clearing & Levelling	65 000	325
Fencing: 7000 m @ R1,57/m	10 500	55
Roads	20 000	100
TOTAL	320 000 199 500	1 000

4.3.4.2 Water Supply System

The water supply system is taken to consist of a number of river intake pumps and distribution pipelines. The sprinkler equipment is connected into the pipe network as required . A description and typical layout of a water supply system is given in APPENDIX A.

TABLE 9 : WATER SUPPLY SYSTEM COSTS

DESCRIPTION	COST R	UNIT RATE R/ha
Civil Works	293 800	1 469
M & E Installation	76 200	381
	370 000	1 850

4.3.2.3 Irrigation Equipment

The equipment required for the irrigation system is detailed in Appendix A. It consists of a number of quick coupling pipes and risers. The capital cost is estimated to be R178 000 or R890/ha.

4.3.2.4 Electricity Supply

It is assumed that on average a farmer will have to provide 4000 metres of electric cable. This is to get the power from a central power point to his own point of demand, i.e. his pumps. In addition step-down transformers will be required. The rating of the transformers will differ depending upon the power to be drawn. To pump water to higher ground, ie to an average height of 40 m above mean water level, will require more power.

Therefore two different cases have been considered. The one case where the average elevation of the irrigated area is 25 metres above mean water level. The other where the average elevation is 40 metres.

TABLE 10 : COSTS OF ELECTRICITY SUPPLY

DESCRIPTION	COST R	UNIT RATE R/ha
Powerlines: 4000 m @ R13/m	52 000	260
Transformers		
25 m elevation: 2 N° 300 KVA @ R6000	12 000	60
40 m elevation: 2 N° 400 KVA @ R8000	16 000	80

4.3.2.5 Mechanisation

A summary of the mechanisation requirements and the costs thereof is given in APPENDIX B. The total cost of this equipment is R125 200, which gives a unit capital cost hectare of R630.

4.3.2.6 Summary

A summary of the capital costs is given in TABLE 11 below.

TABLE 11 : SUMMARY OF CAPITAL COSTS

DESCRIPTION	COST	UNIT RATE
Farm Improvements	199 500	1 000
Water Supply System	370 000	1 850
Irrigation Equipment	178 000	890
Electricity supply	64 000 or 68 000	320 or 340
Mechanisation	125 200	630

4.3.3 Maintenance Cost

Maintenance costs for irrigation units are calculated and given in TABLE 12.

TABLE 12 : MAINTENANCE COSTS

DESCRIPTION	RATE	CAPTIAL R	MAINTENANCE R/a	UNIT RATE R/ha/a
Farm Improvements	0,5% of capital cost	199 500	1 000	5
Water Supply System	0,5% of cost of civil works	293 800	1 469	7
	4% of cost of M & E works	76 200	3 000	15
Irrigation Equipment	5% of cost	178 000	8 800	44
Electricity Supply	2% of cost	64 000	1 200.	6
		68 000	1 400	7
Mechanisation	Item	125 000	9 200	46

The maintenance costs for the mechanised equipment, such as tractors, depends upon the number of hours worked. The hours worked depend in turn upon the crop being cultivated. A detailed breakdown of these maintenance costs is given in APPENDIX B and summerised below:

cotton	R 38/ha
wheat	R 28/ha
maize	R 26/ha.

In any one year one crop of each of the above is cultivated. But only 100 hectares of each is under cultivation. Therefore the total maintenance costs are: R38 x 100 ha + R28 000 x 100 ha + R26 x 100 ha giving R9 200. But since for that year a total of 200 hectares was cultivated the equivalent unit maintenance cost will be R9 200 - 200 Ha ie. R46/ha.

4.3.4 Operations Costs

Operating costs are going to be determined principally by what crops are grown. Cotton for example will require a greater labour input than wheat say. Therefore its labour operating costs are going to be higher than that of the other crops grown.

The other variable to be considered is that of electricity. Apart from the fact that the amount of electricity used will depend upon the crop, there are two other factors to consider. Firstly the power used will depend upon the pumping head required. This in turn depends upon the height of the irrigation land above mean water level. For the purpose of the general model only two heights have been considered, known as the lower ground and the higher ground. The lower ground refers to land with an average elevation of 25 metres above mean water level and a maximum height of 30 metres. The higher ground refers to land with an average elevation of 40 metres above mean water level and a maximum height of 50 metres.

Secondly, there is no established electricity supply grid along the river. Therefore there is no approved tariff structure for electricity. Thus the cost of electricity is an unknown factor.

Attempts were made to obtain from SWAWEC budget estimates of cost but they were unable to supply any details. Therefore three cost structures for electricity have been used in the evaluation, namely; 10c/kWh, 13 c/kWh and 16c/kWh. These are based upon tariffs which are currently being levied at Daberas (16c/kWh), Hakiesdoorn (8,4c/kWh), and Pella Drif (10c/kWh).

4.3.4.1 Electricity Costs

The cost of electricity as a function of pumping height and crops grown is given in TABLE 13 below. Electricity is supplied at a central point and the cost is taken at that point.

TABLE 13 : OPERATING COST OF ELECTRICITY

UNIT COST OF ELECTRICITY c/kWh	AVERAGE PUMPING HEAD m	OPERATING COST R/ha/a			
		COTTON	WHEAT	MAIZE	TOTAL
10	53	215	95	171	481
	68	275	122	220	617
13	53	279	124	223	626
	68	358	159	286	803
16	53	343	152	274	769
	68	441	195	352	988

4.3.4.2 Transport Costs

This covers the cost of transporting goods and materials to the irrigation units. It is assumed that all incoming materials have to be transported 100 km. Produce is road transported to a railhead, which is also taken to be 100 km away. Wheat and maize are to be sent by rail to Mariental while cotton is sent by rail to Upington.

TABLE 14 : TRANSPORT COSTS

ITEM	**UNIT RATE R/ha**			
	COTTON	**WHEAT**	**MAIZE**	**TOTAL**
Road Transport	42,0	56,0	68,0	166,5
Rail Transport	42,5	49,5	62,5	154,5

4.3.4.3 Water

A "river tariff" of 0,12 c/m^3 is levied upon water abstracted from the Orange River. Since the farmers will be responsible for their own water supply, this is the only cost incurred.

4.3.4.4 Labour

The labour requirements and the associated costs are discussed in Appendix B. A summary of the cost of labour, derived from APPENDIX B is given in TABLE 15 below.

TABLE 15 : LABOUR COSTS

ITEM	UNIT RATE R/ha		
	COTTON	WHEAT	MAIZE
Labour	476	32	41

These costs are in terms of rand per hectare cultivated.

4.3.4.5 Material Costs

The cost of materials required for cultivation is summarised in TABLE 16 below. For more detail, the reader is referred to APPENDIX B.

TABLE 16 : MATERIAL COSTS

ITEM	UNIT RATE R/ha		
	COTTON	WHEAT	MAIZE
Seed	37	69	40
Fertilizer	226	215	202
Chemicals	204	38	70
	467		

4.3.4.6 Fuel Costs

Fuel costs for tractors are calculated in APPENDIX B, and are given below.

TABLE 17 : FUEL COSTS

ITEM	UNIT RATE R/ha		
	COTTON	WHEAT	MAIZE
Fuel Cost	46	35	33

4.3.4.7 Contract Services

Apart from transportation, it is assumed that a contracter is used to harvest wheat and maize. Cotton is harvested by hand. Aerial spraying is also carried out by a contractor. The rates quoted are for each hectare under cultivation.

TABLE 18 : CONTRACT SERVICES

ITEM	UNIT RATE R/ha	
	WHEAT	MAIZE
Harvesting	100	120
Spraying	9	-

4.3.4.8 Interest on Production Capital

Loans of varying amounts are made at different stages through the growing season and are repaid shortly after harvesting. Interest is payable on such loans. For a typical irrigation unit in the Ramah area the Directorate of Agricultural Production Economics in the RSA calculated the fixed interest costs for various crops. These figures are adopted here, and are given below.

Cotton	R130/ha
Wheat	R 50/ha
Maize	R 45/ha.

4.3.4.9 Salaries

It is assumed that the farmer or farm manager draws a salary from the enterprise. An amount of R40 000 per year is assumed as the salary drawn.

4.4 COMPARISON AND OUTPUT

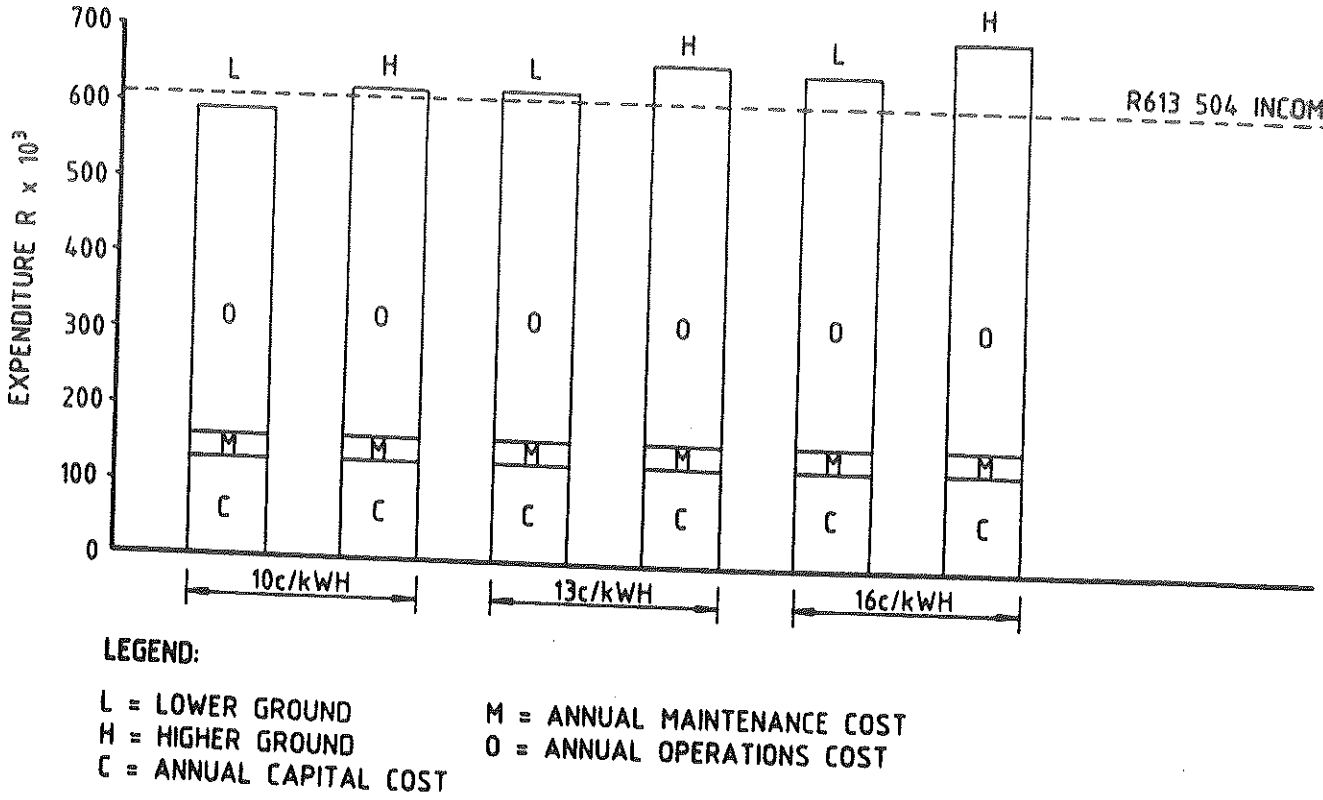
The income generated can be calculated as can the expenditures incurred in running an enterprise. This is for the general case outlined above. These can be compared to each other, in various ways, to determine the viability of

the development. The comparison of income and expenditure based upon the costs derived above is given in TABLE 19. Printouts of each case considered are given in ANNEXURES 3, 4 and 5.

TABLE 19 : COMPARISION OF INCOME AND EXPENITURE (Rand)

CASE	ITEM	FIXED COST		VARIABLE COSTS			
				LOWER GROUND		HIGHER GROUND	
		TOTAL	ANNUAL	TOTAL	ANNUAL	TOTAL	ANNUAL
I (Electricity 10 c/kWH)	Income		613 504				
	Expenditure	555 190	443 926	373 000	148 929	306 600	178 563
	Capital	555 190	84 772	373 000	47 971	386 600	49 880
	Maintenance		20 140		4 432		4 840
	Operations		339 014		96 526		123 843
II (Electricity 13 c/kWH)	Income		613 504				
	Expenditure	555 190	443 926	373 000	177 886	386 600	215 716
	Capital	555 190	84 769	373 000	47 971	386 600	49 880
	Maintenance		20 140		4 432		4 840
	Operations		339 014		125 483		160 996
III (Electricity 16 c/kWH)	Income		613 504				
	Expenditure	555 190	443 926	373 000	206 343	386 600	252 868
	Capital	555 190	84 769	373 000	47 971	386 600	49 880
	Maintenance		20 140		4 432		4 840
	Operations		339 014		154 440		198 148

These results are represented diagrammatically below. The effect of the elevation of the lands to be irrigated can be seen, with respect to the Operational costs. Also it can be seen that the cost of electricity has a marked influence upon profitability.



There are various methods of analysing these figures to investigate the economic and financial feasibility of a project. Given below are the various methods that have been employed.

4.4.1 Benefit-Cost Ratio

The benefit-cost ratio is the annual income or benefit from the project divided by the annual amortized costs. If the ratio exceed unity then the scheme is potentially viable.

From TABLE 20 the various benefit-cost ratio's can be determined for each case, i.e. for a certain land elevation and cost of electricity. These ratio's vary between 0.88 for high lands and most expensive electricity, to 1.04 for the least expensive electricity on the low lands.

TABLE 20 : BENEFIT-COST RATIO'S

COST OF ELECTRICITY	BENEFIT-COST RATIO	
c/kWH	LOW ELEVATION LAND	HIGH ELEVATION LAND
10	1.04	0.99
13	0.99	0.93
16	0.94	0.88

4.4.2 Nett Benefits

Nett benefit is defined as the sum of all benefits minus the sum of all costs. As it is assummed here that both benefits and costs are constant during the project, the annual nett benefit is calculated. The values calculated are given in TABLE 21.

TABLE 21 : NETT BENEFITS

COST OF ELECTRICITY	NETT ANNUAL BENEFIT (R)	
c/kWH	LOW ELEVATION LAND	HIGH ELEVATION LAND
10	20 649	- 8 985
13	- 8 308	- 46 138
16	- 37 265	- 83 290

4.4.3 Internal Rate of Return

The internal rate of return method entails the establishment of the discount rate which would result in the present value of nett income equalling that of the investment. This rate of interal return is the interest rate at which the Benefit-Cost ratio is unity.

The internal rates of return for the various circumstances considered by the general model are given in TABLE 22 below.

TABLE 22 : INTERNAL RATES OF RETURN

COST OF ELECTRICITY c/kWH	INTERNAL RATE OF RETURN	
	LOW ELEVATION LAND	HIGH ELEVATION LAND
10	14	10
13	10	3
16	5	0

4.4.4 Nett Operations Cashflow

The nett operations cashflow is the difference between the gross annual income of the project and the annual operating costs. It is a measure of the benefits produced by a scheme when the amortised capital costs are not included as a cost. In other words how profitable would a scheme be if the capital costs were to be subsidized. In TABLE 23, below, the nett operations cashflows derived from the general model are given.

TABLE 23 : NETT OPERATIONS CASHFLOW

COST OF ELECTRICITY c/kWH	NETT ANNUAL OPERATIONS CASHFLOW	
	LOWER GROUND	HIGHER GROUND
10	R 153 392	R 125 667
13	R 124 435	R 88 514
16	R 95 478	R 51 362

4.4.5 Flood Irrigation

The general model has been applied to the case of flood irrigation using the some electricity costs as before but only the lower ground is used. The Table below summarises the findings of the general model. For a more detailed discussion of the various parameters used refer to APPENDIX C.

TABLE 24 : GENERAL MODEL APPLIED TO FLOOD IRRIGATION

ECONOMIC PARAMETER	COST OF ELECTRICITY (c/kWH)			
	10	13	16	DIESEL POWER
Nett Operations Cashflow	R 172 457	R 153 335	R 134 213	90223
Nett Benefit	R 15 749	- R 3 373	- R 22 495	- 91380
Benefit/Cost Ratio	1.03	0.99	0.97	0.87
Internal Rate of Return	13.4%	11.1%	8.5%	0

A full printout of all the cases considered is given in ANNEXURES 6, 7, 8 and 9.

4.4.6 Conclusions

Given the assumptions made in the general model the following conclusions can be drawn. Irrigation development is economically feasible only on the lower elevation land. This is providing the cost of electricity is 10 c/kWH or less, irrespective of whether flood or sprinkler irrigation is considered.

The model could be utilised to investigate the sensitivity of the results to the various assumptions. For example, the influence of reducing the size of the farm units to 100 ha was investigated. In doing so the capital, maintenance and operations costs were adjusted accordingly. This analysis indicated that under the given conditions assumed the smaller farm units were uneconomic, even with an electricity cost of 10 c/kWH.

5. IRRIGATION POTENTIAL THREE AREAS

5.1 GENERAL

In the previous chapter a general model was developed to evaluate the economic potential of irrigation along the Orange River. In that model certain general assumptions were made. The model will now be applied to analyse a number of specific cases. To do this three potential development areas have been selected for analysis. These areas have been selected on the basis that they constitute three of the larger areas where irrigable soils are available.

The areas chosen for further evaluation are:

Noordoewer
Aussenkjer
Fish River Mouth to Daberas.

For each case considered the assumptions in the general model have been modified, where necessary, to take account of local conditions.

Each of the specific areas are considered separately.

5.2 NOORDOEWER

5.2.1 Project Land

At Noordoewer, there is about 570 ha of Class 1 irrigation soil spread out as a long narrow strip along the river. Almost all present irrigation, namely flood irrigation, is being practised on this soil. Of this 570 hectares a total of 283 ha is scheduled for irrigation, but at stages up to 373 ha is irrigated. Further extension of irrigation land is limited by the water supply capacity of the present integrated canal system.

Up to a height of 50 m above the high water level, there is an additional 1630 ha of Class II irrigable soil of the Dundee B type. These soils also extend above this contour line. However due to the cost of pumping water above these levels, this extension is not considered. The distribution of the irrigable soils is shown in ANNEXURE 10.

There are thus a total of 2200 hectares of soil suitable for irrigation at Noordoewer. This area is reduced to allow for infrastructure and also subdivision into zones as per TABLE 25 and ANNEXURE 11.

TABLE 25: NOORDOEWER IRRIGATION ZONES: EFFECTIVE AREAS ASSUMED

ZONE NO	EFFECTIVE AREA (ha)	COMMENT
1	630	Between river and road to Aussenkjer
2	800	Between road to Aussenkjer and 200 m contour
3	200	Between 200 m and 210 m contours
TOTAL	1630	74% of total available irrigable soil

5.2.2 Development Assumptions

The existing lands scheduled for irrigation are all in Zone 1 and average 13,5 hectare per farmer, for 21 farmers. Since these farming units are very small, it is assumed that all additional land in Zone 1 will be added to the existing farms. This will then increase the size of each farming unit to 30 hectares.

For Zone 2 and Zone 3, new 200 ha farming units are assumed. The farming units obtain irrigation water from a bulk water supply system. A costing for the bulk water supply system is given in APPENDIX D.

5.2.3 Cases Considered

Four specific cases have been considered for Noordoewer. The inputs into the general model have been adopted to each of the cases considered. These were;

(i) extension to the existing development, but only in Zone 1,

(ii) development of Zone 2 only

(iii) development of Zone 2, with the capital cost of bulkwater supply scheme being totally subsidized,

(iv) development of Zones 2 and 3.

Details of the inputs are given on the printouts of each of the cases. The printouts which are given in ANNEXURES 12 to 15.

5.2.4 Summary of Results

As stated above the full results of the analysis are given in the ANNEXURES, only a summary of these results are given here.

TABLE 26 : SUMMARY OF RESULTS FOR NOORDOEWER

ECONOMIC PARAMETERS	CASE			
	(i)	(ii)	(iii)	(iv)
Nett Operations Cashflow	R 13 628	R 81 417	R 126 730	R 49 589
Nett Benefit	R 799	- R 46 308	- R 995	- R 78 723
Benefit/Cost Ratio	1.0	0.9	0.9	0.8
Internal Rate of Return	12.9%	2.8%	11.3%	0

5.3 AUSSENKJER

5.3.1 Project Land

Up to 50 m above the river high water level, as shown in Annexure 15, there is a total of about 470 ha of Class I soil. There is a further 2000 ha of Class II soil of the Dundee B and Dundee C type, with Dundee B being in the majority. Further inland and higher up from the river, there is an additional area of more than 3000 ha of this Class II soil. The Class I soil forms a narrow strip next to the river. Presently, there is about 400 ha of both soil classes under hand movable sprinkler irrigation.

The irrigable soil up to the 170 m contour line (50 m above river high water level) have been subdivided into three irrigation zones, as is shown on the 1:50 000 scale map in Annexure 17. Approximate geographical details of these zones are given in TABLE 27. Only Zones 1 and 2 are considered in the analysis.

TABLE 27: AUSSENKJER IRRIGATION ZONES, GEOGRAPHICAL INFORMATION

ZONE	ASSUMED TOTAL IRRIGABLE AREA	AVERAGE DISTANCE OF NEAREST PLOT BORDER FROM THE RIVER (m)	ELEVATION ABOVE RIVER WATER LEVEL (m)	
			AVERAGE	HIGHEST POINT
1	800	50	20	25
2	600	870	30	35
3	500	1 700	45	55
TOTAL	2000			

5.3.2 Results of Analysis

The assumptions made in the analysis are shown on the printout, which is given in ANNEXURE 18. The result of the analysis is shown in the TABLE 28 below.

TABLE 28 : SUMMARY OF RESULTS OF ANALYSIS

	NETT OPERATIONS CASHFLOW	NETT BENEFIT	BENEFIT/COST RATIO	INTERNAL RATE OF RETURN
Lower Ground Zone 1	R 98 531	- R 29 659	0.9	6.6%
Higher Ground Zone 2	R 58 289	- R 90 530	0.8	0

From this analysis irrigation development at Aussenkjer would not be economic.

It can be seen from the above TABLE that only an extension to the existing irrigation, on Zone 1, would be economically feasible. This remains so even if a capital subsidy were to be given for a bulk water supply scheme. In other words the total area under cultivation would amount to some 630 hectares.

5.4 FISH RIVER MOUTH TO DABERAS

5.4.1 Project Land

Downstream from the Fish River mouth up to Daberas in the Diamond Area no 1, there are a number of larger irrigable areas. For example; at the Dabimub and Boom Rivers, the Sebrasfontein River, Lorelei, Sendelingsdrift and Daberas. The Dabimub, Boom and Sebrasfontein River areas are jointly refered to as the Dabimub Area.

The relevant irrigable areas are shown in Annexures 19 and 20. The only present development in this region is the 392 ha at Daberas. This area has been supplied with electricity at a central supply point at a cost of 16 c/kWh.

Since most of the land forms a narrow strip along the river, only one strip of irrigation plots (one zone) directly adjacent to the river is considered for irrigation.

The areas of irrigation land and approximate geographical details are given in TABLE 29.

TABLE 29: FISH RIVER MOUTH TO DABERAS GEOGRAPHICAL INFORMATION OF IRRIGABLE AREAS

NO	REGION	GROSS AREAS OF IRRIGABLE SOIL		ASSUMED NETT IRRIGABLE AREA	AVERAGE DISTANCE OF NEAREST PLOT BORDER FROM THE RIVER	GROUND ELEVATION ABOVE RIVER WATER LEVEL	
		CLASS I	CLASS II			AVERAGE	HIGHEST POINT
		(ha)	(ha)	(ha)	(m)	(m)	(m)
1	Dabimub	700	740	1200	50	35	50
2	Lorelei	250	630	600	50	35	50
3	Sendelingsdrift	670	1030	1400	50	35	50
4	Daberas	1660	900	1800	50	25	35
TOTAL		3280	3300	5000			

5.4.2 Results of Analysis

The assumptions made in the analysis are shown on the printout, which is given in ANNEXURE 21. The result of the analysis is shown in TABLE 30 below.

TABLE 30 : SUMMARY OF RESULTS OF ANALYSIS

NETT OPERATIONS CASHFLOW	NETT BENEFIT	BENEFIT/COST RATIO	INTERNAL RATE OF RETURN
R 28 839	- R 124 032	0.8	0

From this analysis irrigation development between the Fish River mouth and Daberas would not be considered economic.

6. ADDITIONAL ASPECTS

6.1 ECONOMICS OF EXISTING DEVELOPMENT

Areas of existing development are briefly summarised in TABLE 31

TABLE 31 : EXISTING DEVELOPMENT

TYPE OF DEVELOPMENT	AREA (ha)
1. Gravity flow flood irrigation	430
2. Pumping using electrical power	531
3. Pumping using diesel energy	767
SUB TOTAL : LANDS PRESENTLY UNDER IRRIGATION	1 728
4. Developed land with electricity supply, presently not utilized	422
TOTAL DEVELOPED LAND	2 150

In terms of the general evaluation model, the lands that are economically feasible for irrigation are as shown in TABLE 32.

TABLE 32 : ECONOMICALLY IRRIGABLE LANDS

TYPE OF LANDS	AREA (ha)
1. Land under gravity flow flood irrigation	430
2. Land under irrigation using electrical power	455
3. Land developed but not presently utilized	110
TOTAL	995

Items (2) and (3) above consist of those lands on the farms Hakiesdoorn and Pelladrift and totals less than items (2) and (4) in TABLE 31 since the farm Daberas is excluded from the list of economically feasible land. Refer also to TABLES 4 and 6 for more detail as to locations of the lands discussed.

However, most of the capital works provided for in the general model have already been established and paid for at the existing developments. Also, by producing higher income cash crops the income-cost ratio will increase. This may result in a benefit-cost ratio in excess of one indicating that even diesel schemes can be economically viable.

6.2 POTENTIAL FOR LARGE SCALE DEVELOPMENT

The critical aspect with regard to economic viability is the cost of electricity. If electricity can be provided for a cost of 10 c/kWH or less then it will be economic to operate some irrigation schemes along the Orange River.

It would be possible to supply electricity at an acceptable tariff if economics of scale could be brought into play in providing the electrical infrastructure. In other words, providing an electrical reticulation network along both sides of the Orange River. Taking into consideration the location of the irrigable soils and the extent of the individual stretchs, only the region between the farms Houms Revier and Aussenkjer should be so supplied. Outside of this region extending such a large scale distribution network would not be practical.

The cost of providing such an electrical infrastructure has been estimated to be R12,3 million; R3 million for a substation at Gaidip, R7,8 million for the powerlines and R1,5 million for a further 5 substation. Given the expected level of energy requirements to be met the total energy cost would be in the order of 7,25 c/kWH.

Therefore on the basis of the calculation used in this report, irrigation development of the region between Houms Revier and Aussenkjer would be economically viable. This would be about 10 000 hectares.

The total initial capital investment required for such a development would be approximately R54 million, shared between the South African and South West African governments.

6.3 DEVELOPMENT OF DABERAS

Whilst it has been shown that the development of Daberas is not economically viable under the present model, it is felt that such a scheme could be viable under different parameters. The demand probably exists in that area for fresh vegetables and fruit. Such demand centres would be; Oranjemund, Luderitz, Aus, Alexander Bay and Port Nolloth.

The growing of higher income crops and the development of a smaller area of land could well change the economics of such a scheme. This has not specifically been looked into. To do so properly would require a market survey to be conducted in order to determine the type and volume of each crop that could be marketted.

7. CONCLUSIONS

The economic feasibility of irrigation along the Orange River in general and for three specific areas has been investigated. It has emerged that the biggest single factor governing viability is that of the cost of electricity. Other factors such as the size of irrigation units and the type of crops that are grown also influence the study but to a lesser extent. In coming to these conclusions it must be stated that these are based upon certain assumptions. Briefly these assumptions are that the scheme must generate cash income, that it will enjoy a relatively high level of management and that a certain level of remuneration must be achieved. It certainly does not consider subsistance farming.

It is evident from this study that given the assumptions, the cost of electricity is critical. Irrigation of the proposed farming units is not economical when electricity costs in excess of 10 c/kWH. Increasing the area under cultivation is not considered practical as there is a limit to the area of land that one person can manage. Changing to higher income crops would improve the situation but this has other associated problems already discussed in the report.

Also as part of the economic feasibility of the development the cost of such development must also be considered. The input of capital required to develop further the available land for irrigation is R54 million, in present values. Whether such funds are available is a question which is beyond the scope of this report to consider. But it is one that has a direct bearing on practicality and economic viability.

In terms of practicality the governing physical and socio-economic factors need to be considered separately.

The available land does not always exist in convenient configurations. However sufficient suitable land is available. Water is also available for irrigation. Perhaps not sufficient for all the land but there again all the land would not be developed. The climate is suitable for the growing of

certain crops. On the other hand the physical infrastructure is poorly developed. Whilst this in itself would not rule development out it will act as a constraint and attention will focus on the better provided for areas.

Considering the physical factors alone it is practical to develop irrigation along the Lower Orange River.

With respect to the socio-economic factors these pose the more important constraints on development. Development of any area in the region will require a substantial injection of funds - not just capital funds for the irrigation development itself. Such funds are scarce and there would be competing requirements for those same funds.

Manpower with the appropriate skills to make a success of such a project is seen as posing a problem. The provision of supporting services not only in the economic sphere but also in the social sphere will pose difficulties. This will also be with regard to manpower and infrastructure.

The type of crops to be grown, the volume and the marketting of them is an area which would need more attention and investigation.

Considering the socio economic factors, as outlined above, doubts must be expressed as to the general practicality of the proposed development of irrigation agriculture.

The number of new jobs that could be created by total regional development is approximately 1000 permanent job opportunities and 8000 temparary job opportunities. The cost of creating each new permanent job opportunity is an average R45 000, which is high in comparison with industrial job creation.

However these factors must not be judged in isolation, they must be compared with similar development projects. Only in such a manner can a proper perspective and an objective evaluation be made as to what development action would yield the best results.

8. RECOMMENDATIONS

It is recommended that;

8.1 the conclusions as arrived at in paragraph 7 of this report be accepted

8.2 this report be made available to the following institutions to take cognisance of

Directorate Agriculture and Forestry: Department of Agriculture and Nature Conservation

Department of Economic Affairs

Directorate Agriculture: Administration for Whites

Directorate Development Co-ordination: Department of Governmental Affairs

South West African Agronomic Board

9. APPROVAL

9.1 This Report has been read and approved for submission to the Director: Investigations

CHIEF : PLANNING

DATE: 15/2/88

9.2 I support the recommendations set out in this Report and submit it to the Secretary for Water Affairs for approval in principle.

DIRECTOR : INVESTIGATIONS

DATE: 16/2/88

9.3 The recommendations in this Report have been decided upon as follows:

Approved

SECRETARY FOR WATER AFFAIRS

DATE: 22.2.88

APPENDIX A

1. CROP WATER DEMAND AND PEAK IRRIGATION REQUIREMENTS

In a recent publication (Ref. 2), called the Green Book, the irrigation requirements for various crops at various weather guaging stations were computer simulated by using the "evaporation pan method". The guaging station under consideration here is Vioolsdrift.

In order to use the published data in this book, a decision must be made on the value of the total water input per irrigation cycle in millimetres, called the design application.

Two soil classes are being considered for irrigation, namely Class I and Class II. In the absence of measured soil water infiltration rates and storage capacities, the values of these parameters are assumed to be in accordance with generalised figures that have been given in literature (References 3 and 4) for various soil texture classes. This information is summarized in TABLE A.1

TABLE A.1: SOIL INFILTRATION RATES AND PLANT AVAILABLE MOISTURE

IRRIGABILITY CLASS	ASSUMED TEXTURE CLASS	ASSUMED INFILTRATION RATE (mm/h)	ASSUMED AVAILABLE MOISTURE (mm/m depth)
I	Medium textured Silt Loam	10	150
II	Moderate course textured Loamy Sand	20 25	85 63

It is further assumed that a maximum of 50% of the plant available moisture in the Class I soils and 70% of those in the Class II soils can be consumed before a reduction in plant growth and crop yield will take place. By using this information the required irrigation application needed to restore the soil water content from this level of depletion back to field capacity, called the maximum design application, can be calculated. The results are given in TABLE A.2 below. Any water provided over and above this will leach out of the plant root zone and is unavailable for the plant.

TABLE A.2 IRRIGATION: DESIGN APPLICATION

CROP	DEPTH OF PLANT ROOT ZONE (mm)	MAXIMUM DESIGN APPLICATION (mm)	
		Class I Soil	Class II Soil
Cotton	1 000	75	60
Wheat	900	68	54
Maize	900	68	54

An irrigation system with a design application of 50 mm and an application rate of less than 10 mm/h will therefore be suitable for use on both soil classes.

According to the Green Book, the total evapotranspiration for cotton being grown from 15 September to 12 April, is 1 276 mm. For a 50 mm design application, the effective rainfall is 24 mm, so that the nett average irrigation requirement is 1 252 mm per growing season. The distribution of this water requirement is given in Figure A.1, together with that of maize, which is partly grown over the same period.

Since the seasonal requirements of wheat and maize have not been simulated in the Green Book, an approximate hand calculation is done below. The calculation is based on crop factors being given in the Green Book

To determine the average monthly A-pan evaporation for Vioolsdrif, which is not directly given in the Green Book, the monthly evapotranspiration for lucern has been divided by its crop factors, as in TABLE A.3.

TABLE A.3 DERIVATION OF MONTHLY A-PAN EVAPORATION AT VIOOLSDRIF

MONTH	MONTHLY EVAPO= TRANSPIRATION OF LECURN: E (mm)	MONTHLY CROP FACTORS OF LUCERN	CALCULATED "A-PAN" EVAPORATION: E (mm/month)	(mm/day)
July	60	0,5	120	3,87
August	79	0,5	158	5,10
September	134	0,6	223	7,43
October	198	0,7	283	9,13
November	267	0,8	334	11,13
December	295	0,8	369	11,90
January	290	0,8	363	11,71
February	239	0,8	299	10,68
March	221	0,8	276	8,90
April	155	0,7	221	7,37
May	95	0,6	158	5,10
June	57	0,5	114	3,80
	TOTAL		**2 918**	

NOTE: The original calculation of the evaportranspiration was, apart from the crop factors, based on an adjusted 15 year Symons evaporation pan record (1961-1975).

Using the crop factors of wheat and maize given in the Green Book, the water requirements are derived in TABLE A.4.

TABLE A.4: ESTIMATED EVAPOTRANSPIRATION OF WHEAT AND MAIZE AT VIOOLSDRIF

PERIOD	NUMBER OF DAYS	CROP FACTOR (F)	E (REFER TO TABLE 7.1) (mm/day)	E =F.E (mm/day)	E OVER WHOLE PE (mm
A WHEAT					
15/05-31/05	17	0,3	5,10	1,53	26
01/06-23/06	23	0,3	3,80	1,14	26
24/06-30/06	7	0,5	3,80	1,90	13
01/07-03/07	3	0,5	3,87	1,94	6
04/07-13/07	10	0,7	3,87	2,71	27
14/07-28/07	15	0,9	3,87	3,48	52
29/07-31/07	3	1,0	3,87	3,87	12
01/08-31/08	31	1,0	5,10	5,10	158
01/09-16/09	16	1,0	7,43	7,43	119
17/09-30/09	14	0,7	7,43	5,20	73
01/10	1	0,7	9,13	6,39	6
02/10-11/10	10	0,4	9,13	3,65	37
TOTAL FOR WHEAT	**150**				**555**
B MAIZE					
15/12-31/12	17	0,4	11,90	4,76	81
01/01-17/01	17	0,7	11,71	8,20	139
18/01-31/01	14	1,0	11,71	11,71	164
01/02-03/02	3	1,0	10,68	10,68	32
04/02-28/02	25	1,1	10,68	11,75	294
01/03-10/03	10	1,1	8,90	9,79	98
11/03-27/03	17	0,9	8,90	8,01	136
28/03-31/03	4	0,5	8,90	4,45	18
01/04-13/04	13	0,5	7,37	3,69	48
TOTAL FOR MAIZE	**120**				**1 010**

Assume the effective rainfall for wheat as nil and that for maize as 10 mm, which reduces the nett irrigation requirement to 555 mm and 1 000 mm per season respectively. (The effective rainfall for lucern over the period from

December to March was calculated in the Green Book as 11 mm and that for January to April as 15 mm. The 10 mm assumed for maize is therefore on the conservative side).

In the general model, it was assumed that for any given summer season, 50% of the soil will be under cotton and the other 50% under maize. The area under cotton will be followed by wheat in the next winter and then maize in the following summer and the area under maize will be followed by cotton in the next spring. This system means that the total nett annual crop water demand is (555 + 1 252 + 1 000)/2 = 1403,5 mm or 14 035 m^3/ha.

The peak irrigation requirement is, however, not the average of the individual summer crop peaks since these peaks do not coincide. The water demand distribution with time for cotton and maize as shown in Figure A.1, illustrates this aspect. By calculating a weighted average of the water requirements for each day a nett peak water demand of 9,54 mm/day is derived. This peak is, however, a result of daily evaporation averaged over a whole month and the short term peak will be somewhat higher. Such short term peaks have been calculated in the Green Book for individual crop systems and this data will be used to estimate a peak factor for the composite crop system under consideration.

As can be derived from Figure A.1, the peak water requirement occurs during the end of January. A crop of which the peak also occurs during this period is cotton being planted on 15 November. The long term peak for this crop, as calculated by dividing the total evapotranspiration during the peak period by the number of days in the period, is 9,57 mm/day. The short term peak for this crop is 11,1 mm/day, yielding a long term/short term peak factor of 1,16. However, 90% of the time, the peak will be below 9,8 mm/day, yielding a long term/short term peak factor of 1,024. This latter factor is used, yielding a peak irrigation requirement in our case of 9,54 x 1,024 = 9,77 = 9,8 mm/day. The reason for the latter peak factor being used is that the irrigation system is not designed to operate 24 hours per peak day, thus leaving a couple of hours for extended irrigation when needed. Also during

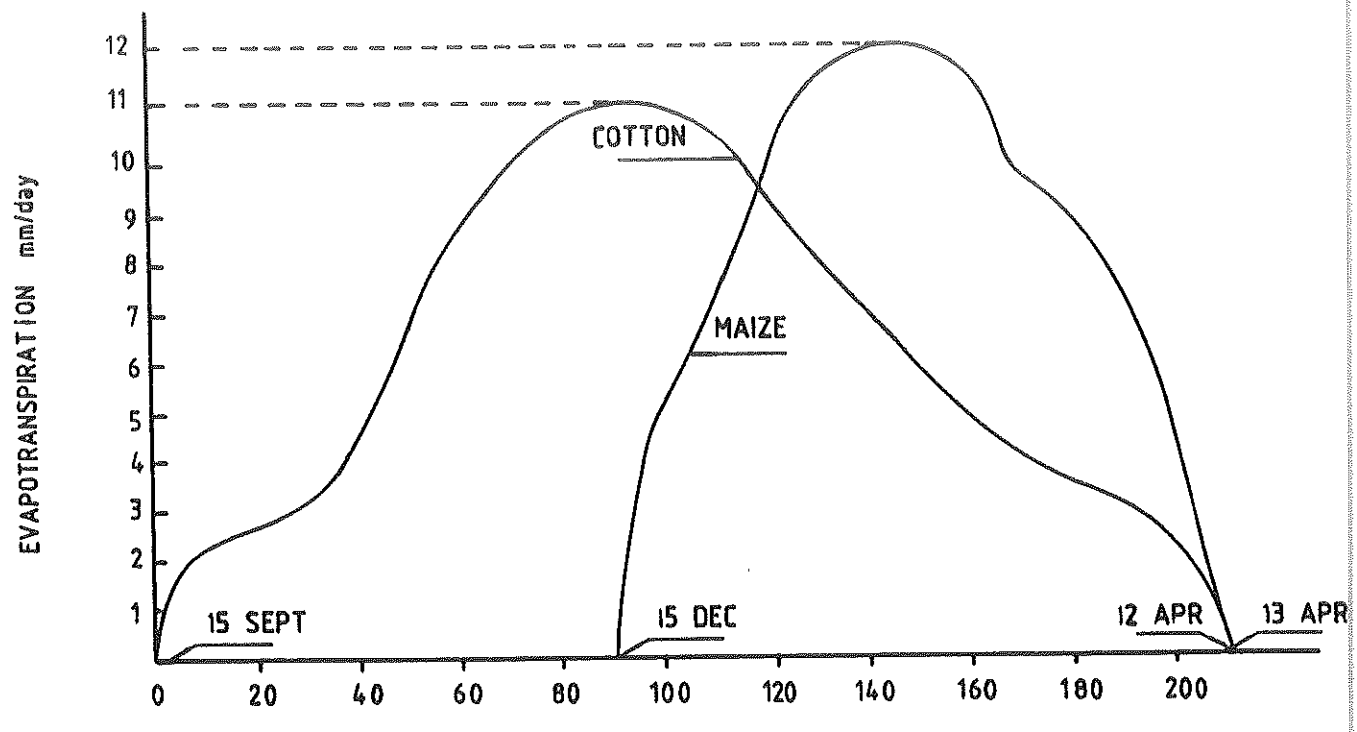
this period, a higher soil moisture tension for cotton can be allowed so that better use is made of the soil water reservoir, which effectively decreases the critical peak factor.

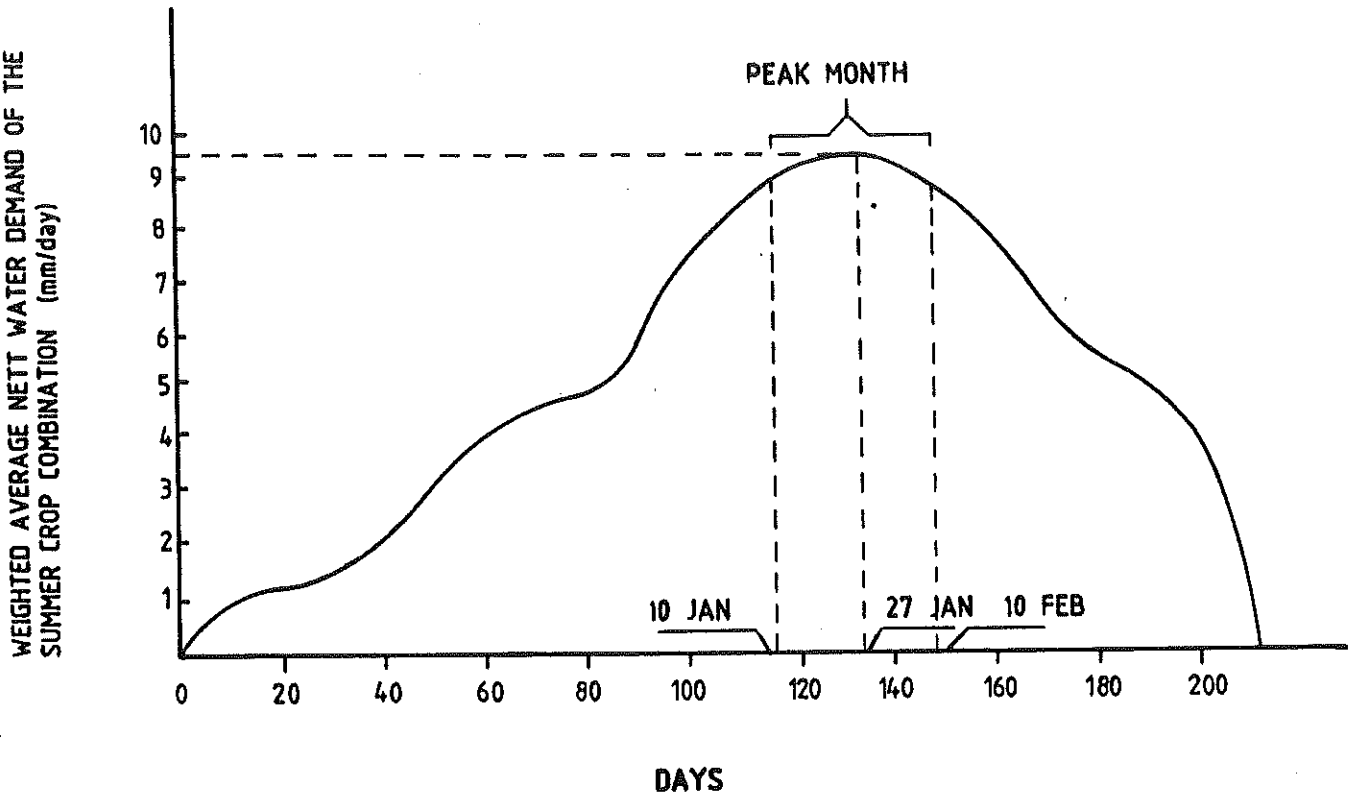
To summarise, the nett peak irrigation requirement is taken as 9,8 mm/day.

The peak month; as derived from Figure A.1 occurs from 10 January to 10 February as can be seen from Figure 7.1, and the water requirement during this period is calculated as 279 mm/month. Allowing for 4 mm of effective rain during this period, the nett peak month irrigation requirement is 275 mm.

FIGURE A.1

NETT WATER DEMAND DISTRIBUTION CURVES FOR COTTON AND MAIZE AND NETT PEAK REQUIREMENTS





2. SPRINKLER SYSTEM LAYOUT, DESIGN AND COSTING

Two basic irrigation land units have been selected to structure and cost the irrigation system, namely 100 ha and 20 ha. Each basic unit has its own main water supply system which subtracts water directly from the river. Refer to Figures A.2 and A.3 for layout sketches. The 20 ha basic unit were selected to represent a typical system layout on soils that form a narrow strip along the river. The 100 ha basic unit is to represent layout systems on wider soil strips so that the soils further away from the river also share in one common water supply system.

The required gross rate for the irrigation systems is determined by the formulae:

$$Q = \frac{i\ A}{360\ z\ u} \qquad (1)$$

where

Q = gross flow rate in m^3/s
i = nett peak irrigation demand in mm/day
A = area under irrigation in ha
z = efficiency of the irrigation system
u = number of irrigation hours per day.

The unit area under consideration is 1 ha and from paragraph 6.3.2, i = 9,8 mm/day.

With z = 0,7 and u = 18, the resulting flow rate Q is 7,778 m^3/ha/h, or approximately 7,78 m^3/ha/h. From the previous section, the nett average annual irrigation volume is 14 035 m^3/ha and the corresponding gross value is thus 14 035/0,7 = 20 050 m^3/ha/a. The resulting average annual number of pumping hours is 20 050/7,778 = 2 578.

The energy requirements for irrigation is calculated from the formulae:

$$P = \frac{Qgh}{rs} \qquad (2)$$

where

P = power requirement in kW
Q = gross flow rate in m^3/s
g = gravitational acceleration in m/s^2
h = average pumping head in metres
r = effeciency factor of the pumps
s = effeciency factor of the motors

For electrical pumpsets the values of r and s are taken as 0,75 and 0,8 respectively and with g = 9,8 m/s^2, formulae (2) reduces to:

$$P = 16,3\ Qh \qquad (3)$$

The maximum and average energy demands for lower ground in the general model are 2,043 kW/ha and 1,866 kW/ha respectively. The average annual energy consumption is therefore 1,866 mulitplied by the number of pumping hours per year, which amounts to 4811 kWh/ha/a. The corresponding figures for higher ground 2 are 2,747 kW/ha, 2,395 kW/ha and 6174 kWh/ha/a.

In TABLE A.5, a schedule of costs and quantities is given for the water supply system of a 100 ha basic unit on lower ground. The sprinkler system is

designed so that five 1,58 ha areas can be irrigated simultaneously, and three such set-ups per day of 6 hours each will suffice in the peak irrigation periods. The peak irrigation cycle for a 50 mm application and 9,8 mm/day application rate is 5 days. The gross precipitation rate of the system is 10 mm/h.

The layout in FIGURE A.2 will be satisfactory as long as the land is fairly flat, but as soon as steeper slopes are encountered, it would be better if one pump supplies the upper horizontal pipeline only and the other pump the lower horizontal line. This implies a double pipeline of smaller diameter over the first 250 m. The extra cost of this is however mostly offset by a cost reduction due to one pumpset now being smaller. This alternative is therefore not considered in the economic analysis.

Costs and quantities for the 20 ha unit on the lower ground are given in TABLE A.2.

The values in TABLE A.5 and TABLE A.5 reduce to R455/ha/a and R453/ha/a respectively when converted to equivalent annual costs with maintenance costs included. This means that the two systems are equivalent as far as annualised cost is concerned. The cost of the system in FIGURE A.2 is therefore taken as being representative for most of the land forms that will be encountered. In the report, for simplicity, all hand movable sprinkler system layouts refer to the one given in FIGURE A.2, unless otherwise specified.

TABLE A.5: COSTS AND QUATITIES FOR THE 100 ha BASIC UNIT SPRINKLER SYSTEM FOR THE LOWER GROUND

ITEM	DESCRIPTION	UNIT	QUANTITY	RATE (R)	ROUNDED OFF AMOUNT
	SECTION 1: MECHANICAL AND ELECTRICAL INSTALLION				
1	Two stage centifugal pumps	No	2	10 300	20
2	132 kW Electric motors	No	2	6 500	13
3	Electrical connections	Sum	-	-	
	TOTAL FOR PUMPSETS				34
	SECTION 2: CIVIL WORKS				
1	450 mm CID FC underground pipe class 12	m	250	98	24
2	350 mm CID FC pipe class 18	m	400	64	25
3	250 mm NB uPVC underground pipe, class 4	m	2 520	23	58
4	Pumpstation and connections, valves, metres	Sum			13
5	On land underground pipe connections	Sum			4
6	Permanent hydrants	No	32	650	20
	TOTAL FOR CIVIL WORKS				146
	SECTION 3: SPRINKLER SYSTEM				
1	108 NB Aluminium quick coupling pipes	m	360	16,33	5
2	89 NB Aluminium quick coupling pipes	m	6 720	10,17	68
3	Sprinklers, 2,5 m risers, saddles and base plates	No	595	19,42	11
4	End caps, T-pieces and bends	Sum			3
	TOTAL FOR SPRINKLER SYSTEM				88
	GRAND TOTAL				R269

TABLE A.6: COSTS AND QUANTITIES FOR THE 20 ha BASIC UNIT SPRINKLER SYSTEM FOR THE LOWER GROUND

ITEM	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
	SECTION 1: MECHANICAL AND ELECTRICAL INSTALLION				
1	Two stage centifugal pumps	No	1	7 800	7 8
2	45 kW Electric motors	No	1	2 700	2 7
3	Electrical Connections	Sum		300	3
	TOTAL FOR PUMPSETS				10 8
	SECTION 2: CIVIL WORKS				
1	250 mm NB uPVC underground pipe, class 6	m	420	30	12 6
2	Pumpstation, connection, valves, etc.	Sum			4 7
3	Permanent hydrants	No	7	650	4 5
	TOTAL FOR CIVIL WORKS				21 8
	SECTION 3: SPRINKLER SYSTEM				
1	108 NB Aluminium quick coupling pipes	m	402	16,33	6 5
2	89 NB Aluminium quick coupling pipes	m	930	10,17	9 4
3	Sprinklers, risers, saddles and base plates	No	105	19,42	2 0
4	End caps, T-pieces, bends	Sum			5
	TOTAL FOR SPRINKLER SYSTEM				18 5
	GRAND TOTAL				51 2

For the layout in FIGURE A.2 as applied to the higher ground the two 132 kW motors are replaced by two 185 kW motors and the first 25 m of pipline are taken as class 18 instead of class 12. The costs for the pumpsets and civil works now become R38 100 and R147 200 respectively, while that of the irrigation system remains unchanged.

A summary of the capital costs, expressed as rand per hectare and as used in the general model, are given in TABLE A.7 below.

TABLE A.7 WATER SUPPLY AND IRRIGATION SYSTEM COST AS FOR THE GENERAL EVALUATION MODEL

NO	DESCRIPTION	UNIT CAPITAL COST (R/ha)	
		ELEVATION GROUP 1	ELEVATION GROUP 2
1	Pumpsets	341	381
2	Civil works	1464	1472
3	Sprinkler System	888	888
	TOTAL	2693	2741

HAND MOVE SPRINKLER SYSTEM LAYOUT : 100ha BASIC UNIT
(25 HECTARE BLOCKS)

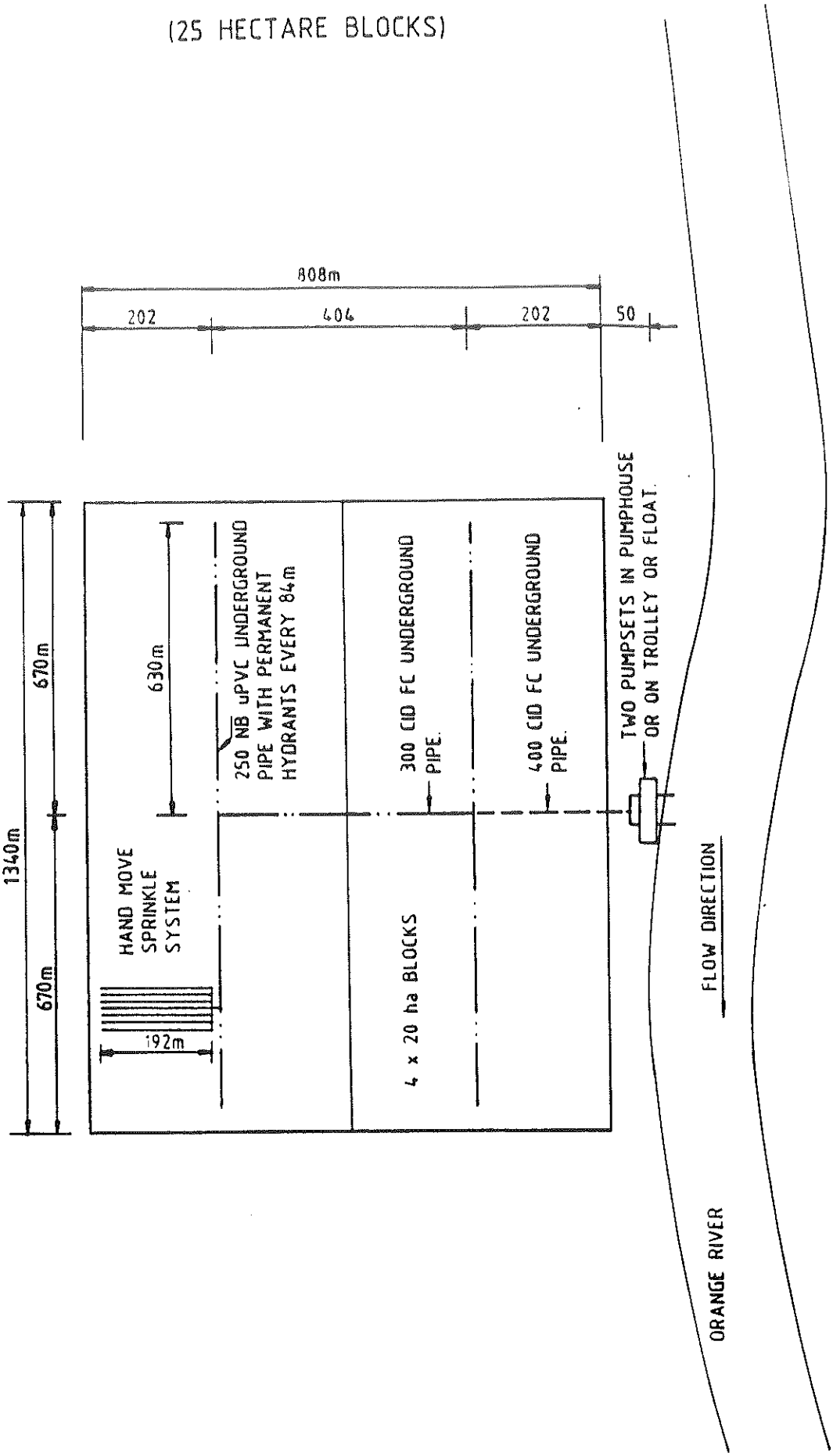
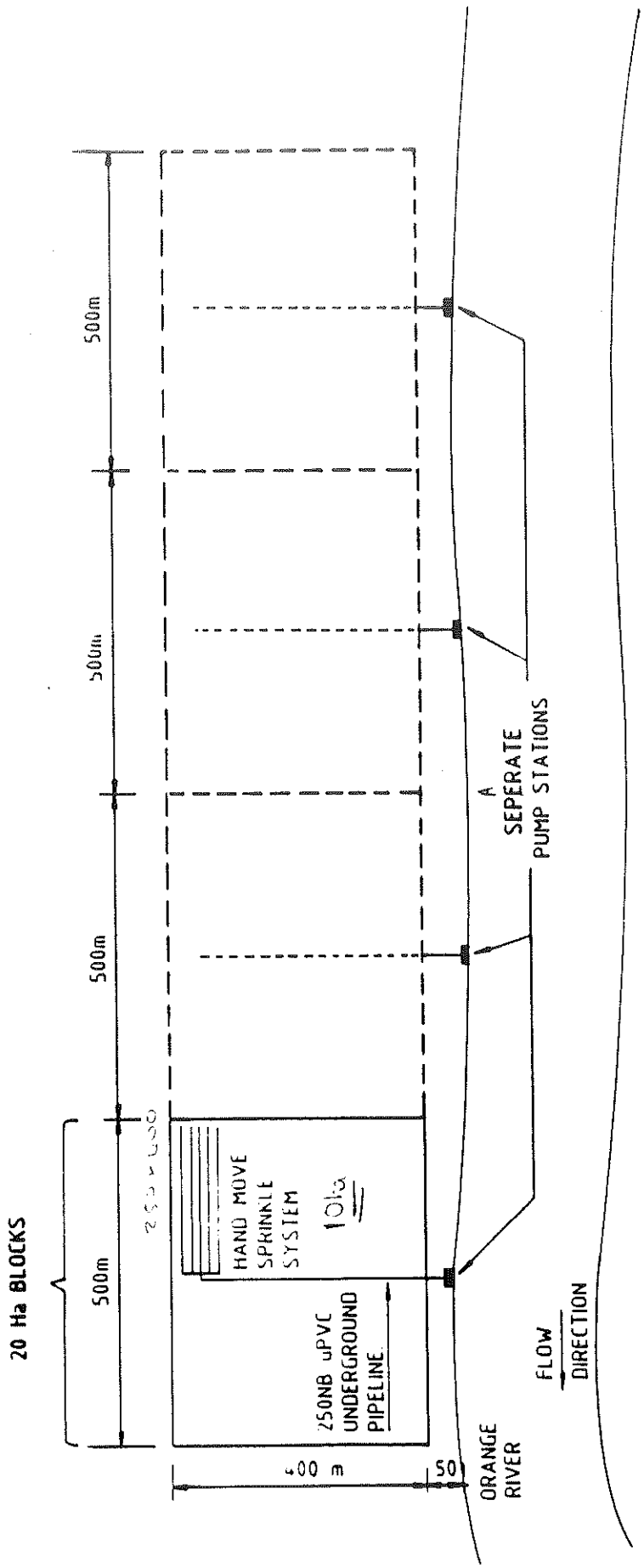


FIGURE A.3

SPRINKLER SYSTEM LAYOUT : 20ha BASIC UNIT.



APPENDIX B

1. CROP GROWING METHODS AND MECHANISATION

The crops considered in this model for cultivation are cotton, wheat and maize. In all cases, the soil preparation before planting is started by chisel ploughing the land. If the previous harvest was cotton, however, the ploughing is preceded by cutting the stems with a rotary disc cutter. Thereafter the land is disced with an offset disc, but in the case of wheat this operation is preceded by the spreading of fertilizer. The seeds are planted and in the case of cotton and maize,starter fertilizer is planted simultaneously. Maize and cotton are thereafter mechanically cultivated. All other weed and pest control is done chemically. For maize and cotton, one nitrogen top application is also done.

Harvesting of maize and wheat is done mechanically by contractors and cotton harvesting is done by hand. All produce is baled and road transported by contractors to the nearest railway station from where the cotton is sent to Upington and the wheat and maize sent via Mariental to Windhoek.

The actual on-land periods for the crop system under consideration was given in paragraph 4.3.3 of this report.

A minimum, but sufficient set of impliments, tractors and vehicles required for the assumed cultivation pattern are listed in TABLE B.1.

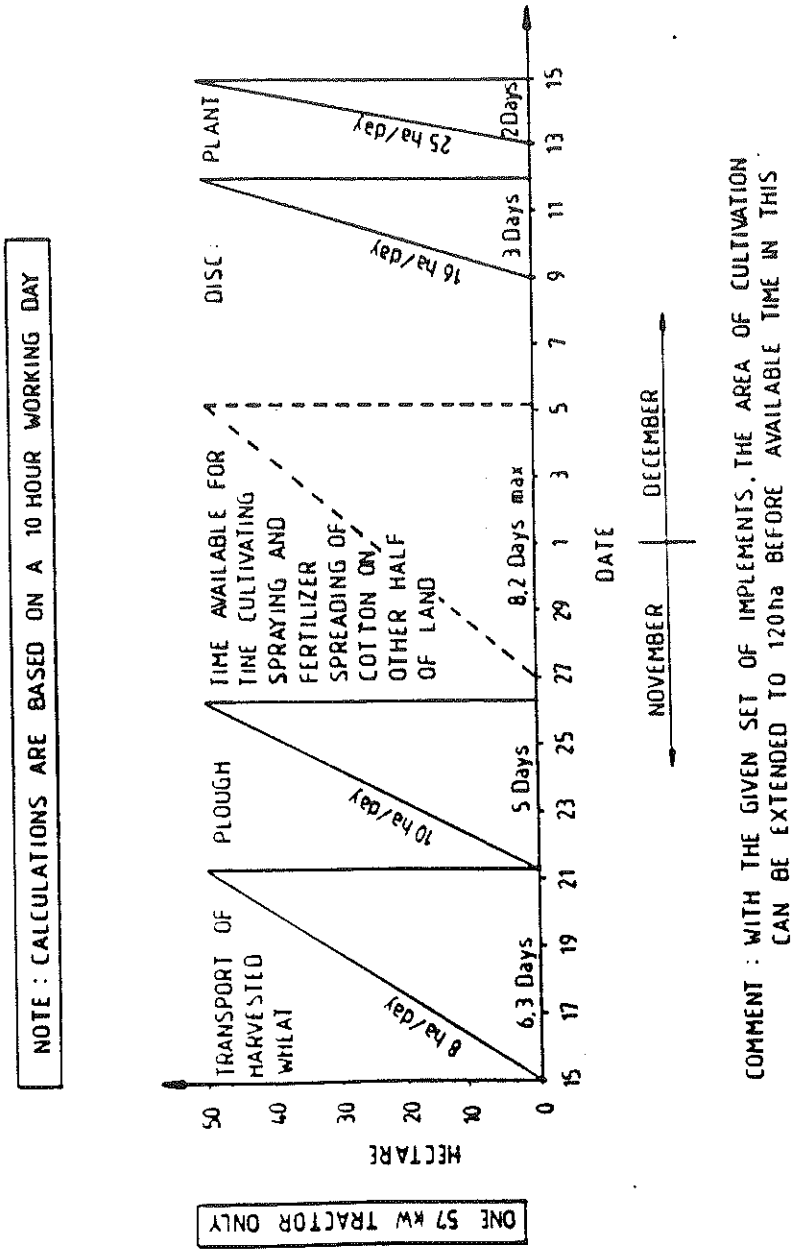
TABLE B.1 BASIC REQUIREMENT OF VEHICLES: TRACTORS AND IMPLIMENTS

IMPLEMENT	AMOUNT	SIZE	1985 PURCHASE COST R
Light duty vehichle	1	1 ton	13 300
Tractor with altitude compensation	1	57 kW	34 860
Four wheeled dropside trailer	2	5 ton	11 600
Rotary type mower (shlasher)	1	1,85 m	3 500
Mounted offset disc harrow	1	1,9 m	2 500
Mounted chisel plough	1	7 tyne; 2,1 m	3 550
Mounted pneumatic planter	1	4 row x 0,09 m	8 150
Trailed disc wheat planter	1	14 row x 0,15 m	8 190
Mounted fertilizer speader	1	3 m; 350 kg	1 710
Boom type sprayer	1	600 ℓ; 10 m boom	2 680
TOTAL CAPITAL COST			R90 040

Note that in TABLE B.1 no provision is made for lorries and harvesters, since these services are obtained from contractors.

The critical period in the whole mechanised cultivation process have been identified as the switching from wheat to maize on half of the irrigation land, while cotton on the other half of the land may require spraying, tine cultivation and fertilizer spreading. A mechanised working program for this period is given in FIGURE B.1 for a 100 ha irrigation unit. It have been calculated that the maximum area that can be served by the basic mechanisation set is 120 ha. This can be deduced from FIGURE B.1.

WORKING PROGRAM FOR CRITICAL STAGE ON 100 ha UNITS : SWITCHING FROM WHEAT TO MAIZE ON HALF OF THE LAND.



COMMENT : WITH THE GIVEN SET OF IMPLEMENTS, THE AREA OF CULTIVATION CAN BE EXTENDED TO 120 ha BEFORE AVAILABLE TIME IN THIS CRITICAL PERIOD ARE FULLY UTILISED.

By just adding one 29 kw turbo tractor and two more 5 ton trailors to the list, a total area of up to 200 ha can be cultivated, as is shown in FIGURE B.2 The total mechanisation cost is now R125 185. Further extensions to mechanisation have not been considered since 200 hectares is already a large irrigation unit.

In FIGURE B.3 a graph is presented which gives the capital cost for mechanisation per hectare, as calculated for various sizes of independant irrigation units.

From the graph it is clear that when the size of the independant irrigation unit decreases from 200 ha, the cost per hectare of mechanisation gradually increases until a unit of about 80 ha is reached, from there on this unit cost increases at a much faster rate.

In this study, two basic independant units, namely a 100 ha unit and a 200 ha unit are considered, unless it is specifically otherwise stated.

WORKING PROGRAM FOR CRITICAL STAGE ON 200ha UNITS SWITCHING FROM WHEAT TO MAIZE ON HALF OF THE LAND.

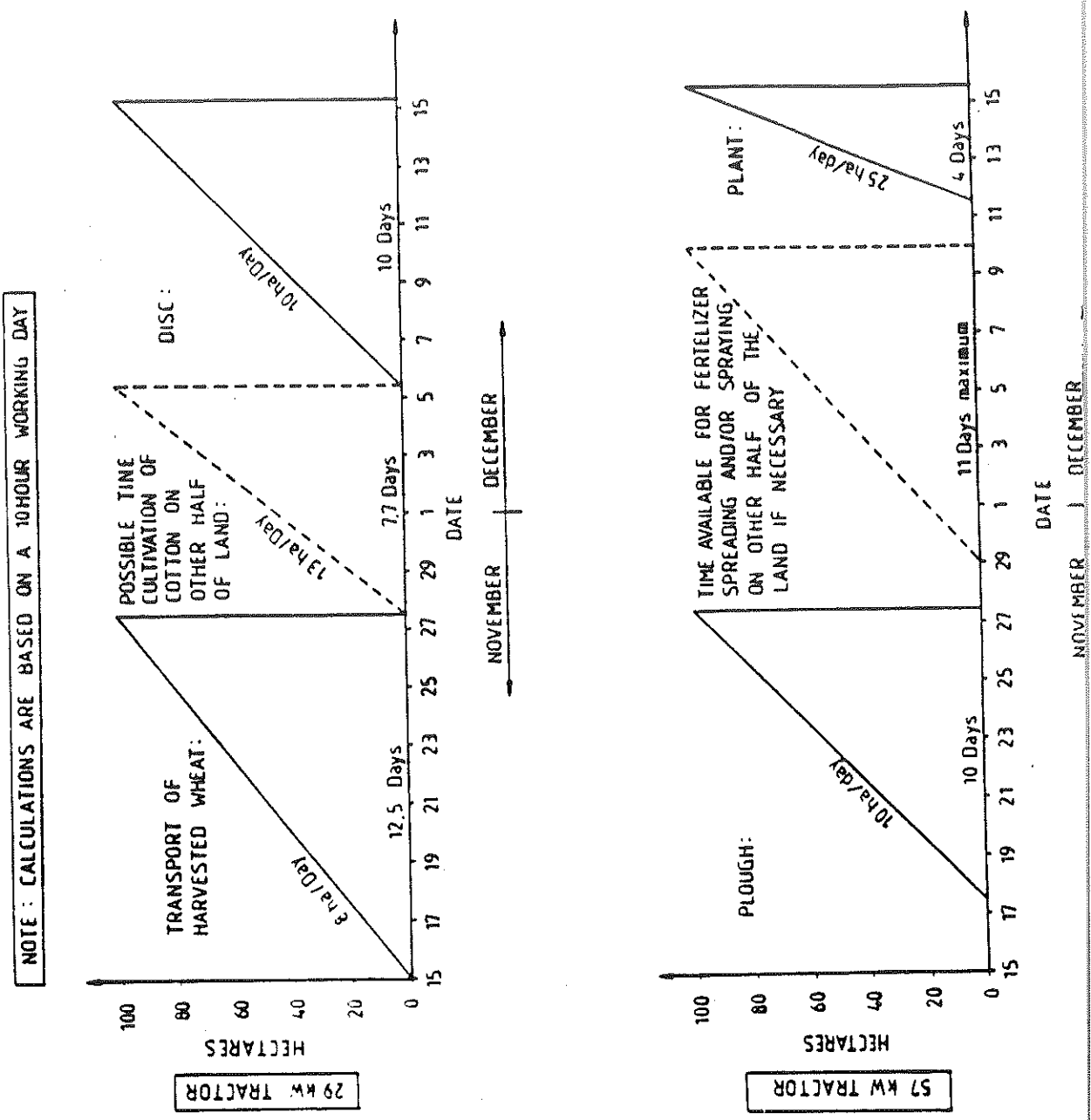
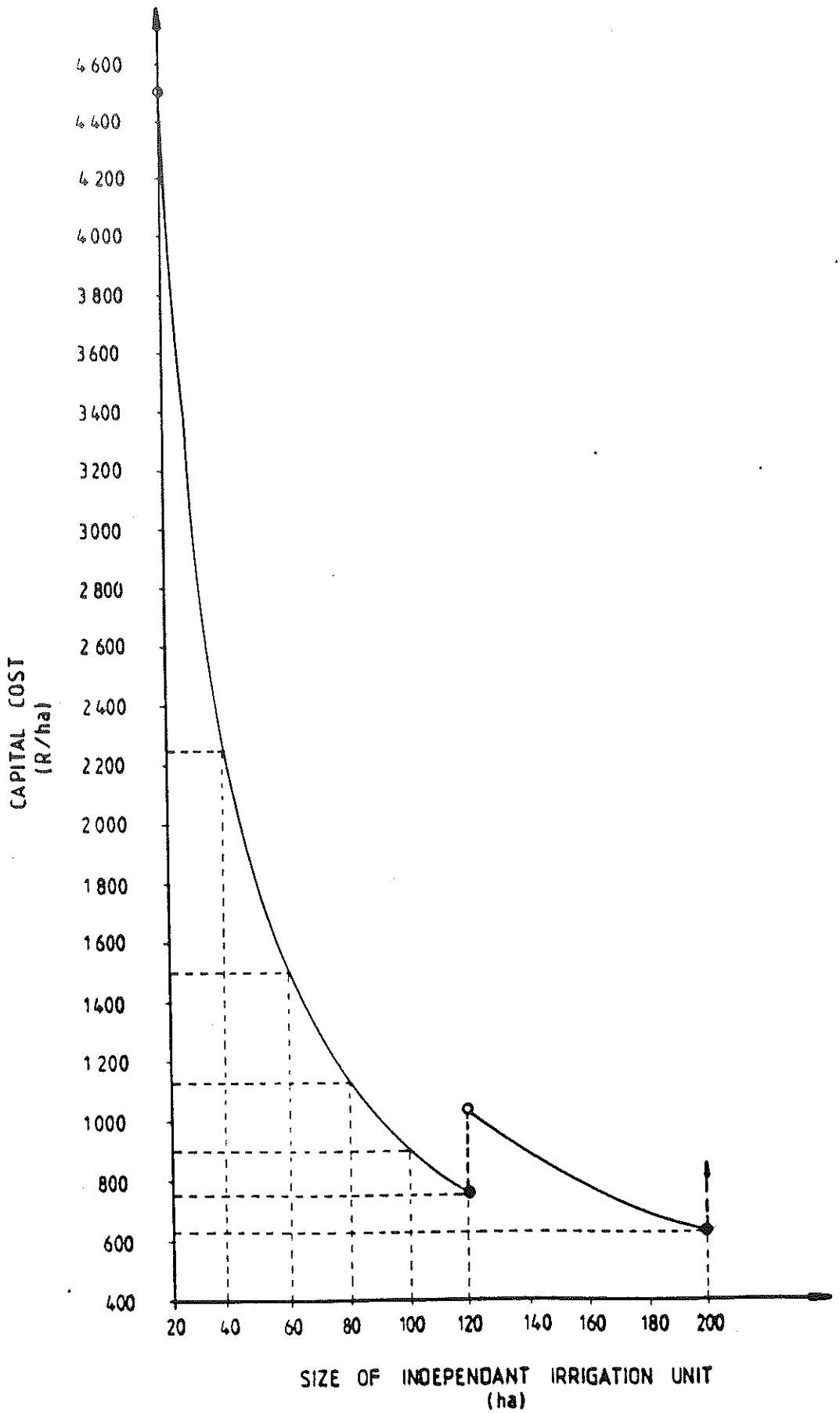


FIGURE 8

CAPITAL COST OF MECHANISATION.



2. LABOUR REQUIREMENTS AND OPERATING COSTS

Permanent labour is required to operate the irrigation system and mechanised equipment, to do maintenance on all capital works and to act as co-workers and supervisors to seasonal workers on all other aspects requiring labour. Seasonal workers are required for hand intensive operations like de-weeding, harvesting of cotton, packaging and loading, etc.

It is estimated by the Division of Agricultural Engineering in Pretoria that, when working in a team, one labourer must be provided for every 10 ha to 15 ha to operate a hand movable sprinkler irrigation system. For a 200 ha unit, therefore 20 labourers are require to operate irrigation. It is further calculated that 8 labourers for mechanised operations and two more for general maintenance and assistence are required per 200 ha unit. However, since only half of the land is irrigated simultaneously with the peak mechanised input, the persons needed for all operations need not be all different labourers, but they can work interchangebly between operation types. An average figure of 20 permanent workers per 200 ha irrigation unit is therefore used in this model. This reduce to one worker per 10 ha. This unit figure also holds for 100 ha irrigation units, but not necessarily for units significantly smaller.

The peak number of temporary or seasonal workers are required during cotton picking. It is estimated that between 1,5 and 1,8 labourers are required per hectare under cotton, for the harvesting. Therefore, additional to the 20 permanent workers on a 200 ha land, another 180 temporary workers are needed for cotton picking. The total labour requirement therefore reduce to one per hectare during the peak period.

Figures provided by the Noordoewer farmer's association regarding their peak labour requirements under the present cropping system also reduce to about one labourer per hectare. This figure is therefore assumed as a norm in this report.

As far as allocated operating costs are concerned, transport costs and electricity costs for irrigation are dealt with elsewhere. Here, a breakdown of material costs, labour costs and costs for fuel, maintenance and repair on tractors and implements are given. The material cost is given in TABLE B.2.

TABLE B.2: MATERIAL COSTS

ITEM	UNIT	COTTON		WHEAT		MAIZE	
		QUAN= TITY	COST (R/ha)	QUAN= TITY	COST (R/ha)	QUAN= TITY	COS (R/
Seed	kg/ha	30	37	115	69	20	4
Fertilizers (a) 2.3.4 (30)	kg/ha	170	84	208	103	189	9
(b) Uream (46) HB	kg/ha	178	96	205	112	196	10
(c) Potash Nitrate	kg/ha	51	46				
Chemicals (a) Weed Control	Sum		53		23		3
(b) Pest Control	Sum		151		15		3
TOTAL COST			467		322		31

In TABLE B.2 the mechanised tillage actions and its requirements are given, while the cost for labour, fuel, maintenance and repair is given in the sub= sequent tables, namely TABLE B.4, B.5 and B.6.

30 kg/ha * R2/kg. 60
170 kg/ha * 0.64 108.8
178 kg/ha * 1.14 202.72
51 * 0,51 26.
398
200
598. ≡ L60.0/ha

TABLE B.3: MECHANISED TILLAGE ACTIONS

ACTIVITY	TIMES OVER	INPUT (hours/ha)			NUMBER OF LABOURERS	POWER DEMAND (kW)	C TA (
		IMPLEMENT	TRACTOR	LABOUR			
SECTION 1: COTTON							
1. Plough	1	1	1,10	1,21	1	48	
2. Disc	1	0,63	0,69	0,76	1	33	
3. Plant with starter fertilizer	1	0,40	0,44	1,45	3	26	
4. Tine cultivation	1	0,50	0,55	0,61	1	32	
5. Fertilizer spreading	1	0,71	0,78	1,72	2	15	
6. Spray for weeds	1	0,28	0,31	1,02	3	25	
7. Spray for pests	6	1,68	1,85	6,10	3	25	
8. Stem cutting	1	0,56	0,62	0,68	1	20	
9. On-farm transport	-	0,14	0,15	0,33	2	-	
TOTAL FOR COTTON		5,90	6,49	13,88			
SECTION 2: WHEAT							
1. Plough	1	1	1,10	1,21	1	48	
2. Spread fertilizer	1	0,71	0,78	1,72	2	15	
3. Disc	1	0,63	0,69	0,76	1	33	
4. Plant	1	1	1,10	3,63	3	39	
5. Spray weed killer	1	0,28	0,31	1,02	3	25	
6. On-farm transport	-	0,79	0,87	1,18			
TOTAL FOR WHEAT		4,41	4,86	9,52			
SECTION 3: MAIZE							
1. Plough	1	1	1,10	1,21	1	48	
2. Disc	1	0,63	0,69	0,76	1	33	
3. Plant with starter fertilizer	1	0,40	0,44	1,45	3	26	
4. Tine cultivation	1	0,50	0,55	0,61	1	32	
5. Fertilizer spreading	1	0,71	0,78	1,72	2	15	
6. Spraying	2	0,56	0,62	2,03	3	25	
7. On farm transport	-	0,50	0,55	0,77			
TOTAL FOR MAIZE		4,30	4,73	8,55			

TABLE B.4: LABOUR COSTS

ACTION	LABOUR UNIT COST (R/h)	COTTON		WHEAT		MAIZE	
		QUANTITY (h/ha)	COST (R/ha)	QUANTITY (h/ha)	COST (R/ha)	QUANTITY (h/ha)	CO (R
Operating of tractor	0,7	7,14	5,00	5,34	3,75	5,20	
Operating of impliments	0,5	6,74	3,40	4,19	2,10	3,35	1
Irrigation	0,5	30	15,00	30	15,00	30	15
Loading input materials	0,5	0,7	0,35	0,65	0,35	0,80	0
Loading produce	0,35	3,5	1,25	5	1,75	6	2
Thinning by hand	0,35	25	8,75	-	-	-	
Cultivate by hand	0,35	50	17,50	-	-	-	
Picking up of maize	0,35	-	-	-	-	20	7
Cotton picking	12c/kg	3500 kg	420,00	-	-	-	
Bale, weigh and stitch	0,35	12	4,20	25	8,75	30	10
TOTAL COST (ROUNDED TO NEXT RAND)(R/ha)			476 - 420 56		32		

TABLE B.5: FUEL COSTS

NO	DESCRIPTION	COTTON	WHEAT	MAIZE
1.	Power consumption: (kWh/ha)	183	138	132
2.	On farm transport: (ton-km)	0,45	5,55	6,45
3.	Fuel consumption	70	53	51
4.	Fuel cost: (R/ha)	46	35	33

NOTE: Fuel consumption has been taken as 0,38 ℓ/kWh or 0,1 ℓ/ton-km and the fuel price as 65,04 c/ℓ

TABLE B.5: MAINTENANCE AND REPAIR COST

IMPLIMENT/TRACTOR	MAINT & REPAIR UNIT COSTS (R/ha)	COTTON		WHEAT		MAIZE	
		(h/ha)	(R/ha)	(h/ha)	(R/ha)	(h/ha)	(R/ha)
57 kW Tractor	4,18	6,49	27,13	4,85	20,27	4,73	19,77
Trailors	0,29	0,14	0,04	0,79	0,23	0,50	0,15
Rotary Mower	2,80	0,56	1,57	-	-	-	-
Disc Harrow	1,20	0,63	0,76	0,63	0,76	0,63	0,76
Chissel Plough	1,06	1,50	1,59	1,00	1,06	1,50	1,59
Pneumatic Planter	4,35	0,45	1,96	-	-	0,40	1,74
Wheat Planter	4,37	-	-	1,00	4,37	-	-
Fertilizer Spreader	1,71	0,71	1,21	0,71	1,21	0,71	1,21
Spray Equipment	1,79	1,96	3,51	0,28	0,50	0,56	1,00
TOTAL COST (R/ha)			38		28		26

APPENDIX C

COSTS RELATED TO FLOOD IRRIGATION

The following costs apply when having flood irrigation with electrical power instead of the sprinkler irrigation system evaluated earlier. Only the changes to the sprinkler system costs for the low Elevation Ground of the general evaluation model are given here.

Land preparation cost is increased by R100/ha to make provision for land levelling. Implement costs have been increased by R1 050 to provide for ridging equipment.

The layout of the grounds and water supply system chosen is sketched in FIGURE A.2 of APPENDIX A.

Costs of the water supply system changes to those tabled below.

TABLE C.1: COSTS AND QUANTITIES OF A FLOOD IRRIGATION WATER SUPPLY SYSTEM

(20 ha Units)

ITEM	DESCRIPTION	UNIT	QUANTITY	UNIT COST (R)	AMOUNT (R)
	SECTION 1: MECHANICAL AND ELECTRICAL INSTALLIONS				
1	Pumps	No	1	7 500	7 50
2	45 kW Electric motors	No	1	2 800	2 80
3	Electrical Connections		-	Sum	25
	TOTAL FOR PUMPSETS				10 55
	SECTION 2: CIVIL WORKS				
1	315 mm NB uPVC pipe, class 4	m	450	38	17 10
2	Pipe specials, valves, metres, pump house			Sum	4 73
3	Hydrants and outlet structures	No	4	800	3 20
	TOTAL FOR CIVIL WORKS				25 03
	SECTION 3: IRRIGATION SYSTEM				
1	Irrigation Furrows	ha	20	1 500	30 00

Other capital cost changes are an increase in the electrical distribution cost of R160/ha due to more transformers needed. As far as allocated operations costs are concerned, the pumping cost for water decreases by R163/ha/a, R213/ha/a and R260/ha/a respectively for the 10c/kWh, 13c/kWh and 16c/kWh cases respectively, but higher labour and mechanisation costs cause an increase of R55/ha/a on the total allocated operating costs. The labour input have been taken as 100 man-hours per hectare per year.

Maintenance cost on capital works and thus operating overhead costs increases by R38/ha/a.

When irrigation with diesel power instead of electricity is considered, all the costs for electrical distribution and electrical connections fall away, but the capital layout on the diesel motors increases by R22 500 to that of the electrical motors. This reduces to an increased annualised capital cost of R165/ha/a and maintenance cost of R45/ha/a.

The diesel motor's fuel consumption is given by a supplier of the equipment as 0,25 ℓ/kWh. With a diesel cost of 65,04 c/ℓ and an energy consumption 4235 kWh/ha/a, the operating energy cost is R689 per hectare per year.

A motor efficiency of 60% has been assumed.

APPENDIX D

COSTING FOR NOORDOEWER BULK WATER SUPPLY SYSTEM

A cost breakdown of the assumed bulk water supply system at Noordoewer for Zones 2 and 3 is given in TABLE D.1.

TABLE D.1: COSTS AND QUANTITIES FOR THE ASSUMED BULK WATER SUPPLY SYSTEM FOR NOORDOEWER ZONE 2 AND ZONE

ITEM	DESCRIPTION	UNIT	QUANTITY	RATE (R)	AMOUNT (R)
	SECTION 1: MECHANICAL INSTALLATIONS				
1	Type 16 "Mono Floodlifter" pumps	No	8	43 000	344 00
2	300 kW Electric motors	No	8	14 300	114 4
3	5% Allowance for transport and installment			Sum	22 6
4	Overhead crane installed in pumphouse			Sum	59 0
	SUBTOTAL				**540 0**
	SECTION 2: ELECTRICAL INSTALLATION				
1	All cables, transformers, switchboards, control devices, etc.			Sum	**140 0**
	SECTION 3: PUMP HOUSE				
1	Foundation blocks and stilling basin			Sum	43 0
2	Pumphouse building			Sum	30 0
	SUBTOTAL				**73 0**
	SECTION 4: WATER SUPPLY CIVIL WORKS				
1	Canal			Sum	1 000 0
2	1 m NB Pipeline	m	400	361	144 4
3	Pipe specials for connections at pump house			Sum	138 0
	SUBTOTAL				**1 282 4**
	TOTAL				**2 035 4**

Due to the 100% stand-by facility, the redemption period for mechanical equipment is taken as 25 years and the annual maintenance cost as 2,5% of the capital cost. All other cost items are annualised as before.

The total annualised capital and maintenance cost as well as that assumed for salaries and the resulting water unit cost is given in TABLE D.2. The average water production is 20 050 m^3/a.

TABLE D.2: WATER UNIT COST OF THE INTEGRATED WATER SUPPLY SYSTEM

DESCRIPTION	AMOUNT (R/a)	COST PER CUBIC METRE WATER PUMP (c/m^3)
Annualised capital cost	264 300	1,318
Annual maintenance cost	24 000	0,120
Salaries	30 000	0,150
Electricity @ 11c/kWh	316 630	1,579
TOTAL ANNUAL COST	634 930	3,167

STUDY CASE : GENERAL MODEL WITH UNIT ELECTRICITY COST AT 10 c/kWh

EXPENDITURE

CAPITAL

ITEM	DESCRIP'N	QUANTITY	UNIT	RATE	AMOUNT	FIXED COSTS INTEREST	PERIOD	AM AMOUNT	LOWER GROUND AMOUNT	INTEREST %	PERIOD	AM AMOUNT	AMOUNT	HIGHER GROUND INTEREST %	PERIOD	AM AMOUNT
FARM IMP	SHEDS		3 No	18400	54000	12	45	6529								
	HOUSE		1 No	58000	58000	12	45	6837								
	LAND CLEAR	200 Ha		325	65000	12	45	7848								
	FENCING	7000 m		1.57	10990	12	45	1327								
	MISC		1 ITEM	20000	20000	12	45	2415								
	SUBTOTAL				199999			24147								
WATER SUP	CIVIL WKS		1 ITEM	292000					292000	12	30	34358				
	CIVIL WKS		1 ITEM	294400									294400	12	30	34548
	M+E WORKS		1 ITEM	68200					68200	12	15	14814				
	M+E WORKS		1 ITEM	76200									76200	12	15	11189
	SUBTOTAL								361000			46364	370600			47737
IRRIG EQUP	PIPES ETC		1 ITEM	170000	170000	12	10	31504								
ELECT SUPP	POWER LINE	4000 m		13	52000	12	20	6962								
	TRANSFORMER		2 No	6000					12000	12	20	1607				
	TRANSFORMER		2 No	6000									16000	12	20	2143
	SUBTOTAL				52000			6962	12000			1607	16000			2143
MECHANISE	EQUIPMENT		1 ITEM	125200	125200	12	10	23159								
SUB TOTAL					555199			84772	373000			47971	386600			49880

MAINTENANCE

ITEM	DESCRIP'N	QUANTITY	UNIT	RATE	CAP AM'NT	FIXED COSTS AM AMOUNT	CAP AM'NT	RATE	LOWER GROUND AMOUNT	CAP AM'NT	RATE	AM AMOUNT	HIGHER GROUND CAP AM'NT	RATE	AM AMOUNT
FARM IMP	ALL	% of Cap		.005	199990	1000									
WATER SUP	CIVIL WKS	% of Cap		.005		0	292000	.005				1464	294400	.005	1472
	M+E WKS	% of Cap		.04		0	68200	.04				2728	76200	.04	3048
IRRIG EQP	ALL	% of Cap		.05	170000	8500									
ELEC SUP	POWER LN	% of Cap		.02	52000	1040									
	300 KVA	% of Cap					12000	12		240					
	400 KVA	% of Cap										1600	.02		320
MECHANISE	COTTON		100 Ha	38		3800									
	WHEAT		100 Ha	28		2800									
	MAIZE		100 Ha	26		2600									
SUB TOTAL						20140						4432			4840

OPERATIONS

ITEM	DESCRIPTION	QUANTITY	UNIT	RATE	FIXED COSTS UNIT	FIXED COSTS Rs AMOUNT	LOADED WEIGHT n	LOADED QUANT KGS	LOADED UNITS	HIRED Rs AMOUNT	HIRED WEIGHT n	HIRED QUANT KGS	HIRED UNITS	Rs AMOUNT
SEED	COTTON	100	Ha	.1	R/KGS		53	17886	m^3/Ha	41854	68	17886	m^3/Ha	75238
	WHEAT	100	Ha	.1	R/KGS		53	7929	m^3/Ha	17886	68	7929	m^3/Ha	24488
	MAIZE	100	Ha	.1	R/KGS		53	14285	m^3/Ha	34886	68	14285	m^3/Ha	44119
	SUBTOTAL									94526				128843
ROAD TRANS	COTTON	100	Ha	94	R/Ha	9400								
	WHEAT	100	Ha	113	R/Ha	11300								
	MAIZE	100	Ha	136	R/Ha	13600								
	SUBTOTAL					33300								
RAIL TRANS	COTTON	100	Ha	85	R/Ha	8500								
	WHEAT	100	Ha	99	R/Ha	9900								
	MAIZE	100	Ha	125	R/Ha	12500								
	SUBTOTAL					30900								
WATER	COTTON	1785600	m^3	.0012	R/m^3	2147								
	WHEAT	792900	m^3	.0012	R/m^3	952								
	MAIZE	1428500	m^3	.0012	R/m^3	1715								
	SUBTOTAL					4814								
LABOUR	COTTON	100	Ha	476	R/Ha	47600								
	WHEAT	100	Ha	32	R/Ha	3200								
	MAIZE	100	Ha	41	R/Ha	4100								
	SUBTOTAL					54900								
MATERIALS	COTTON	100	Ha	467	R/Ha	46700								
	WHEAT	100	Ha	322	R/Ha	32200								
	MAIZE	100	Ha	312	R/Ha	31200								
	SUBTOTAL					110100								
FUEL	COTTON	100	Ha	44	R/Ha	4400								
	WHEAT	100	Ha	35	R/Ha	3500								
	MAIZE	100	Ha	33	R/Ha	3300								
	SUBTOTAL					11400								
HARVEST	WHEAT	100	Ha	100	R/Ha	10000								
	MAIZE	100	Ha	120	R/Ha	12000								
	SUBTOTAL					22000								
SPRAY	WHEAT	100	Ha	9	R/Ha	900								
INTEREST	COTTON	100	Ha	130	R/Ha	13000								
	WHEAT	100	Ha	50	R/Ha	5000								
	MAIZE	100	Ha	45	R/Ha	4500								
	SUBTOTAL					22500								
MANAGEMENT	AGRONOMIST	1	ITEM	40000	R	40000								
	TRANSPORT	30000	km	.14	R/Ha	4200								
	DIVERSE	1	ITEM	4000	R	4000								
	SUBTOTAL					48200								
SUB TOTAL						339814				94526				173843

INCOME

ITEM	AREA (ha)	YIELD (t/ha)	PRICE (R/t)	INCOME (R)
COTTON	100	3.5	800	280000
WHEAT	100	5	331.14	165570
MAIZE	100	6	279.89	167934
SUB TOTAL			R	613504

S U M M A R Y

ITEM	FIXED COSTS		VARIABLE COSTS				TOTAL	
			LOWER GROUND		HIGHER GROUND			
	TOTAL	ANN AMOUNT	TOTAL	ANN AMOUNT	TOTAL	ANN AMOUNT	TOTAL	ANNUAL AMNT
INCOME		413504						413504
EXPENDITURE								
CAPITAL	555190	84772	373000	47971			928190	132743
					386600	49880	941790	134652
MAINTENANCE		20148		4432				24572
						4840		24988
OPERATIONS		339014		96526				435540
						123843		462857
SUBTOTAL	555190	443926	373000	148929	386600	178563		

ECONOMIC PARAMETERS		LOWER GROUND	HIGHER GROUND
NETT OPERATIONS CASH FLOW	(R)	153392	125667
NETT BENEFIT	(R)	20649	8985
BENEFIT/COST RATIO		1.035	.786
INTERNAL RATE OF RETURN	(%)	14.277	10.217

STUDY CASE : GENERAL MODEL WITH UNIT ELECTRICITY COST AT 13 c/kWh

EXPENDITURE

CAPITAL

ITEM	DESCRIPTION	QUANTITY	UNIT	RATE	FIXED COSTS AMOUNT	INTEREST	PERIOD	AM AMOUNT	LOWER GROUND AMOUNT	INTEREST %	PERIOD	AM AMOUNT	HIGHER GROUND AMOUNT	INTEREST %	PERIOD	AM AMOUNT
FARM INP	SHEDS	3	No	18000	54000	12	45	6329								
	HOUSE	1	No	58000	58000	12	45	6829								
	LAND CLEAR	210	Ha	325	65100	12	45	7648								
	FENCING	7100	m	1.57	10990	12	45	1327								
	ROADS	1	ITEM	20000	20000	12	45	2615								
	SUBTOTAL				199990			24147								
WATER SUP	CIVIL WORK	1	ITEM	272000					272000	12	30	36358				
	CIVIL WORK	1	ITEM	294400									294400	12	30	36548
	M+E WORKS	1	ITEM	68200					68200	12	15	11014				
	M+E WORKS	1	ITEM	76200									76200	12	15	11189
	SUBTOTAL								361400			44364	370600			47737
IRRIG EQUP	PIPES ETC	1	ITEM	178000	178000	12	10	31584								
ELECT SUPP	POWER LINE	4600	m	13	52000	12	20	6962								
	TRANSFORMER	2	No	6000					12000	12	20	1607				
	TRANSFORMER	2	No	6000									16000	12	20	2143
	SUBTOTAL				52000			6962	12000			1607	16000			2143
MECHANISE	EQUIPMENT	1	ITEM	125200	125200	12	10	22159								
SUB TOTAL					535190			84772	373400			47971	336600			49880

MAINTENANCE

ITEM	DESCRIPTION	QUANTITY	UNIT	RATE	FIXED COSTS CAP AM'NT	AM AMOUNT	LOWER GROUND CAP AM'NT	RATE	AM AMOUNT	HIGHER GROUND CAP AM'NT	RATE	AM AMOUNT
FARM INP	ALL	% of Cap		.005	199990	1000						
WATER SUP	CIVIL WORK	% of Capx		.005		0	292000	.005	1464	294400	.005	1472
	M+E WORK	% of Cap		.04		0	68200	.04	2728	76200	.04	3048
IRRIG EQP	ALL	% of Cap		.05	178000	8900						
ELEC SUP	POWER LIN	% of Cap		.02	52000	1040						
	380 KVA	% of Cap					12000	.02	240			
	400 KVA	% of Cap								16000	.02	320
MECHANISE	COTTON	100	Ha	30		3000						
	WHEAT	100	Ha	20		2000						
	MAIZE	100	Ha	26		2600						
SUB TOTAL						28140			4432			4840

PERATIONS

ITEM	DESCRIPTION	QUANTITY	UNIT	RATE	UNIT	FIXED COSTS AM AMOUNT	LOWER HEIGHT a	GROUND QUANT H20	UNITS	HIGHER AM AMOUNT	HEIGHT a	GROUND QUANT H20	UNITS	AM AMOUNT
FUEL	COTTON	100	Ha	13	R/Ha		53	17886	m^3/Ha	53978	68	17886	m^3/Ha	71318
	WHEAT	100	Ha	13	R/Ha		53	7929	m^3/Ha	24312	68	7929	m^3/Ha	31638
	MAIZE	100	Ha	13	R/Ha		53	14285	m^3/Ha	44701	68	14285	m^3/Ha	57752
	SUBTOTAL									125483				160708
ROAD TRANS	COTTON	100	Ha	84	R/Ha	8400								
	WHEAT	100	Ha	113	R/Ha	11300								
	MAIZE	100	Ha	134	R/Ha	13400								
	SUBTOTAL					33100								
RAIL TRANS	COTTON	100	Ha	95	R/Ha	9500								
	WHEAT	100	Ha	99	R/Ha	9900								
	MAIZE	100	Ha	125	R/Ha	12500								
	SUBTOTAL					31900								
WATER	COTTON	1790640	m^3	.0012	R/m^3	2147								
	WHEAT	792990	m^3	.0012	R/m^3	952								
	MAIZE	1428560	m^3	.0012	R/m^3	1715								
	SUBTOTAL					4814								
LABOUR	COTTON	100	Ha	476	R/Ha	47600								
	WHEAT	100	Ha	32	R/Ha	3200								
	MAIZE	100	Ha	41	R/Ha	4100								
	SUBTOTAL					54900								
MATERIALS	COTTON	100	Ha	467	R/Ha	46700								
	WHEAT	100	Ha	322	R/Ha	32200								
	MAIZE	100	Ha	312	R/Ha	31200								
	SUBTOTAL					110100								
FUEL	COTTON	100	Ha	44	R/Ha	4400								
	WHEAT	100	Ha	35	R/Ha	3500								
	MAIZE	100	Ha	33	R/Ha	3300								
	SUBTOTAL					11400								
HARVEST	WHEAT	100	Ha	100	R/Ha	10000								
	MAIZE	100	Ha	120	R/Ha	12000								
	SUBTOTAL					22000								
SPRAY	WHEAT	100	Ha	9	R/Ha	900								
INTEREST	COTTON	100	Ha	130	R/Ha	13000								
	WHEAT	100	Ha	50	R/Ha	5000								
	MAIZE	100	Ha	45	R/Ha	4500								
	SUBTOTAL					22500								
MANAGEMENT	REMUNERATE	1	ITEM	40000	R	40000								
	TRANSPORT	10000	km	.10	R/km	4200								
	OTHERSE	1	ITEM	4000	R	4000								
	SUBTOTAL					48200								
SUB TOTAL						339114				125483				160708

I N C O M E

ITEM	AREA (ha)	YIELD (t/ha)	PRICE (R/t)	INCOME (R)
COTTON	100	3.5	800	280000
WHEAT	100	5	331.14	165570
MAIZE	100	6	279.89	167934
SUB TOTAL			R	613504

S U M M A R Y

ITEM	FIXED COSTS		VARIABLE COSTS				TOTAL	
			LOWER GROUND		HIGHER GROUND			
	TOTAL	ANN AMOUNT	TOTAL	ANN AMOUNT	TOTAL	ANN AMOUNT	TOTAL	ANNUAL AMNT
INCOME		413504						413504
EXPENDITURE								
CAPITAL	555190	84772	373000	47071			928190	131743
					306600	42000	241770	134652
MAINTENANCE		20140		1130				24522
						1840		24980
OPERATIONS		339014		125403				464417
						140224		508010
SUBTOTAL	555190	443926	373000	177006	306600	215214		

ECONOMIC PARAMETERS	LOWER GROUND	HIGHER GROUND
NETT OPERATIONS CASH FLOW (R)	104435	88514
NETT BENEFIT (R)	-9308	46138
BENEFIT/COST RATIO	.287	.931
INTERNAL RATE OF RETURN (%)	10.299	7.408

STUDY CASE: GENERAL MODEL WITH UNIT ELECTRICITY COST AT 16 c/kWh

EXPENDITURE

CAPITAL

ITEM	DESCRIP'N	QUANTITY	UNIT	RATE	AMOUNT	FIXED COSTS INTEREST	PERIOD	AN AMOUNT	LOWER GROUND AMOUNT	INTEREST %	PERIOD	AN AMOUNT	HIGHER GROUND AMOUNT	INTEREST %	PERIOD	AN AMOUNT
FARM INP	SHEDS	3	No	18000	54000	12	15	6520								
	HOUSE	1	No	50000	50000	12	15	6037								
	LAND CLEAR	200	Ha	325	65000	12	15	7848								
	FENCING	7000	m	1.57	10990	12	15	1327								
	ROADS	1	ITEM	20000	20000	12	15	2415								
	SUBTOTAL				199990			24147								
WATER SUP	CIVIL WKS	1	ITEM	292000					292000	12	30	36350				
	CIVIL WKS	1	ITEM	294400									294400	12	30	36548
	M+E WORKS	1	ITEM	68200					68200	12	15	16814				
	M+E WORKS	1	ITEM	76200									76200	12	15	11189
	SUBTOTAL								361000			44364	370600			47737
IRRIG EQUP	PIPES ETC	1	ITEM	178000	178000	12	10	31504								
ELECT SUPP	POWER LINE	4000	m	13	52000	12	20	6962								
	TRANSFORMER	2	No	6000					12000	12	20	1607				
	TRANSFORMER	2	No	9000									16000	12	20	2143
	SUBTOTAL				52000			6962	12000			1607	16000			2143
MECHANISE	EQUIPMENT	1	ITEM	125200	125200	12	10	22159								
SUB TOTAL					555190			84772	373000			47971	386600			49880

MAINTENANCE

ITEM	DESCRIP'N	QUANTITY	UNIT	RATE	CAP AM'NT	FIXED COSTS AN AMOUNT	CAP AM'NT	RATE	LOWER GROUND AN AMOUNT	CAP AM'NT	RATE	AN AMOUNT	HIGHER GROUND CAP AM'NT	RATE	AN AMOUNT
FARM INP	ALL	% of Cap		.005	199990	1000									
WATER SUP	CIVIL WKS	% of Cap		.005		0	292000	.005	1460	294400	.005	1472			
	M+E WKS	% of Cap		.04		0	68200	.04	2728	76200	.04	3048			
IRRIG EQP	ALL	% of Cap		.05	178000	8900									
ELEC SUP	POWER LN	% of Cap		.02	52000	1040									
	300 KVA	% of Cap					12000	.02	240						
	400 KVA	% of Cap								16000	.02	320			
MECHANISE	COTTON	100	Ha	18		3800									
	WHEAT	100	Ha	29		2900									
	MAIZE	100	Ha	26		2600									
SUB TOTAL						20140			4432			4840			

OPERATIONS

ITEM	DESCRIPTN	QUANTITY	UNIT	RATE	UNIT	FIXED COSTS AM AMOUNT	LOWER WEIGHT n	QUANT H2O	GROWING UNITS	HIGHER AM AMOUNT	WEIGHT n	QUANT H2O	GROWING UNITS	AM AMOUNT
FLTG	COTTON	100	Ha	16	R/Ha		53	17886	m^3/Ha	68883	68	17886	m^3/Ha	88381
	WHEAT	100	Ha	16	R/Ha		53	7929	m^3/Ha	30538	68	7929	m^3/Ha	39186
	MAIZE	100	Ha	16	R/Ha		53	14285	m^3/Ha	55017	68	14285	m^3/Ha	70587
	SUBTOTAL									154448				198154
ROAD TRANS	COTTON	100	Ha	94	R/Ha	9400								
	WHEAT	100	Ha	113	R/Ha	11300								
	MAIZE	100	Ha	136	R/Ha	13600								
	SUBTOTAL					33300								
RAIL TRANS	COTTON	100	Ha	85	R/Ha	8500								
	WHEAT	100	Ha	99	R/Ha	9900								
	MAIZE	100	Ha	125	R/Ha	12500								
	SUBTOTAL					30900								
WATER	COTTON	1788680	m^3	.0012	R/m^3	2147								
	WHEAT	792900	m^3	.0012	R/m^3	952								
	MAIZE	1428580	m^3	.0012	R/m^3	1715								
	SUBTOTAL					4814								
LABOUR	COTTON	100	Ha	476	R/Ha	47600								
	WHEAT	100	Ha	32	R/Ha	3200								
	MAIZE	100	Ha	41	R/Ha	4100								
	SUBTOTAL					54900								
MATERIALS	COTTON	100	Ha	467	R/Ha	46700								
	WHEAT	100	Ha	322	R/Ha	32200								
	MAIZE	100	Ha	312	R/Ha	31200								
	SUBTOTAL					110100								
FUEL	COTTON	100	Ha	46	R/Ha	4600								
	WHEAT	100	Ha	35	R/Ha	3500								
	MAIZE	100	Ha	33	R/Ha	3300								
	SUBTOTAL					11400								
HARVEST	WHEAT	100	Ha	100	R/Ha	10000								
	MAIZE	100	Ha	126	R/Ha	12600								
	SUBTOTAL					22600								
SPRAY	WHEAT	100	Ha	9	R/Ha	900								
INTEREST	COTTON	100	Ha	130	R/Ha	13000								
	WHEAT	100	Ha	50	R/Ha	5000								
	MAIZE	100	Ha	45	R/Ha	4500								
	SUBTOTAL					22500								
MANAGEMENT	RENUMERATE	1	ITEM	40000	R	40000								
	TRANSPORT	30000	km	.14	R/km	4200								
	DIVERSE	1	ITEM	4000	R	4000								
	SUBTOTAL					48200								
SUB TOTAL						339914				154448				198154

I N C O M E

ITEM	AREA (ha)	YIELD (t/ha)	PRICE (R/t)	INCOME (R)
COTTON	100	3.5	800	280000
WHEAT	100	5	331.14	165570
MAIZE	100	6	279.89	167934
SUB TOTAL			R	613504

S U M M A R Y

ITEM	FIXED COSTS		VARIABLE COSTS				TOTAL	
			LOWER GROUND		HIGHER GROUND			
	TOTAL	ANN AMOUNT	TOTAL	ANN AMOUNT	TOTAL	ANN AMOUNT	TOTAL	ANNUAL AMNT
INCOME		413504						413504
EXPENDITURE								
CAPITAL	555190	84772	173000	47971			928190	132743
					194600	49080	241790	134652
MAINTENANCE		20140		4432				24572
						4840		24988
OPERATIONS		339014		154440				493454
						128140		537162
SUBTOTAL	555190	443926	173000	206843	194600	252060		

ECONOMIC PARAMETERS		LOWER GROUND	HIGHER GROUND
NETT OPERATIONS CASH FLOW	(R)	95478	51362
NETT BENEFIT	(R)	-37265	-83290
BENEFIT/COST RATIO		.743	.881
INTERNAL RATE OF RETURN	(%)	5.392	NON-EXISTENT

STUDY CASE : FLOOD IRRIGATION MODEL WITH UNIT ELECTRICITY COST AT 10 c/kWh

E X P E N D I T U R E

CAPITAL

ITEM	DESCRIP'N	QUANTITY	UNIT	RATE	AMOUNT (Zand)	INTEREST RATE (%)	PERIOD (Years)	ANNUAL AMOUNT
FARM IMP	SHEDS	3	No	18000	54000	12	45	6520
	HOUSE	1	No	50000	50000	12	45	6037
	LAND CLEAR	200	Ha	425	85000	12	45	10263
	FENCING	7000	m	1.57	10990	12	45	1327
	ROADS	1	ITEM	20000	20000	12	45	2415
	SUBTOTAL				219990			26562
WATER SUP	CIVIL WKS	1	ITEM	250300	250300	12	20	31074
	MHE WORKS	1	ITEM	105500	105500	12	15	15490
	SUBTOTAL				355800			46564
IRRIG SYST	FURROWS ETC	1	ITEM	300000	300000	12	10	53096
ELECT SUPP	POWER LINE	4000	m	13	52000	12	20	6962
	TRANSFORMER	2	No	4400	8800	12	20	1179
	SUBTOTAL				60800			8141
MECHANISE	EQUIPMENT	1	ITEM	126250	126250	12	10	22345
SUB TOTAL					1962840			156708

MAINTENANCE

ITEM	DESCRIP'N	QUANTITY	UNIT	RATE	CAPITAL AMOUNT	ANNUAL AMOUNT
FARM IMP	ALL	% of Cap		.005	219990	1100
WATER SUP	CIVIL WKS	% of Cap		.005	250300	1252
	MHE WKS	% of Cap		.04	105500	4220
IRRIG EQP	ALL	% of Cap		.05	300000	15000
ELEC SUP	ALL	% of Cap		.02	60800	1216
MECHANISE	COTTON	100	Ha	40		4000
	WHEAT	100	Ha	29		2900
	MAIZE	100	Ha	28		2800
SUB TOTAL						32488

OPERATIONS

ITEM	DESCRIP'N	QUANTITY	UNIT	RATE	UNIT	PUMPING HEAD(m)	ANNUAL AMOUNT
ELEC	COTTON	2984700	m^3	.1	R/KWH	30	28432
	WHEAT	925000	m^3	.1	R/KWH	30	12604
	MAIZE	1666680	m^3	.1	R/KWH	30	22788
	SUBTOTAL						63744
ROAD TRANS	COTTON	100	Ha	94	R/Ha		9400
	WHEAT	100	Ha	113	R/Ha		11300
	MAIZE	100	Ha	136	R/Ha		13600
	SUBTOTAL						33300
RAIL TRANS	COTTON	100	Ha	65	R/Ha		6500
	WHEAT	100	Ha	99	R/Ha		9900
	MAIZE	100	Ha	125	R/Ha		12500
	SUBTOTAL						28900
WATER	COTTON	2984700	m^3	.0012	R/m^3		2585
	WHEAT	925000	m^3	.0012	R/m^3		1110
	MAIZE	1666680	m^3	.0012	R/m^3		2000
	SUBTOTAL						5615
LABOUR	COTTON	100	Ha	498	R/Ha		49800
	WHEAT	100	Ha	42	R/Ha		4200
	MAIZE	100	Ha	59	R/Ha		5900
	SUBTOTAL						59900
MATERIALS	COTTON	100	Ha	447	R/Ha		44700
	WHEAT	100	Ha	322	R/Ha		32200
	MAIZE	100	Ha	312	R/Ha		31200
	SUBTOTAL						108100
FUEL	COTTON	100	Ha	46	R/Ha		4600
	WHEAT	100	Ha	35	R/Ha		3500
	MAIZE	100	Ha	33	R/Ha		3300
	SUBTOTAL						11400
HARVEST	WHEAT	100	Ha	100	R/Ha		10000
	MAIZE	100	Ha	120	R/Ha		12000
	SUBTOTAL						22000
SPRAY	WHEAT	100	Ha	9	R/Ha		900
INTEREST	COTTON	100	Ha	130	R/Ha		13000
	WHEAT	100	Ha	50	R/Ha		5000
	MAIZE	100	Ha	45	R/Ha		4500
	SUBTOTAL						22500
MANAGEMENT	REMUNERATE	1	ITEM	40000	R		40000
	TRANSPORT	36000	kg	.14	R/kg		4200
	DIVERSE	1	ITEM	4000	R		4000
	SUBTOTAL						48200
SUB TOTAL							486539

INCOME

ITEM	AREA (ha)	YIELD (t/ha)	PRICE (R/t)	INCOME (R)
COTTON	100	3.5	800	280000
WHEAT	100	5	331.14	165570
MAIZE	100	6	279.09	167234
SUB TOTAL				613304

S U M M A R Y

ITEM	AMOUNT (Rand) INITIAL	ANNUAL
INCOME		613504
EXPENDITURE		
CAPITAL	1062840	156708
MAINTENANCE		32488
OPERATIONS		408559
SUBTOTAL	1062840	597755

ECONOMIC PARAMETERS		VALUE
NETT OPERATIONS CASH FLOW	(R)	172457
NETT BENEFIT	(R)	15749
BENEFIT/COST RATIO		1.027
INTERNAL RATE OF RETURN	(%)	13.4

STUDY CASE : FLOOD IRRIGATION MODEL WITH UNIT ELECTRICITY COST AT 11 c/kWh

EXPENDITURE

CAPITAL

ITEM	DESCRIP'N	QUANTITY	UNIT	RATE	AMOUNT (Rand)	INTEREST RATE (%)	PERIOD (Years)	ANNUAL AMOUNT
FARM IMP	SHEDS	3	No	18000	54000	12	45	6528
	HOUSE	1	No	50000	50000	12	45	6037
	LAND CLEAR	200	Ha	425	85000	12	45	10263
	FENCING	7000	m	1.57	10990	12	45	1327
	ROADS	1	ITEM	20000	20000	12	45	2415
	SUBTOTAL				219990			26562
WATER SUP	CIVIL WKS	1	ITEM	258380	258380	12	30	31074
	M+E WORKS	1	ITEM	105580	105580	12	15	15490
	SUBTOTAL				363880			46564
IRRIG SYST	FURROWS ETC	1	ITEM	300000	300000	12	10	53896
ELECT SUPP	POWER LINE	4000	m	13	52000	12	20	6962
	TRANSFORMER	2	No	4400	8800	12	20	1179
	SUBTOTAL				60800			8141
MECHANISE	EQUIPMENT	1	ITEM	126250	126250	12	10	22345
SUB TOTAL					1062840			156708

MAINTENANCE

ITEM	DESCRIP'N	QUANTITY	UNIT	RATE	CAPITAL AMOUNT	ANNUAL AMOUNT
FARM IMP	ALL	% of Cap		.005	219990	1100
WATER SUP	CIVIL WKS	% of Cap		.005	258380	1252
	M+E WKS	% of Cap		.04	105580	4220
IRRIG EQP	ALL	% of Cap		.05	300000	15000
ELEC SUP	ALL	% of Cap		.02	60800	1216
MECHANISE	COTTON	100	Ha	40		4000
	WHEAT	100	Ha	29		2900
	MAIZE	100	Ha	28		2800
SUB TOTAL						32488

OPERATIONS

ITEM	DESCRIP'N	QUANTITY	UNIT	RATE	UNIT	PUMPING HEAD(m)	ANNUAL AMOUNT
ELEC	COTTON	2886700	m^3	.13	R/KWH	30	36961
	WHEAT	925000	m^3	.13	R/KWH	30	16385
	MAIZE	1666600	m^3	.13	R/KWH	30	29528
	SUBTOTAL						82866
ROAD TRANS	COTTON	100	Ha	84	R/Ha		9400
	WHEAT	100	Ha	113	R/Ha		11300
	MAIZE	100	Ha	136	R/Ha		13600
	SUBTOTAL						33300
RAIL TRANS	COTTON	100	Ha	85	R/Ha		8500
	WHEAT	100	Ha	99	R/Ha		9900
	MAIZE	100	Ha	125	R/Ha		12500
	SUBTOTAL						30900
WATER	COTTON	2886700	m^3	.0012	R/m^3		3463
	WHEAT	925000	m^3	.0012	R/m^3		1110
	MAIZE	1666600	m^3	.0012	R/m^3		2000
	SUBTOTAL						5613
LABOUR	COTTON	100	Ha	498	R/Ha		49800
	WHEAT	100	Ha	42	R/Ha		4200
	MAIZE	100	Ha	59	R/Ha		5900
	SUBTOTAL						59900
MATERIALS	COTTON	100	Ha	467	R/Ha		46700
	WHEAT	100	Ha	322	R/Ha		32200
	MAIZE	100	Ha	312	R/Ha		31200
	SUBTOTAL						110100
FUEL	COTTON	100	Ha	46	R/Ha		4600
	WHEAT	100	Ha	35	R/Ha		3500
	MAIZE	100	Ha	33	R/Ha		3300
	SUBTOTAL						11400
HARVEST	WHEAT	100	Ha	100	R/Ha		10000
	MAIZE	100	Ha	120	R/Ha		12000
	SUBTOTAL						22000
SPRAY	WHEAT	100	Ha	9	R/Ha		900
INTEREST	COTTON	100	Ha	130	R/Ha		13000
	WHEAT	100	Ha	58	R/Ha		5800
	MAIZE	100	Ha	45	R/Ha		4500
	SUBTOTAL						22500
MANAGEMENT	REMUNERATE	1	ITEM	40000	R		40000
	TRANSPORT	30000	ha	.14	R/ha		4200
	DIVERSE	1	ITEM	4000	R		4000
	SUBTOTAL						48200
SUB TOTAL							427681

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* I N C O M E *

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ITEM	AREA (ha)	YIELD (t/ha)	PRICE (R/t)	INCOME (R)
COTTON	100	3.5	900	280000
WHEAT	100	5	331.14	165570
MAIZE	100	6	279.89	167934
SUB TOTAL			R	613504

SUMMARY

ITEM	AMOUNT (Rand) INITTAL	ANNUAL
INCOME		613304
EXPENDITURE		
CAPITAL	1062840	156708
MAINTENANCE		32488
OPERATIONS		427601
SUBTOTAL	1062840	616877

ECONOMIC PARAMETERS		VALUE
NETT OPERATIONS CASH FLOW	(R)	153335
NETT BENEFIT	(R)	-3373
BENEFIT/COST RATIO		.995
INTERNAL RATE OF RETURN	(%)	11.052

STUDY CASE : FLOOD IRRIGATION MODEL WITH UNIT ELECTRICITY COST AT 16 c/kWh

EXPENDITURE

CAPITAL

ITEM	DESCRIP'N	QUANTITY	UNIT	RATE	AMOUNT (Rand)	INTEREST RATE (%)	PERIOD (Years)	ANNUAL AMOUNT
FARM INP	SHEDS	3	No	18000	54000	12	45	6520
	HOUSE	1	No	50000	50000	12	45	6037
	LAND CLEAR	200	Ha	425	85000	12	45	10263
	FENCING	7000	m	1.57	10990	12	45	1327
	ROADS	1	ITEM	20000	20000	12	45	2415
	SUBTOTAL				219990			26562
WATER SUP	CIVIL WKS	1	ITEM	250300	250300	12	10	31074
	M+E WORKS	1	ITEM	105300	105300	12	15	15490
	SUBTOTAL				355800			46564
IRRIG SYST	FURROWS ETC	1	ITEM	300000	300000	12	10	53096
ELECT SUPP	POWER LINE	4000	m	13	52000	12	20	6962
	TRANSFORMER	2	No	4400	8800	12	20	1179
	SUBTOTAL				60800			8141
MECHANISE	EQUIPMENT	1	ITEM	126250	126250	12	10	22345
SUB TOTAL					1962840			156708

MAINTENANCE

ITEM	DESCRIP'N	QUANTITY	UNIT	RATE	CAPITAL AMOUNT	ANNUAL AMOUNT
FARM INP	ALL	% of Cap		.005	219990	1100
WATER SUP	CIVIL WKS	% of Cap		.005	250300	1252
	M+E WKS	% of Cap		.04	105300	4220
IRRIG EQP	ALL	% of Cap		.05	300000	15000
ELEC SUP	ALL	% of Cap		.02	60800	1216
MECHANISE	COTTON	100	Ha	40		4000
	WHEAT	100	Ha	29		2900
	MAIZE	100	Ha	28		2800
SUB TOTAL						32488

OPERATIONS

ITEM	DESCRIP'N	QUANTITY	UNIT	RATE	UNIT	PUMPING HEAD(m)	ANNUAL AMOUNT
ELEC	COTTON	2886700	m^3	.16	R/KWH	30	45491
	WHEAT	925000	m^3	.16	R/KWH	30	20169
	MAIZE	1666600	m^3	.16	R/KWH	30	36332
	SUBTOTAL						101990
ROAD TRANS	COTTON	100	Ha	84	R/Ha		8400
	WHEAT	100	Ha	113	R/Ha		11300
	MAIZE	100	Ha	136	R/Ha		13600
	SUBTOTAL						33300
RAIL TRANS	COTTON	100	Ha	85	R/Ha		8500
	WHEAT	100	Ha	99	R/Ha		9900
	MAIZE	100	Ha	125	R/Ha		12500
	SUBTOTAL						30900
WATER	COTTON	2886700	m^3	.0012	R/m^3		2585
	WHEAT	925000	m^3	.0012	R/m^3		1110
	MAIZE	1666600	m^3	.0012	R/m^3		2000
	SUBTOTAL						5615
LABOUR	COTTON	100	Ha	498	R/Ha		49800
	WHEAT	100	Ha	42	R/Ha		4200
	MAIZE	100	Ha	59	R/Ha		5900
	SUBTOTAL						59900
MATERIALS	COTTON	100	Ha	447	R/Ha		44700
	WHEAT	100	Ha	322	R/Ha		32200
	MAIZE	100	Ha	312	R/Ha		31200
	SUBTOTAL						108100
FUEL	COTTON	100	Ha	46	R/Ha		4600
	WHEAT	100	Ha	35	R/Ha		3500
	MAIZE	100	Ha	33	R/Ha		3300
	SUBTOTAL						11400
HARVEST	WHEAT	100	Ha	100	R/Ha		10000
	MAIZE	100	Ha	120	R/Ha		12000
	SUBTOTAL						22000
SPRAY	WHEAT	100	Ha	9	R/Ha		900
INTEREST	COTTON	100	Ha	130	R/Ha		13000
	WHEAT	100	Ha	50	R/Ha		5000
	MAIZE	100	Ha	45	R/Ha		4500
	SUBTOTAL						22500
MANAGEMENT	REMUNERATE	1	ITEM	40000	R		40000
	TRANSPORT	30000	km	.14	R/km		4200
	DIVERSE	1	ITEM	4000	R		4000
	SUBTOTAL						48200
SUB TOTAL							446803

I N C O M E

ITEM	AREA (ha)	YIELD (t/ha)	PRICE (R/t)	INCOME (R)
COTTON	100	3.5	800	280000
WHEAT	100	5	331.14	165570
MAIZE	100	6	279.89	167934
SUB TOTAL			R	613504

S U M M A R Y

ITEM	AMOUNT (Rand) INITIAL	ANNUAL
INCOME		413504
EXPENDITURE		
CAPITAL	1062840	134708
MAINTENANCE		32488
OPERATIONS		344803
SUBTOTAL	1062840	433999

ECONOMIC PARAMETERS		VALUE
NETT OPERATIONS CASH FLOW	(R)	134213
NETT BENEFIT	(R)	-20495
BENEFIT/COST RATIO		.945
INTERNAL RATE OF RETURN	(%)	8.461

STUDY CASE : FLOOD IRRIGATION MODEL : DIESEL ENERGY

0 E Y P F H B T T U 2 E 0

CAPITAL

ITEM	DESCRIP'N	QUANTITY	UNIT	RATE	AMOUNT (Rand)	INTEREST RATE (%)	PERIOD (Years)	ANNUAL AMOUNT
FARM IMP	SHEDS	3	No	18000	54000	12	45	6520
	HOUSE	1	No	50000	50000	12	45	6037
	LAND CLEAR	200	Ha	425	85000	12	45	10263
	FENCING	7000	m	1.57	10990	12	45	1327
	ROADS	1	ITEM	20000	20000	12	45	2415
	SUBTOTAL				219990			26562
WATER SUP	CIVIL WKS	1	ITEM	258388	258388	12	30	31874
	M+E WORKS	1	ITEM	338588	338588	12	15	40526
	SUBTOTAL				588888			79688
IRRIG SYST	FURROWS ETC	1	ITEM	388888	388888	12	10	53896
ELECT SUPP	POWER LINE	0	m	13	0	12	20	0
	TRANSFORMER	0	No	4488	0	12	20	0
	SUBTOTAL				0			0
MECHANISE	EQUIPMENT	1	ITEM	126258	126258	12	10	22345
SUB TOTAL					1227848			181683

MAINTENANCE

ITEM	DESCRIP'N	QUANTITY	UNIT	RATE	CAPITAL AMOUNT	ANNUAL AMOUNT
FARM IMP	ALL	% of Cap		.005	219990	1100
WATER SUP	CIVIL WKS	% of Cap		.005	258388	1252
	M+E WKS	% of Cap		.04	338588	13228
IRRIG EQP	ALL	% of Cap		.05	388888	15888
ELEC SUP	ALL	% of Cap		.02	0	0
MECHANISE	COTTON	100	Ha	48		4888
	WHEAT	100	Ha	29		2988
	MAIZE	100	Ha	28		2888
SUB TOTAL						44272

OPERATIONS

ITEM	DESCRIP'N	QUANTITY	UNIT	RATE	UNIT	PUMPING HEAD(m)	ANNUAL AMOUNT
ELEC	COTTON	2886700	m^3	.1626	R/KWH	30	61640
	WHEAT	925000	m^3	.1626	R/KWH	30	27324
	MAIZE	1666600	m^3	.1626	R/KWH	30	49230
	SUBTOTAL						138194
ROAD TRANS	COTTON	100	Ha	84	R/Ha		8400
	WHEAT	100	Ha	113	R/Ha		11300
	MAIZE	100	Ha	136	R/Ha		13600
	SUBTOTAL						33300
RAIL TRANS	COTTON	100	Ha	85	R/Ha		8500
	WHEAT	100	Ha	99	R/Ha		9900
	MAIZE	100	Ha	125	R/Ha		12500
	SUBTOTAL						30900
WATER	COTTON	2886700	m^3	.0012	R/m^3		3463
	WHEAT	925000	m^3	.0012	R/m^3		1110
	MAIZE	1666600	m^3	.0012	R/m^3		2000
	SUBTOTAL						5613
LABOUR	COTTON	100	Ha	498	R/Ha		49800
	WHEAT	100	Ha	42	R/Ha		4200
	MAIZE	100	Ha	59	R/Ha		5900
	SUBTOTAL						59900
MATERIALS	COTTON	100	Ha	467	R/Ha		46700
	WHEAT	100	Ha	322	R/Ha		32200
	MAIZE	100	Ha	312	R/Ha		31200
	SUBTOTAL						110100
FUEL	COTTON	100	Ha	46	R/Ha		4600
	WHEAT	100	Ha	35	R/Ha		3500
	MAIZE	100	Ha	33	R/Ha		3300
	SUBTOTAL						11400
HARVEST	WHEAT	100	Ha	100	R/Ha		10000
	MAIZE	100	Ha	120	R/Ha		12000
	SUBTOTAL						22000
SPRAY	WHEAT	100	Ha	9	R/Ha		900
INTEREST	COTTON	100	Ha	130	R/Ha		13000
	WHEAT	100	Ha	50	R/Ha		5000
	MAIZE	100	Ha	45	R/Ha		4500
	SUBTOTAL						22500
MANAGEMENT	REMUNERATE	1	ITEM	40000	R		40000
	TRANSPORT	30000	km	.14	R/km		4200
	DIVERSE	1	ITEM	4000	R		4000
	SUBTOTAL						48200
SUB TOTAL							483069

INCOME

ITEM	AREA (ha)	YIELD (t/ha)	PRICE (R/t)	INCOME (R)
COTTON	100	3.5	800	280000
WHEAT	100	5	331.14	165570
MAIZE	100	6	279.89	167934
SUB TOTAL			R	613504

S U M M A R Y

ITEM	AMOUNT (Rand) INITIAL	ANNUAL
INCOME		613504
EXPENDITURE		
CAPITAL	1227040	181603
MAINTENANCE		40272
OPERATIONS		483009
SUBTOTAL	1227040	704884

ECONOMIC PARAMETERS		VALUE
NETT OPERATIONS CASH FLOW	(R)	70223
NETT BENEFIT	(R)	-91300
BENEFIT/COST RATIO		.871
INTERNAL RATE OF RETURN	(%)	NON-EXISTENT

STUDY CASE: WOORDOEWER ZONE 1 (EXTENSION TO EXISTING DEVELOPMENT)

EXPENDITURE

CAPITAL

ITEM	DESCRIP'N	QUANTITY	UNIT	RATE	AMOUNT (Rand)	INTEREST RATE (%)	PERIOD (Years)	ANNUAL AMOUNT
FARM IMP	SHEDS	0	Ha	18000	0	12	45	0
	HOUSE	0	Ha	50000	0	12	45	0
	LAND CLEAR	17	Ha	329	5525	12	45	668
	FENCING	1600	m	1.57	2512	12	45	304
	ROADS	1	ITEM	1700	1700	12	45	206
	SUBTOTAL				9737			1178
WATER SUP	CIVIL WKS	1	ITEM	16100	16100	12	30	1999
	M+E WORKS	1	ITEM	7500	7500	12	15	1102
	SUBTOTAL				23600			3101
IRRIG EQUP	PIPES ETC	1	ITEM	15850	15850	12	10	2886
ELECT SUPP	POWER LINE	0	m	13	0	12	20	0
	TRANSFORMER	0	Ha	6400	0	12	20	0
	SUBTOTAL				0			0
MECHANISE	EQUIPMENT	1	ITEM	32485	32485	12	10	5750
SUB TOTAL					81672			12835

MAINTENANCE

ITEM	DESCRIP'N	QUANTITY	UNIT	RATE	CAPITAL AMOUNT	ANNUAL AMOUNT
FARM IMP	ALL	1	of Cap	.005	115237	577
WATER SUP	CIVIL WKS	1	of Cap	.005	16100	81
	M+E WKS	1	of Cap	.04	7500	300
IRRIG EQP	ALL	1	of Cap	.05	15850	793
ELEC SUP	ALL	1	of Cap	.02	0	0
MECHANISE	COTTON		15 Ha	38		570
	WHEAT		15 Ha	28		420
	MAIZE		15 Ha	26		390
SUB TOTAL						3131

OPERATIONS

ITEM	DESCRIP'N	QUANTITY	UNIT	RATE	UNIT	PUMPING HEAD(m)	ANNUAL AMOUNT
ELEC	COTTON	152031	m^3	.13	R/KWH	39	3301
	WHEAT	67397	m^3	.13	R/KWH	39	1532
	MAIZE	121423	m^3	.13	R/KWH	39	2796
	SUBTOTAL						7849
ROAD TRANS	COTTON	15	Ha	97	R/Ha		1385
	WHEAT	15	Ha	116	R/Ha		1740
	MAIZE	15	Ha	139	R/Ha		2083
	SUBTOTAL						5138
RAIL TRANS	COTTON	15	Ha	85	R/Ha		1275
	WHEAT	15	Ha	99	R/Ha		1485
	MAIZE	15	Ha	125	R/Ha		1875
	SUBTOTAL						4633
WATER	PUMPED:COT	1788680	m^3	.0012	R/m^3		2147
	:WHT	772990	m^3	.0012	R/m^3		952
	:MZE	1428580	m^3	.0012	R/m^3		1715
	FROM CANAL	13	Ha	90	R/Ha		1170
	SUBTOTAL						5984
LABOUR	COTTON	15	Ha	476	R/Ha		7140
	WHEAT	15	Ha	32	R/Ha		480
	MAIZE	15	Ha	41	R/Ha		615
	SUBTOTAL						9235
MATERIALS	COTTON	15	Ha	467	R/Ha		7395
	WHEAT	15	Ha	322	R/Ha		4830
	MAIZE	15	Ha	312	R/Ha		4680
	SUBTOTAL						16515
FUEL	COTTON	15	Ha	46	R/Ha		690
	WHEAT	15	Ha	35	R/Ha		525
	MAIZE	15	Ha	33	R/Ha		495
	SUBTOTAL						1710
HARVEST	WHEAT	15	Ha	100	R/Ha		1500
	MAIZE	15	Ha	120	R/Ha		1800
	SUBTOTAL						3300
SPRAY	WHEAT	15	Ha	9	R/Ha		135
INTEREST	COTTON	15	Ha	130	R/Ha		1950
	WHEAT	15	Ha	50	R/Ha		750
	MAIZE	15	Ha	45	R/Ha		675
	SUBTOTAL						3375
MANAGEMENT	REMUNERATE	1	ITEM	15000	R		15000
	TRANSPORT	10000	km	.14	R/km		1400
	DIVERSE	1	ITEM	2000	R		2000
	SUBTOTAL						18400
SUB TOTAL							75268

I N C O M E

ITEM	AREA (ha)	YIELD (t/ha)	PRICE (R/t)	INCOME (R)
COTTON	15	3.5	800	42000
WHEAT	15	5	331.14	24036
MAIZE	15	6	279.09	25191
SUB TOTAL			R	92027

S U M M A R Y

ITEM	AMOUNT (Rand)	
	INITIAL	ANNUAL
INCOME		93027
EXPENDITURE		
CAPITAL	81672	12835
MAINTENANCE		3131
OPERATIONS		75268
SUBTOTAL	81672	91234

ECONOMIC PARAMETERS		VALUE
NETT OPERATIONS CASH FLOW	(R)	17620
NETT BENEFIT	(R)	723
BENEFIT/COST RATIO		1.009
INTERNAL RATE OF RETURN	(%)	12.732

STUDY CASE : MOOIBOOMEIR : DEVELOPMENT OF ZONE 2 ONLY (OMITTING ZONE 3)

E X P E N D I T U R E

CAPITAL

ITEM	DESCRIP'N	QUANTITY	UNIT	RATE	AMOUNT (Rand)	INTEREST RATE (%)	PERIOD (Years)	ANNUAL AMOUNT
FARM IMP	SHEDS	1	No	10000	54000	12	45	6528
	HOUSE	1	No	50000	50000	12	45	6037
	LAND CLEAR	200	Ha	325	65000	12	45	7848
	FENCING	7000	m	1.57	10990	12	45	1327
	ROADS	1	ITEM	20000	20000	12	45	2415
	SUBTOTAL				179990			24147
WATER SUP	CIVIL WKS	1	ITEM	292800	292800	12	20	36350
	M+E WORKS	1	ITEM	51800	51800	12	15	7606
	SUBTOTAL				344600			43956
IRRIG EQUP	PIPES ETC	1	ITEM	178000	178000	12	10	31584
ELECT SUPP	POWER LINE	2500	m	13	32500	12	20	4352
	TRANSFORMER	2	No	6000	12000	12	20	1607
	SUBTOTAL				44500			5959
MECHANISE	EQUIPMENT	1	ITEM	125200	125200	12	10	22199
SUB TOTAL					892290			127725

MAINTENANCE

ITEM	DESCRIP'N	QUANTITY	UNIT	RATE	CAPITAL AMOUNT	ANNUAL AMOUNT
FARM IMP	ALL	% of Cap		.005	199990	1000
WATER SUP	CIVIL WKS	% of Cap		.005	292800	1464
	M+E WKS	% of Cap		.04	51800	2072
IRRIG EQP	ALL	% of Cap		.05	178000	8900
ELEC SUP	ALL	% of Cap		.02	44500	890
MECHANISE	COTTON	100	Ha	38		3800
	WHEAT	100	Ha	28		2800
	MAIZE	100	Ha	26		2600
SUB TOTAL						23526

OPERATIONS

ITEM	DESCRIP'N	QUANTITY	UNIT	RATE	UNIT	PUMPING HEAD(m)	ANNUAL AMOUNT
ELEC	COTTON	1788680	m^3	.13	R/KWH	15	15841
	WHEAT	792900	m^3	.13	R/KWH	15	7023
	MAIZE	1428580	m^3	.13	R/KWH	15	12652
	SUBTOTAL						35516
ROAD TRANS	COTTON	100	Ha	97	R/Ha		9700
	WHEAT	100	Ha	116	R/Ha		11600
	MAIZE	100	Ha	139	R/Ha		13900
	SUBTOTAL						34200
RAIL TRANS	COTTON	100	Ha	95	R/Ha		9500
	WHEAT	100	Ha	99	R/Ha		9900
	MAIZE	100	Ha	123	R/Ha		12300
	SUBTOTAL						38900
WATER	COTTON	1788680	m^3	.8344	R/m^3		61528
	WHEAT	792900	m^3	.8344	R/m^3		27276
	MAIZE	1428580	m^3	.8344	R/m^3		49141
	SUBTOTAL						137945
LABOUR	COTTON	100	Ha	476	R/Ha		47600
	WHEAT	100	Ha	32	R/Ha		3200
	MAIZE	100	Ha	41	R/Ha		4100
	SUBTOTAL						54900
MATERIALS	COTTON	100	Ha	467	R/Ha		46700
	WHEAT	100	Ha	322	R/Ha		32200
	MAIZE	100	Ha	312	R/Ha		31200
	SUBTOTAL						110100
FUEL	COTTON	100	Ha	46	R/Ha		4600
	WHEAT	100	Ha	35	R/Ha		3500
	MAIZE	100	Ha	33	R/Ha		3300
	SUBTOTAL						11400
HARVEST	WHEAT	100	Ha	100	R/Ha		10000
	MAIZE	100	Ha	120	R/Ha		12000
	SUBTOTAL						22000
SPRAY	WHEAT	100	Ha	9	R/Ha		900
INTEREST	COTTON	100	Ha	138	R/Ha		13800
	WHEAT	100	Ha	58	R/Ha		5800
	MAIZE	100	Ha	45	R/Ha		4500
	SUBTOTAL						22500
MANAGEMENT	REMUNERATE	1	ITEM	40000	R		40000
	TRANSPORT	30000	km	.14	R/km		4200
	DIVERSE	1	ITEM	4000	R		4000
	SUBTOTAL						48200
SUB TOTAL							380561

INCOME

ITEM	AREA (ha)	YIELD (t/ha)	PRICE (R/t)	INCOME (R)
COTTON	100	3.5	800	280000
WHEAT	100	5	331.14	165570
MAIZE	100	6	279.09	167234
SUB TOTAL			R	613304

S U M M A R Y

ITEM	AMOUNT (Rand)	
	INITIAL	ANNUAL
INCOME		613504
EXPENDITURE		
CAPITAL	892290	127725
MAINTENANCE		23526
OPERATIONS		508561
SUBTOTAL	892290	659812

ECONOMIC PARAMETERS		VALUE
NETT OPERATIONS CASH FLOW	(R)	81417
NETT BENEFIT	(R)	-46308
BENEFIT/COST RATIO		.93
INTERNAL RATE OF RETURN	(%)	2.774

STUDY CASE : NOORDOEWER : ZONE 2 WITH THE CAPITAL COST OF THE BULK WATER SUPPLY SCHEME SUBSIDISED

E X P E N D I T U R E

CAPITAL

ITEM	DESCRIP'N	QUANTITY	UNIT	RATE	AMOUNT (Rand)	INTEREST RATE (%)	PERIOD (Years)	ANNUAL AMOUNT
FARM IMP	SHEDS	3	Ha	18000	54000	12	45	6520
	HOUSE	1	Ha	50000	50000	12	45	6037
	LAND CLEAR	200	Ha	325	65000	12	45	7848
	FENCING	7000	m	1.57	10990	12	45	1327
	ROADS	1	ITEM	20000	20000	12	45	2415
	SUBTOTAL				199990			24147
WATER SUP	CIVIL WKS	1	ITEM	292000	292000	12	30	36350
	M+E WORKS	1	ITEM	51000	51300	12	15	7606
	SUBTOTAL				344600			43956
IRRIG EQUP	PIPES ETC	1	ITEM	178000	178000	12	10	31504
ELECT SUPP	POWER LINE	2500	m	13	32500	12	20	4352
	TRANSFORMER	2	Ha	6000	12000	12	20	1607
	SUBTOTAL				44500			5959
MECHANISE	EQUIPMENT	1	ITEM	125200	125200	12	10	22159
SUB TOTAL					892290			127725

MAINTENANCE

ITEM	DESCRIP'N	QUANTITY	UNIT	RATE	CAPITAL AMOUNT	ANNUAL AMOUNT
FARM IMP	ALL	% of Cap		.005	199990	1000
WATER SUP	CIVIL WKS	% of Cap		.005	292000	1464
	M+E WKS	% of Cap		.04	51000	2072
IRRIG EQP	ALL	% of Cap		.05	178000	8900
ELEC SUP	ALL	% of Cap		.02	44500	890
MECHANISE	COTTON		100 Ha	38		3800
	WHEAT		100 Ha	28		2800
	MAIZE		100 Ha	26		2600
SUB TOTAL						23526

OPERATIONS

ITEM	DESCRIP'N	QUANTITY	UNIT	RATE	UNIT	PUMPING HEAD(m)	ANNUAL AMOUNT
ELEC	COTTON	1708800	m^3	.13	R/KWH	15	15841
	WHEAT	792900	m^3	.13	R/KWH	15	7023
	MAIZE	1428500	m^3	.13	R/KWH	15	12652
	SUBTOTAL						35516
ROAD TRANS	COTTON	100	Ha	97	R/Ha		9700
	WHEAT	100	Ha	116	R/Ha		11600
	MAIZE	100	Ha	139	R/Ha		13900
	SUBTOTAL						34200
RAIL TRANS	COTTON	100	Ha	95	R/Ha		9500
	WHEAT	100	Ha	99	R/Ha		9900
	MAIZE	100	Ha	125	R/Ha		12500
	SUBTOTAL						38900
WATER	COTTON	1708800	m^3	.0231	R/m^3		41317
	WHEAT	792900	m^3	.0231	R/m^3		18316
	MAIZE	1428500	m^3	.0231	R/m^3		32999
	SUBTOTAL						92632
LABOUR	COTTON	100	Ha	476	R/Ha		47600
	WHEAT	100	Ha	32	R/Ha		3200
	MAIZE	100	Ha	41	R/Ha		4100
	SUBTOTAL						54900
MATERIALS	COTTON	100	Ha	467	R/Ha		46700
	WHEAT	100	Ha	322	R/Ha		32200
	MAIZE	100	Ha	312	R/Ha		31200
	SUBTOTAL						110100
FUEL	COTTON	100	Ha	46	R/Ha		4600
	WHEAT	100	Ha	35	R/Ha		3500
	MAIZE	100	Ha	33	R/Ha		3300
	SUBTOTAL						11400
HARVEST	WHEAT	100	Ha	100	R/Ha		10000
	MAIZE	100	Ha	120	R/Ha		12000
	SUBTOTAL						22000
SPRAY	WHEAT	100	Ha	9	R/Ha		900
INTEREST	COTTON	100	Ha	130	R/Ha		13000
	WHEAT	100	Ha	50	R/Ha		5000
	MAIZE	100	Ha	45	R/Ha		4500
	SUBTOTAL						22500
MANAGEMENT	REMUNERATE	1	ITEM	40000	R		40000
	TRANSPORT	30000	ha	.14	R/ha		4200
	DIVERSE	1	ITEM	4000	R		4000
	SUBTOTAL						48200
SUB TOTAL							443248

I N C O M E

ITEM	AREA (ha)	YIELD (t/ha)	PRICE (R/t)	INCOME (R)
COTTON	100	3.5	800	280000
WHEAT	100	5	331.14	165570
MAIZE	100	6	279.89	167934
SUB TOTAL			R	613504

SUMMARY

ITEM	AMOUNT (Rand) INITIAL	ANNUAL
INCOME		613504
EXPENDITURE		
CAPITAL	092290	-
MAINTENANCE		127725
OPERATIONS		33526
		463248
SUBTOTAL	092290	614499

ECONOMIC PARAMETERS		VALUE
NETT OPERATIONS CASH FLOW	(R)	126730
NETT BENEFIT	(R)	-995
BENEFIT/COST RATIO		.999
INTERNAL RATE OF RETURN	(%)	11.348

STUDY CASE : MOOMOOMBEE : ZONE 2 AND ZONE 3

TYPE HOUSEHOLD

CAPITAL

ITEM	DESCRIPTION	QUANTITY	UNIT	RATE	AMOUNT	FIXED COSTS INTEREST	PERIOD	AM AMOUNT	LOWER GROUND AMOUNT	INTEREST	PERIOD	AM AMOUNT	HIGHER GROUND AMOUNT	INTEREST	PERIOD	AM AMOUNT
FARM IMP	SHEDS	3	No	10000	54000	12	45	6529								
	HOUSE	1	No	50000	50000	12	45	4837								
	LAND CLEAR	200	Ha	325	65000	12	45	7860								
	FENCING	7000	m	1.57	10990	12	45	1329								
	DAMS	1	ITEM	20000	20000	12	45	2415								
	SUBTOTAL				199990			24167								
WATER SUP	CIVIL WORK	1	ITEM	292000					292000	12	30	34358				
	CIVIL WORK	1	ITEM	292000									292300	12	30	34358
	M+E WORKS	1	ITEM	51000					51000	12	15	7686				
	M+E WORKS	1	ITEM	55000									55000	12	15	8193
	SUBTOTAL								344A00			43934	348600			44543
ELECT SUPP	ELEC EQUIP PIPES ETC	1	ITEM	170000	170000	12	10	31504								
	POWER LINE	2500	m	13	32500	12	20	4332								
	TRANSFORMER	2	No	6000												
	TRANSFORMER	2	No	6000					12000	12	20	1607				
	SUBTOTAL				32500			4332	12000			1607	12000	12	20	1607
MECHANISE	EQUIPMENT	1	ITEM	125200	125200	12	10	22197					12000			1607
SUB TOTAL					535490			82162	356A00			45563	360600			46158

MAINTENANCE

ITEM	DESCRIPTION	QUANTITY	UNIT	RATE	CAP AM'NT	FIXED COSTS AM AMOUNT	CAP AM'NT	RATE	LOWER GROUND AM AMOUNT	CAP AM'NT	RATE	HIGHER GROUND AM AMOUNT	AM AMOUNT
FARM IMP	ALL	% of Cap		.005	199990								
WATER SUP	CIVIL WORK	% of Cap		.005		1000							
	M+E WORK	% of Cap		.04		0	292000	.005	1464	292000	.005		1464
ELEC SUP	ALL	% of Cap		.05	170000	1	51000	.04	2072	55000	.04		2232
	POWER LN	% of Cap		.02	32500	6500							
	300 KVA	% of Cap				650							
	400 KVA	% of Cap					12000	.02	240				
MECHANISE	CUTTER	100	Ha	30						12000	.02		240
	WHEAT	100	Ha	28		3000							
	MAIZE	100	Ha	24		2000							
						2600							
SUB TOTAL						19750			3776				3934

OPERATIONS

ITEM	DESCRIPTION	QUANTITY	UNIT	RATE	UNIT	FIXED COSTS	AM AMOUNT	WEIGHT n	LOADER QUANT M3	LOADER UNITS	AM AMOUNT	WEIGHT n	TRACTOR QUANT M3	TRACTOR UNITS	AM AMOUNT
FLOC	COTTON	100	Ha	13	R/Ha			15	17884	m^3/Ha	15041	13	17884	m^3/Ha	14344
	WHEAT	100	Ha	13	R/Ha			15	7929	m^3/Ha	7421	13	7929	m^3/Ha	1544
	MAIZE	100	Ha	13	R/Ha			15	14285	m^3/Ha	12652	13	14285	m^3/Ha	2733
	SUBTOTAL										35516				701 31
ROAD TRANS	COTTON	100	Ha	97	R/Ha		9700								
	WHEAT	100	Ha	116	R/Ha		11600								
	MAIZE	100	Ha	139	R/Ha		13900								
	SUBTOTAL						34200								
RAIL TRANS	COTTON	100	Ha	95	R/Ha		8540								
	WHEAT	100	Ha	99	R/Ha		9900								
	MAIZE	100	Ha	125	R/Ha		12500								
	SUBTOTAL						30940								
WATER	COTTON	1788680	m^3	.03167	R/m^3		56645								
	WHEAT	792940	m^3	.03167	R/m^3		25112								
	MAIZE	1428280	m^3	.03167	R/m^3		45241								
	SUBTOTAL						126998								
LABOUR	COTTON	100	Ha	476	R/Ha		47680								
	WHEAT	100	Ha	32	R/Ha		3200								
	MAIZE	100	Ha	41	R/Ha		4100								
	SUBTOTAL						54980								
MATERIALS	COTTON	100	Ha	447	R/Ha		44700								
	WHEAT	100	Ha	322	R/Ha		32240								
	MAIZE	100	Ha	312	R/Ha		31200								
	SUBTOTAL						111100								
FUEL	COTTON	100	Ha	46	R/Ha		4600								
	WHEAT	100	Ha	35	R/Ha		3500								
	MAIZE	100	Ha	33	R/Ha		3300								
	SUBTOTAL						11400								
HARVEST	WHEAT	100	Ha	100	R/Ha		10000								
	MAIZE	100	Ha	120	R/Ha		12000								
	SUBTOTAL						22000								
SPRAY	WHEAT	100	Ha	9	R/Ha		900								
INTEREST	COTTON	100	Ha	130	R/Ha		13000								
	WHEAT	100	Ha	50	R/Ha		5000								
	MAIZE	100	Ha	45	R/Ha		4500								
	SUBTOTAL						22500								
MANAGEMENT	REMUNERATE	1	ITEM	40000	R		40000								
	TRANSPORT	30000	km	.14	R/km		4200								
	DIVERSE	1	ITEM	4000	R		4000								
	SUBTOTAL						48200								
SUB TOTAL							462890				35516				701 31

INCOME

ITEM	AREA (ha)	YIELD (t/ha)	PRICE (R/t)	INCOME (R)
COTTON	100	3.5	800	280000
WHEAT	100	5	331.14	165570
MAIZE	100	6	279.89	167934
SUB TOTAL			?	613504

ANNEXURE

S U M M A R Y

ITEM	FIXED COSTS		VARIABLE COSTS				TOTAL	
			LOWER GROUND		HIGHER GROUND			
	TOTAL	ANN AMOUNT	TOTAL	ANN AMOUNT	TOTAL	ANN AMOUNT	TOTAL	ANNUAL AMNT
INCOME		613504						613504
EXPENDITURE								
CAPITAL	535690	82162	356600	45563			892290	127725
MAINTENANCE		19750		3776	360600	46150	896290	128312
OPERATIONS		463090		75516		7936		23536
						28131		23604
								497614
								540229
SUBTOTAL	535690	564010	356600	84855	360600	128217		

ECONOMIC PARAMETERS		LOWER GROUND	HIGHER GROUND
NETT OPERATIONS CASH FLOW	(R)	92364	49589
NETT BENEFIT	(R)	-35361	-78723
BENEFIT/COST RATIO		.946	.887
INTERNAL RATE OF RETURN	(%)	5.504	NON-EXISTENT

STUDY CASE : [illegible] : ZONE 1 AND ZONE 2

CAPITAL

ITEM	DESCRIP'N	QUANTITY	UNIT	RATE	AMOUNT	FIXED COSTS INTEREST	PERIOD	AN AMOUNT	AMOUNT	LOWER CROSSING INTEREST %	PERIOD	AN AMOUNT	AMOUNT	HIGHER CROSSING INTEREST %	PERIOD	AN AMOUNT
FARM IMP	SHEDS	3	No	10000	54000	12	45	6528								
	HOUSE	1	No	50000	50000	12	45	6037								
	LAND CLEAR	200	Ha	325	65000	12	45	7858								
	FENCING	7000	m	1.57	10990	12	45	1327								
	BOARD	1	ITEM	20000	20000	12	45	2415								
	SUBTOTAL				199990			24147								
WATER SUP	CIVIL WKS	1	ITEM	292900					292900	12	30	16358				
	CIVIL WKS	1	ITEM	453600									453600	12	10	56312
	M+E WORKS	1	ITEM	65000					65000	12	15	9544				
	M+E WORKS	1	ITEM	69000									69000	12	15	10131
	SUBTOTAL								357900			45394	522600			66443
IRRIG EQUIP	PIPES ETC	1	ITEM	170000	170000	12	10	31304								
ELECT SUPP	POWER LINE	1700	m	13	22100	12	20	2959								
	TRANSFORMER	2	No	5700					11400	12	20	1527				
	TRANSFORMER	2	No	6000									12000	12	20	1607
	SUBTOTAL				22100			2959	11400			1527	12000			1607
MECHANISE	EQUIPMENT	1	ITEM	125200	125200	12	10	22159								
SUB TOTAL					525290			80769	369290			47471	534600			68050

MAINTENANCE

ITEM	DESCRIP'N	QUANTITY	UNIT	RATE	CAP AM'NT	FIXED COSTS AN AMOUNT	CAP AM'NT	RATE	LOWER CROSSING AN AMOUNT	CAP AM'NT	RATE	HIGHER CROSSING AN AMOUNT
FARM IMP	ALL	% of Cap		.005	199990	1000						
WATER SUP	CIVIL WKS	% of Cap		.005		0	292900	.005	1464	453600	.005	2268
	M+E WKS	% of Cap		.04		0	65000	.04	2600	69000	.04	2760
IRRIG EQP	ALL	% of Cap		.05	170000	8500						
ELEC SUP	POWER LN	% of Cap		.02	22100	442						
	380 EWA	% of Cap					11400	.02	228			
	480 EWA	% of Cap								12000	.02	240
MECHANISE	COTTON	100	Ha	38		3800						
	WHEAT	100	Ha	20		2000						
	MAIZE	100	Ha	26		2600						
SUB TOTAL						19542			4292			5268

OPERATIONS

ITEM	DESCRIPTN	QUANTITY	UNIT	RATE	UNIT	FIXED COSTS AN AMOUNT	COVER CROPS HEIGHT m	QUANT M2B	UNITS	AN AMOUNT	MULCH HEIGHT m	QUANT M2B	UNITS	AN AMOUNT
FLEX	COTTON	100	Ha	.154	R/KGM		40	17886	m^3/Ha	68847	42	17886	m^3/Ha	77361
	WHEAT	100	Ha	.154	R/KGM		40	7929	m^3/Ha	26520	42	7929	m^3/Ha	34346
	MAIZE	100	Ha	.154	R/KGM		40	14285	m^3/Ha	47998	42	14285	m^3/Ha	51946
	SUBTOTAL									134625				173891
ROAD TRANS	COTTON	100	Ha	120	R/Ha	12000								
	WHEAT	100	Ha	173	R/Ha	17300								
	MAIZE	100	Ha	207	R/Ha	21700								
	SUBTOTAL					51000								
RAIL TRANS	COTTON	100	Ha	95	R/Ha	9500								
	WHEAT	100	Ha	99	R/Ha	9900								
	MAIZE	100	Ha	125	R/Ha	12500								
	SUBTOTAL					31900								
WATER	COTTON	1780680	m^3	.0012	R/m^3	2147								
	WHEAT	792900	m^3	.0012	R/m^3	952								
	MAIZE	1428580	m^3	.0012	R/m^3	1715								
	SUBTOTAL					4814								
LABOUR	COTTON	100	Ha	476	R/Ha	47600								
	WHEAT	100	Ha	32	R/Ha	3200								
	MAIZE	100	Ha	41	R/Ha	4100								
	SUBTOTAL					54900								
MATERIALS	COTTON	100	Ha	467	R/Ha	46700								
	WHEAT	100	Ha	322	R/Ha	32200								
	MAIZE	100	Ha	312	R/Ha	31200								
	SUBTOTAL					110100								
FUEL	COTTON	100	Ha	46	R/Ha	4600								
	WHEAT	100	Ha	35	R/Ha	3500								
	MAIZE	100	Ha	33	R/Ha	3300								
	SUBTOTAL					11400								
HARVEST	WHEAT	100	Ha	100	R/Ha	10000								
	MAIZE	100	Ha	120	R/Ha	12000								
	SUBTOTAL					22000								
SPRAY	WHEAT	100	Ha	9	R/Ha	900								
INTEREST	COTTON	100	Ha	130	R/Ha	13000								
	WHEAT	100	Ha	50	R/Ha	5000								
	MAIZE	100	Ha	45	R/Ha	4500								
	SUBTOTAL					22500								
MANAGEMENT	OVERHEADS	1	ITEM	40000	R	40000								
	TRANSPORT	30000	km	.14	R/km	4200								
	DIVERSE	1	ITEM	4000	R	4000								
	SUBTOTAL					48200								
SUB TOTAL						354514				134625				173891

ITEM	AREA (ha)	YIELD (t/ha)	PRICE (R/t)	INCOME (R)
COTTON	100	3.5	700	280000
WHEAT	100	5	331.14	165570
MAIZE	100	6	372.89	167934
SUB TOTAL			R	613504

S U M M A R Y

ITEM	FIXED COSTS		VARIABLE COSTS				TOTAL	
			LOWER GROUND		HIGHER GROUND			
	TOTAL	ANN AMOUNT	TOTAL	ANN AMOUNT	TOTAL	ANN AMOUNT	TOTAL	ANNUAL AMNT
INCOME		413504						413504
EXPENDITURE								
CAPITAL	525290	80749	369200	47421			894490	128170
					534600	68650	1059090	148819
MAINTENANCE		19542		4292				23834
						5268		24810
OPERATIONS		356514		134625				491139
						173891		530405
SUBTOTAL	525290	456825	369200	186338	534600	247209		

ECONOMIC PARAMETERS		LOWER GROUND	HIGHER GROUND
NETT OPERATIONS CASH FLOW	(R)	88531	50209
NETT BENEFIT	(R)	-296459	88530
BENEFIT/COST RATIO		.954	1.022
INTERNAL RATE OF RETURN	(%)	7.646	NON-EXISTENT

STUDY CASE: FISH RIVER MOUTH TO DAIRIES

E X P E N D I T U R E

CAPITAL

ITEM	DESCRIP'N	QUANTITY	UNIT	RATE	AMOUNT (Rand)	INTEREST RATE (%)	PERIOD (Years)	ANNUAL AMOUNT
FARM IMP	SHEDS	3	No	18000	54000	12	45	6529
	HOUSE	1	No	50000	50000	12	45	6037
	LAND CLEAR	200	Ha	325	65000	12	45	7860
	FENCING	7000	m	1.57	10990	12	45	1327
	ROADS	1	ITEM	160400	160400	12	45	19367
	SUBTOTAL				340390			41099
WATER SUP	CIVIL WKS	1	ITEM	293800	293800	12	30	35474
	M+E WORKS	1	ITEM	73300	73300	12	15	10763
	SUBTOTAL				367100			47237
IRRIG EQUP	PIPES ETC	1	ITEM	170000	170000	12	10	31504
ELECT SUPP	POWER LINE	4000	m	13	52000	12	20	6962
	TRANSFORMER	2	No	14400	29200	12	20	3910
	SUBTOTAL				81200			10872
MECHANISE	EQUIPMENT	1	ITEM	125200	125200	12	10	22159
SUB TOTAL					1691890			132871

MAINTENANCE

ITEM	DESCRIP'N	QUANTITY	UNIT	RATE	CAPITAL AMOUNT	ANNUAL AMOUNT
FARM IMP	ALL	% of Cap		.005	340390	1702
WATER SUP	CIVIL WKS	% of Cap		.005	293800	1469
	M+E WKS	% of Cap		.04	73300	2932
IRRIG EQP	ALL	% of Cap		.05	170000	8500
ELEC SUP	ALL	% of Cap		.02	81200	1624
MECHANISE	COTTON		100 Ha	38		3800
	WHEAT		100 Ha	28		2800
	MAIZE		100 Ha	26		2600
SUB TOTAL						25927

OPERATIONS

ITEM	DESCRIP'N	QUANTITY	UNIT	RATE	UNIT	PUMPING HEAD(m)	ANNUAL AMOUNT
ELEC	COTTON	1788440	m^3	.16	R/KWH	59	76484
	WHEAT	792960	m^3	.16	R/KWH	59	33995
	MAIZE	1428528	m^3	.16	R/KWH	59	61245
	SUBTOTAL						171924
ROAD TRANS	COTTON	100	Ha	176	R/Ha		17600
	WHEAT	100	Ha	238	R/Ha		23800
	MAIZE	100	Ha	286	R/Ha		28600
	SUBTOTAL						70000
RAIL TRANS	COTTON	100	Ha	170	R/Ha		17000
	WHEAT	100	Ha	111	R/Ha		11100
	MAIZE	100	Ha	140	R/Ha		14000
	SUBTOTAL						42100
WATER	COTTON	1788440	m^3	.0012	R/m^3		2147
	WHEAT	792960	m^3	.0012	R/m^3		952
	MAIZE	1428528	m^3	.0012	R/m^3		1715
	SUBTOTAL						4814
LABOUR	COTTON	100	Ha	476	R/Ha		47600
	WHEAT	100	Ha	32	R/Ha		3200
	MAIZE	100	Ha	41	R/Ha		4100
	SUBTOTAL						54900
MATERIALS	COTTON	100	Ha	447	R/Ha		44700
	WHEAT	100	Ha	322	R/Ha		32200
	MAIZE	100	Ha	312	R/Ha		31200
	SUBTOTAL						110100
FUEL	COTTON	100	Ha	46	R/Ha		4600
	WHEAT	100	Ha	33	R/Ha		3300
	MAIZE	100	Ha	33	R/Ha		3300
	SUBTOTAL						11400
HARVEST	WHEAT	100	Ha	100	R/Ha		10000
	MAIZE	100	Ha	120	R/Ha		12000
	SUBTOTAL						22000
SPRAY	WHEAT	100	Ha	9	R/Ha		900
INTEREST	COTTON	100	Ha	130	R/Ha		13000
	WHEAT	100	Ha	58	R/Ha		5800
	MAIZE	100	Ha	45	R/Ha		4500
	SUBTOTAL						22500
MANAGEMENT	REMUNERATE	1	ITEM	40000	R		40000
	TRANSPORT	30000	km	.14	R/km		4200
	DIVERSE	1	ITEM	4000	R		4000
	SUBTOTAL						48200
SUB TOTAL							538039

I N C O M E

ITEM	AREA (ha)	YIELD (t/ha)	PRICE (R/t)	INCOME (R)
COTTON	100	3.5	800	280000
WHEAT	100	5	331.14	165570
MAIZE	100	6	279.89	167934
SUB TOTAL			R .	613504

S U M M A R Y

ITEM	AMOUNT (Rand) INITIAL	ANNUAL
INCOME		413504
EXPENDITURE		
CAPITAL	1091890	152871
MAINTENANCE		35827
OPERATIONS		558838
SUBTOTAL	1091890	737536

ECONOMIC PARAMETERS		VALUE
NETT OPERATIONS CASH FLOW	(R)	20839
NETT BENEFIT	(R)	-124032
BENEFIT/COST RATIO		.933
INTERNAL RATE OF RETURN	(%)	NON-EXISTENT