EXTENSION OF IRRIGATION NETWORK FOR ADAPTATION TO CLIMATE CHANGE

NORTHERN PLAINS, REPUBLIC OF MAURITIUS

INVESTMENT MEMORANDUM

FOR THE

INVESTMENT COMMITTEE

OF THE

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1. Description of Proposed Investment

Will be completed after second set of comments

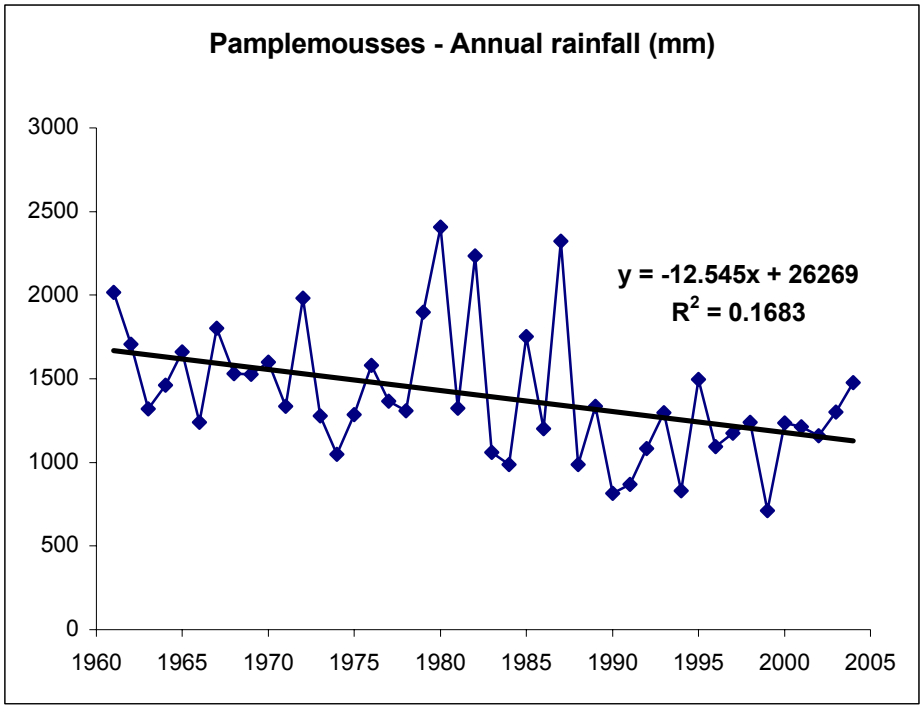
2. Executive Summary

3. Project Background

The project forms part of the Northern Plains Irrigation Project Phase II. The Northern Plains of Mauritius is part of the districts of Pamplemousses and Riviere du Rempart that extend over an area of 38 000 ha, out of which some 50% is devoted to agriculture with some 17 300 ha under sugar cane. The area is generally dry with open evaporation exceeding rainfall.

The Northern Plains have been classified as being suitable to highly suitable for agriculture but the development of the latter has been severely hindered by the dry climate and lack of irrigation facilities. Only 4251 ha for Miller Planters are presently irrigated, 1519 ha on an intensive basis and 2732 ha occasionally out of a potential area of 11 450 ha. Small planters' land (2092 ha) is irrigated by the Irrigation Authority and 980 ha on a private basis. The Government in its endeavour to develop that part of the island constructed a pipeline, MIBI to convey water from the Nicoliere reservoir to service irrigation of about 1900ha in 1972. However a shortage of water due to increased

demands from other economic sectors and several years when drought episodes were experienced resulted in a relatively low level of irrigation since 1982. Concurrently yearly rainfall fell from about 1000-1500 mm average for the period 1961-1990 for this irrigated perimeter to less than 1000 mm average for the period 1991-2000. This situation culminated when the island faced the most severe drought of the century in 1999, when only 58% of normal rainfall was recorded over the island and 52 % in the Northern Plains. The whole island was subjected to water cuts and the Nicoliere reservoir also met with problems in supplying potable water to the Northern part of the island. The situation has improved as from the year after and rainfall in that region has been above the long-term mean in 2004 and up to now in 2005.



Studies by indicated that the limitations of The Nicoliere Reservoir could be easily addressed if another dam was erected in the wettest hydrological basin and water transferred from this dam to the Nicoliere Reservoir to regulate its flow and solve existing problems of water shortages occurring at some periods of the year. According to studies conducted by Coyne and Bellier in 1991, Government proceeded with the recommendations and commissioned the Midlands Dam in 2003 to store additional water for optimising irrigation of the initial 1900ha, for irrigating an additional 3500 ha and also for meeting increased demands for potable water required in the other economic sectors of the economy. The Midlands Dam has been constructed primarily for irrigation, 60 % of its water to be used for this purpose. Domestic supply in this area is catered for from boreholes. In case of water shortages arising from prolonged dry periods, then water from the Midlands Dam is used to supplement boreholes for industrial and domestic purposes. No power is generated from it.

The second phase of the Northern Plains Irrigation Project comprise 8 blocks, the land belonging to small and large growers. A few large growers own Block 1 and they are presently installing center pivot systems for irrigation of sugar cane. Blocks 2 to 7 and part of 8, owned by small holders are being cared for by the Irrigation Authority. Part of the financing has been raised for some 750 ha, (Blocks 2, 3 and 8a) and center pivot systems are being commissioned to irrigate these blocks. Funding still needs to be raised for laying of laterals and farm equipment for the remaining Blocks and in this proposal we are addressing Blocks 4, 5 and 6.

Impact assessment conducted for the sugar cane crop indicated a high vulnerability as a result of increased water requirements stemming from the higher temperatures and the change in pattern and/or reduction in rainfall amount. Provision of irrigation topped the list of adaptation measures evaluated. These results apply to other crops also.

4. Country and Region – Overview

The Project is located in the districts of Pamplemousses and Riviere du Rempart in the North of the Republic of Mauritius.

Map of Mauritius will be given with project area indicated and the two dams

a. Overview of the Republic of Mauritius

The Republic of Mauritius has one of the densest populations in the world, with 600 per Km^2 for a population of about 1.2 million for 1865 km^2. Urban population makes up for about 42%. The Republic of Mauritius has witnessed constant growth in the 1980's and 1990's following diversification of the economy from a sole reliance on sugar production to tourism and light manufacturing. The island has also embarked on the development of a services sector. Sugar production has however been one of the best net foreign income earners for the country due to the low level of imported inputs utilised in this industry. Mauritius is considered nowadays as one of the success stories of Africa.

After sustaining an economic growth of 5.3 % on average for the period 2000-2003, the country slipped into recession for fiscal year 2003-2004 when GDP was less than 4%. This was a result of the globalisation of the economy, namely the new WTO regulations regarding the textile industry. Strong economic growth is not forecasted for the next several years, especially in light of the fact that the EU sugar regime will be reviewed with a probable reduction in the preferential price paid for Mauritian sugar. The Government has earmarked Information and Communication Technology (ICT) as another economic engine along with further development of tourism in order to continue the transformation of the Republic in the coming years. The Mauritian stock market rose by XX % last year.

GDP growth for the period 1996 – 2004 (%)

Year	1996	1997	1998	1999	2000	2001	2002	2003	2004
Rate	5.8	5.8	5.7	2.3	9.3	5.6	1.8	4.4	4.2

Mauritius macro economic policy is characterized by an open monetary and foreign exchange policy. The above economic growth has taken place in an environment of ---- inflation and ---- interest rates, coupled with a --------- current account. Foreign reserves stood at USD ------ in 2004. One setback is the high fiscal deficit which stood at XX % for 2004 and debt servicing which remains major stumbling blocks to more rapid development.

b. Overview of the Northern Plains

The Northern Plains comprise two out of the seven districts of the Republic of Mauritius and carries 231 200 people out of the 1.2 million. The Northern Districts makes up for about 20% of the island that covers an area of 1865 km^2. These districts house major tourism infrastructure apart from its agricultural activities as well as the biggest cogeneration plant working with sugar cane bagasse during the crop season and coal during the intercrop. The continued functioning of this plant to meet the sustainable

development goals of the country partly rests on the future of sugar cane production in this area. All cane, from the project area will be processed by this factory and the bagasse used for electricity generation by this plant. Additional production resulting from irrigation of rainfed crops can be accommodated without further investment as spare capacity exists.

Abandonment of agriculture and conversion to other uses is a common feature of this area because of the low and unstable returns under water unavailability. The North in a year with well-distributed rainfall can contribute to more than 25% of the sugar production of the island. In most years of the last decade production has averaged about 17 % only. Extension of the irrigation network while increasing productivity will also stabilize production and renders agricultural activities less risky. It will permit adaptation to climate change directly or through changes in the cultivated crop from sugar cane to vegetables and fruits. Increased sugar cane production will provide more renewable biomass for the production of electricity to meet the increased needs of the country. In case of a major price cut (39%) by the European Community, most of these areas will no longer be viable under rainfed conditions. Irrigation will however shift the viability and guarantees profitability. Government, in a road map recently rendered public, has clearly indicated its intention of supporting small growers through a reduction of their costs of production by mechanisation and increasing productivity through derocking and provision of irrigation. The export quota with the European Community at a guaranteed price higher than world market prices will continue to prevail and all sugar produced within the project will be sold at this preferential price. Moreover the socio-economic returns in terms of employment, income and prevention of migration to urban areas cannot be neglected.

5. Irrigation needs in Mauritius and the Northern Plains

a. Overview of the irrigation sector in Mauritius and the Northern Plains

As at 2004, Mauritius had 21 416 ha under irrigation. Most of the area confined to irrigation is in the West, North and coastal areas of the East and South. Lack of water storage capacity has been the major constraint for further development of irrigation. Rehabilitation of the major water conveying canals in the recent years has improved water availability. Concurrently there has been an increase in irrigation efficiency as new technologies have evolved and been transferred successfully. Thus furrow irrigation and wild flooding have almost disappeared while the low efficiency high pressure overhead guns have given way to the more efficient drip or center pivot systems

Table : Area under different systems in 1994 and 2004

	HP rainguns	C Pivot	LP Dragline	Surface	Drip
1994	12 857*	NA	NA	3618	831
2004	6153	6069	5326	1837	2032

* Inclusive of center pivot and dragline

Development of irrigation in the Northern Plains has lagged behind other sectors because of its low hydrological regime that could not support erection of dams and its flat topography. Storage has to be on the uplands with the water conveyed to the irrigable areas. The oldest system installed in this area dates back to 1965 on the St Antoine sugar estate and commanded an area of 750 ha. The system adopted was the rain guns using water from a borehole. Other small schemes owned by private holders pumped water from deep wells for irrigation.

A private scheme, Belle Vue Mauricia Scheme, drawing water from the M1- pipeline started in 1974 and covered an area of about 670 ha. Initially under the raingun system, the system has been upgraded over time to increase irrigation efficiency and is now partially under drip, center pivot or the low pressure dragline systems. Due to the suitability of the Northern Plains for agricultural activities, the first phase of an irrigation scheme was set up in 1979 by Government to service 1895 ha belonging to 1700 small growers. Water is supplied by the same M1- pipeline and the scheme is still in operation using rainguns.
These two schemes could not be operated to the optimum due to water shortages following recurrent drought in the 1980's and 1990's and problems with the M1 conveying pipe. Following a study conducted by DHV Consultants and Mega Design, Consulting engineers in 1995, the M1 pipeline was replaced. Extension of irrigation to an additional area of 3500 ha was also covered by this study in relation to the construction of the Midlands Dam for water storage. This Dam has been commissioned in 2003 and is now fully operational with a storage capacity of 25.5 Mm^3 and an annual yield of 41 M m^3. The extension of the irrigation network has been planned into 8 blocks and finance has been raised for 3 blocks which is currently under implementation.

The study did not integrate climate change and this is an essential feature nowadays. Analysis of historical data shows that rainfall has decreased by an average of 64 mm over while maximum temperatures have increased by 0.16 ^oC and sunshine hours by 46.7 over a decade. This will result in higher water requirements that need to be integrated during implementation to avoid future problems.

GCM scenarios indicated an increase in temperature ranging from 2.12 ^oC to 3.59 ^oC. Three GCMs indicated an increase in annual rainfall by 3% to 19% while a fourth one indicated a reduction of 13%. All four GCMs indicated a change in rainfall pattern.

b. Agricultural reform in Mauritius

Agriculture in Mauritius has been and is still dominated by sugar cane cultivation. This situation has evolved since the crop is the most resistant to the tropical depressions and cyclones that regularly visit the island and to drought episodes that are recurrent annually. The Government has created the environment for diversification of the economy but still maintains sugar cane cultivation as one of the important economic engines. This is so as it requires a low level of local inputs. Thus it is a good foreign income earner. Moreover

sugar production and sale are well regulated within a finely developed framework that guarantees every grower its share. Additionally, bagasse, the main by-product of sugar cane cultivation is a source of renewable energy that is used to produce electricity thereby preventing emissions of greenhouse gases from burning of fossil fuels while the production of ethanol from the other by-product molasses for use as a fuel is contemplated.

The agricultural sector has been under continuous reform to meet the needs of the society and the economy. Thus various regulations have been enacted to cope with the demands and institutions created to implement the required changes. The liberalization of commerce under the World Trade Organisation (WTO) is presently imposing major reforms in this sector. The guaranteed preferential price for sugar sold with the European Union will most probably be reduced to be in line with WTO regulations. The sugar sector reform that started some years back will be accelerated to meet this new environment. Milling activities are being centralized to gain on economies of scale. Field operations are mechanized to lower costs of production while efforts are deployed on all fronts to increase productivity. In line with this objective, Government is supporting the extension of irrigation in the Northern Plains, namely for small growers who lack the ability, means and financial resources for development of this importance. The private sector is integrated within this project through the provision of water to them for fields falling in the Project area. The Irrigation Authority, a para-statal body was created in 1979 to implement irrigation schemes and run these for small growers. It is governed by the Irrigation Authority Act (Appendix 1).

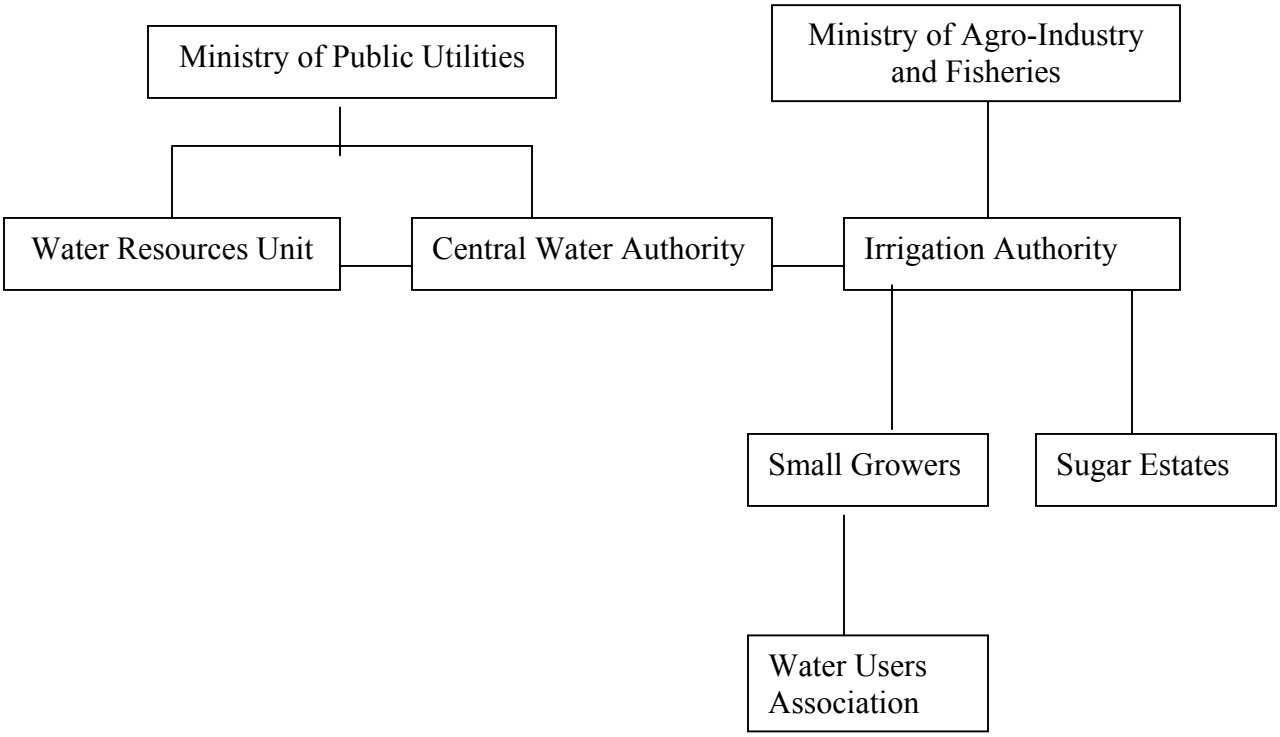
The sugar sector reform does not consist in reviewing sugar production only. In parallel with centralization of milling activities, reduction of production costs and increasing of productivity, diversification from sole production of sugar is planned to raise the competitiveness of the industry and enable it to face the price erosion that may materialise in the coming years. Co-generation of electricity from bagasse during the crop season and coal in the intercrop is currently under way. This is in line with the sustainable development strategy of the country and also to limit greenhouse gas emissions as otherwise this electricity would have had to be produced from fossil fuels. Molasses is presently utilized only on a small scale for the manufacture of ethanol and cane liquor. One additional plant has been recently commissioned to produce ethanol for export and the feasibility of converting all molasses into ethanol for use as a fuel mixed with gasoline is seriously contemplated. The share of proceeds received by growers will rise as the molasses and bagasse gains added-values when transformed into ethanol or electricity. Moreover, the possibilities of trading carbon credits is not included.

Other avenues such as production of Rhum Agricole and value-added special sugars and organic sugars can be further reinforced. Government and all segments of the industry have shown a strong will to succeed in the reform as the sugar industry forms part of the Mauritian culture and is very important socio-economically.

The Non-Sugar sector is also being reformed. In addition to the traditional field cultivation techniques for vegetables, new cultural methods such as hydroponics and

protected cultures are being adopted quite rapidly. This has permitted the successful exploitation of certain crops such as salad tomatoes and sweet peppers that are required to service the needs of the tourism industry and of the local population as the purchasing power of the latter increases. Horticultural crops are being exploited on a larger scale while certain fruits such as litchis and citrus are produced on a wider commercial scale for export and local production to cut on imports.

c. Regulatory Structure in Country



d. Need for irrigation in Mauritius and Northern Plains

Agricultural production is seriously constrained in the North, West and coastal areas of the East and South of the island as a result of insufficient rainfall and uneven distribution. Studies have revealed that a potential area of 33 000 ha needs irrigation and presently only 21 416 ha are irrigated. Most of the areas requiring irrigation in the East and South are irrigated with water tapped from rivers while the West is serviced by water stored in Dams. The estate or miller planters being better organized and able financially have significantly developed irrigation on their lands. Further development in their case are linked to availability of water resources and funds. The case of small growers is somewhat different as the plot size varies from less than a hectare to about 2 ha. Even if most of them are organized in societies or cooperatives, a lack of financial resources and capacity have hindered development of irrigation. Production and profitability being subject to the vagaries of the weather, many small growers have been abandoning cultivation of their plots. Government, aware of this situation has been implementing

various schemes around the island for these small growers. To date 17 schemes have been commissioned to supply irrigation to small growers as per table below.

Project	**Area (ha)**	**No. of Planters**	**Irrigation system**	**Crops grown**
Northern Plains Stage 1	1895	1500	Overhead high pressure sprinkler	Sugar cane, tobacco, Vegetables and Food crops
Belle Mare SSIP	217	465	Low pressure sprinkler	Onion and Vegetables
Souvenir Drip Pilot Project	162	184	Drip	Sugar cane, Vegetables and Food crops
Palma SSIP	137	125	Low Pressure Drag Line	Sugar cane, Vegetables and Food crops
Plaisance SSIP	66	132	Low Pressure Drag Line	Onion, Vegetables and Food crops
Bel Ombre SSIP	32	68	Low Pressure Drag Line	Vegetables and Foodcrops
Trou D'eau Douce SSIP	15	64	Low pressure sprinkler	Onion and Vegetables
Arsenal litchi SSIP	11	25	Low pressure sprinkler	Litchi, vegetables and Foodcrops
Riche Terre SSIP	95	215	Low pressure sprinkler	Vegetables and Foodcrops
Western Coast Irr. project	1238	66	Surface, Drip and Sprinkler	Sugar cane and vegetables
Solitude SSIP	95	141	Drip	Vegetables and Foodcrops
Cressonville SSIP	9	28	Low pressure sprinkler	Litchi, Vegetables and Foodcrops
Riviere du Rempart SSIP	179	320	Semi-solid sprinkler set	Sugar cane and Vegetables
Solitude Drip Phase II	70	117	Drip	Vegetables and Foodcrops
St Felix LAMU Irr Project	95	141	Medium pressure sprinkler	Sugar cane and Foodcrops
Pointe Aux Piments scheme	42	90	Center Pivot	Sugar cane and Foodcrops
Western Coast Turnkey Project	230	46	Drip	Sugar cane
Total	4557	3610		

The Northern Plains has witnessed a slower rate of development of irrigation due to lack of water and the high cost of water storage in the uplands and its conveyance to the area. Underground water is mostly tapped for domestic use leaving very little for agricultural purposes. Productivity stayed at a low level and risky despite improvements in crop

husbandry practices and the cultivation of better varieties bred especially for this zone with drought resistant characteristics. Small growers have thus very often faced drastic reductions in their production due to drought and if it was not for the existence of an insurance scheme, many of these would have already abandoned agricultural activity.

This area has been marked by the highest rate of abandonment of agricultural land or its conversion to other purposes. Climate change is expected to worsen this situation as plant water requirements will increase and drought spells become longer and more severe. A master plan devised to cater for irrigation of the Northern Plains recommended the construction of the Midlands Dam for supplying additional water to the first phase of the irrigation project and for its extension over another 3500 ha. This dam is fully operational now and extension of the Project to new areas has been planned in eight phases. The land, 1400 ha, belongs to miller planters and 2100 ha, to small growers.

Extension of irrigation is included in the sugar sector reform as it is the best mean to raise productivity to a level profitable and competitive for these growers who may be called upon to face price reductions. Moreover the higher productivity stemming from provision of irrigation will increase the production of biomass and hence the amount of electricity generated from this source as opposed to burning of fossil fuels.

6. Irrigation dues

a. Summary of agreements with the different planter groups

The Irrigation Authority agrees to provide water to large growers on a bulk basis at an agreed price for a known period. With regards to small planters, all participants of a project is required prior to implementation to sign and approve documents as to the irrigation of their land against payment of irrigation dues on an annual basis. The dues are calculated annually according to water applied and the cost of running the system.

b. Credit Analysis of Irrigation Authority

The Irrigation Authority since its inception in 1979 has been implementing projects with monies obtained as loans from International Funding Institutions, grants and allocations from Government of Mauritius budget. The track record of obligations towards financial institutions in the past and presently as well as the positive outcomes of projects indicate the credibility of the Irrigation Authority.

c. Avenues of recourse in Case of Non-Payment of dues or default

Marketing of sugar is under the responsibility of the Mauritius Sugar Syndicate (MSS) who also has the right to withhold obligatory payments, namely cess and insurance. In case of defaulting by growers, payment is recovered at source from the proceeds of sale of sugar (see clause of appendix 1) by the MSS.

d. Reference checks on IAs receiving payment of dues on past developments

This can be done on previous projects that have been commissioned and are running.

7. Project Infrastructure and Approvals

a. Infrastructure for Plant Construction

One interesting aspect of the project is that it is situated to the proximity of inhabited areas such that major infrastructure in terms of access and other facilities are already existent and not far. In fact the developments comprise fields that are already cultivated under rainfed conditions with access roads to all plots. The main connecting arteries and electricity adjoins the three blocks and will thus facilitate implementation. Other facilities and labour will come from the villages surrounding or in between the areas to be developed.

b. Project Land

The land covered under the Project is of mixed tenureship. Some 2100 ha belong to small planters and 1400 ha to estate planters. The part of the Project under consideration, namely Blocks 4, 5 belong totally to small planters while Block 6 includes a large planter owning 56 ha. Spread over this land is infrastructure such as roads, electricity and telephone lines to link villages. Details of Blocks 4, 5 and 6 are given in the table below.

Block No.	Region	No of SP	Area of SP	Area LP	Total area
4	Vale/Sottise	582	412	0	412
5	Petit Raffray	798	397	o	397
6	Petit Raffray	791	438	56	494
Total		**2171**	**1247**	**56**	**1303**

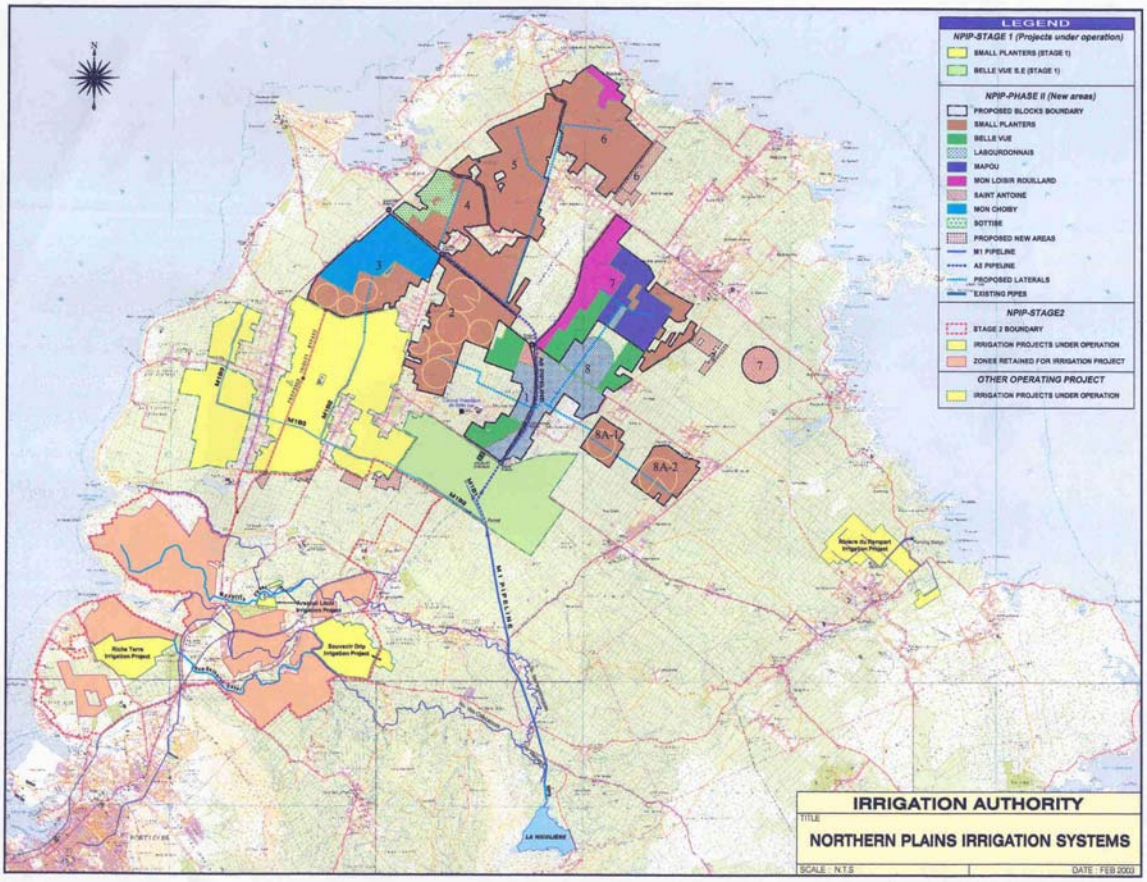


Figure 1. Map of Project Area

c. Water Distribution

Water distribution rests with the Central Water Authority (CWA). Water are extracted from boreholes, rivers and Dams by the CWA and sold to consumers for domestic, industrial or agricultural purposes. Some boreholes and river outlets are under private management following water rights that are allocated and regulated by CWA. Water for domestic purposes has priority over other uses and the situation requiring diversion from other uses exceptionally happens. Water for irrigation projects are supplied by CWA and regulated by the Irrigation Authority. A bulk volume is released to estate planters who manage this water according to their wish while water used in small growers schemes, is managed by the Irrigation Authority. This ensures a proper control and application of the pricing mechanism. IA pays a nominal price to CWA and claims a higher price as irrigation dues. The latter include conveyance to the irrigation schemes and operational costs where applicable.

8. Project Technical Parameters

Contents	Remarks
Approvals/Clearance	All necessary approvals and certificates have already been obtained from the relevant Authorities.
Lifetime project –timeframe implementation	The project will be implemented over 5 years and is expected to run for 25 years as from implementation. Year 1-3 – Block 4 – 412 ha Year 3-4 – Block 5 – 397 ha Year 4-5 – Block 6 – 438 ha
Brief Geology	Three main soil types have been identified according to the Soil Map of Mauritius (Parish and Feillafe, 1965). These are the Lithosol (T3) that is defined as very rocky skeletal soil; Lathosolic Reddish Prairy (P2 and P3) that is gravely to rocky and Low Humic Latosol (L1) that is stony. Substantial areas have been derocked and Government has set up a derocking programme which is currently operational. Infiltration rates are high to very high varying from 70 mm/h to 500 mm/h.
EIA	This project does not represent any major problem for the environment. It does not represent any environmental risk to: -The presence of wild life and biodiversity -The presence of heritage sites in the area - Water, air or noise pollution risk No deforestation is planned within the project area
Project Cost	The total project cost is estimated at XXXX
Implementation schedule	The implementation rate is 30% over 2 years periods
Design of structure	The structure, namely conveying pipes has already been laid down. Laterals will have to be installed to bring water to the farmgate in blocks 4, 5 and 6. Final infield laterals will be laid along with the installation of the center pivots and are not expected to present any major problem.
Risks	Increasing implementation costs Delay in implementation schedule Reduction in initial area earmarked in relation to rate of land conversion and climate change
Recommendation	Shortage of water is not expected to crop up and affect the project. The Midlands dam is sited in the wettest region of the island with an annual rainfall averaging nearly 4m. This dam has remained full for the past two years despite being currently in use.
Others	Irrigation Authority has successfully implemented and still runs several projects up to now. Water users Associations are being formed for the successful transfer of the day to day management to the growers to lower costs of operation and develop a sense of belonging for optimum efficiency.
Conclusion	The Project is feasible from a technical viewpoint. Further investigation on expected changes in the hydrological regime to climate change has to be done. In case of a reduction, the project can still be kept operational but on a smaller scale.

a. Project Hydrology

The Northern Plains is a dry zone of the island and experiences between 1000 to 1500 mm of rainfall annually that are unevenly distributed. Most of this rain falls during the summer period that extends from December to April and associated with tropical

depressions and cyclones. Thus water for irrigation is abstracted from the Nicoliere Reservoir itself fed by the Midlands Dam. The Nicoliere reservoir has a storage capacity of 5.26 Mm^3. The Midlands Dam stores 25.5 Mm^3 for a regulated yield of 41.2 Mm^3.
Even if rainfall measurements are available at numerous sites of the area, full meteorological datasets exist over an extended period for Pamplemousses only which is situated in the South of this area with an annual rainfall averaging about 1500 mm. Thus water requirements for the project has been calculated from these data and using Penman equation.

Rainfall and water requirements data for Pamplemousses

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Rainfall (1971-2000)	53	67	159	235	228	190	175	99	80	84	81	57
ET cane (1979-2004)												

b. Project Components

Water storage have been completed and is operational.
Main distribution pipes already laid for the 8 blocks (3500 ha).
Lateral pipes not yet installed for Blocks 4, 5 and 6 that are under consideration. Infield equipments consisting of the distribution pipes and center pivots also have to be installed.

c. Engineering, Procurement and Contracts

Civil, Hydrological and Management

The civil contract is only awarded to Grade 1 registered contractors. They all have proven track records in these types of undertaking and will be required to sign a contract including liabilities and guarantees. Usually a % of the contract (retention money) is also retained in such contracts until the contractor hands over the work.

The hydrology of the project has been worked out by consulting engineers who are fully fledged in these types of projects.

Management during implementation of the project is under the responsibility of the different contractors.

d. Plant Operations

Once the plant has been commissioned satisfactorily, there is a period of handing over when staff and personnel of the Irrigation Authority are trained. The operation team of IA comprise engineers, agronomists, technicians and operators to oversee to the smooth running of the equipment. The technical experts are backed up with the necessary administrative and management surroundings.

9. Local Partners

9.1 IA/Government Investments

IA and/or Government invest directly and indirectly in all projects pertaining to small growers because of the socio-economic importance. Funds secured for the Midlands dam and for overhauling the conveyance of water from this dam to the Nicoliere are under the care of Government. IA has an annual budget from Government to supplement proceeds from sale of irrigation services and grants for its smooth running. In the new project, IA/Government investment will thus be annual and provided in the way described above.

9.2 Investment Route for Fund

9.3 Exit for Fund Investment

10 Project Economics

10.1 Project Costs

The total cost is MUR million. The main components of the project cost is given below:

Item	Cost(MUR million)
Hard costs	
Center pivot	67.423
Semi solid set	76.616
Infield pipes	57.332
Construction costs	15.636
Total in	217.007
Total in Million USD	7.233

10.2 Project Financing

Funds to come from Lender
Funds in kind from IA management, use of assets, etc.
Contribution in terms of Governments previous investments and laterals
Funds from CDM or carbon credits not included yet

10.3 Tax and Accounting Assumptions

10.4 Economic Assumptions

10.5 Key Assumptions in Base Case

10.6 Base Case Economics

11 Due Diligence

11.1 Accounting Due Diligence on IA

11.2 Tax Due Diligence

11.3 Technical Due diligence

11.4 Legal Due Diligence

11.5 Due Diligence Expenses

Appendix 1

ECONOMIC FEASIBILITY

1. Introduction and methodology

The object of this chapter is to assess the profitability of the implementation of a centre-pivot irrigation system in the Blocks 4, 5 and 6 of the NPIP-phase II project for the parties involved in it, namely the community of small planters and the Irrigation Authority.

Planters budget have been calculated on a per hectare basis. The same approach was adopted for the budget for the Irrigation Authority, the body that will be responsible for the commissioning and operation of the irrigation system. One irrigation system comprising a centre-pivot of 340m radius and the remaining area to complete the square is under a semi-solid set system, the ratio being 0.79 for centre-pivot and 0.21 semi-solid set system. All figures from this system are brought to a per hectare basis. The figures from planters budget and irrigation system were then combined to extrapolate for blocks 4, 5 and 6 that constitute the project. Finally, the feasibility of the project is assessed.

The budgets have been prepared on a cash flow basis at constant 2005 prices and the net present value (NPV) and internal rate of return (IRR) calculated on a 25 year basis, the adopted life of the project.

2. Planters budget on a per hectare basis

Production system

Budgets were prepared for the rainfed and the irrigated sugarcane production systems based on short season plant cane and 12 months ratoons. Intercropping with vegetables in the plant cane and first ratoon crops were not taken into consideration.

Cultural practices

Recommended practices have been adopted in the study. The only outlays that differed between rainfed and irrigated conditions were the higher amount of fertilizer applied and the higher harvesting and transport costs associated with yield increments stemming from irrigation.

Cane yield

Rainfed cane yield estimate using the APSIM-Sugarcane model at the Pamplemousses site with daily weather data for the period 1961 to 1995 was 94 t ha^{-1} with a fairly high coefficient of variability of ---% (Cheeroo-Nayamuth, 2000). The study was done using a

deep and fairly rock-free soil and assuming that there were no limitations resulting from management or pest and diseases. The project area being presently rocky and receiving lower rainfall, the rainfed yield was assumed to be about 50% of the modelled yield, i.e., 45 t ha^{-1}.

According to the same modelling study, the irrigated cane yield was estimated as 132 t ha^{-1}. Since some of the rocks will remain and some management limitation is expected, the attainable yield was assumed to be 75% of the potential, i.e., 99 t ha^{-1} and was rounded off to 100 t ha^{-1}.

The cane yield was assumed to be equivalent in the plant cane (PC) and ratoon crops since for the purpose of this appraisal, cane was planted as a short season crop, 12 to 14 months duration and ratoons of 12 months. For cost allocation, the first year was allowed for rock disposal, and installation of laterals and infield mains, and of the centre-pivot system. During the remaining 24 years of project lifetime, the cropping schedule will comprise three cycles of one plant cane crop and seven ratoon crops.

Cost of operation of irrigation

The amount of water to be applied was estimated from the simulation study mentioned above. The model simulated a water requirement of 500 mm ha^{-1}. However as all plots within the project area will not be at the same stage of development, some water will be wasted in crops in the early stages of growth and drying off schedules will not be feasible. 60% more water is computed to account for the efficiency of the center pivot being 80% only, for increased water requirements due to climate change and losses incurred from the irrigation system. Thus the amount of water to be applied was set at 800 mm ha^{-1}, i.e, 8000 m^3 ha^{-1}. The cost of operation for the centre-pivot and the semisolid set system, shown in Table AP 1 below, included the cost of an operator, the cost of electricity and the cost of water applied.

	Center pivot	**Semi solid set**
Operator	3600	5000
Electricity (700kWh ha^{-1} @ MUR 2.0 m^{-3}	1400	
Water (8000 m^3 @ MUR 1.0 m^{-3}	8000	8000
TOTAL	**13 000**	**13 000**

Table AP 1 – Operational costs (MUR ha-1) for center pivot and semi-solid set systems

Cost of sugarcane cultivation

Using recommended practices, the costs of production of the different crop classes have been computed. A summary is shown in table AP 2 and details are provided in Appendix----.

		Rainfed	Irrigated*
Cane yield (t ha^{-1})		45	100
Cost of production (MUR ha^{-1})			
	Plant cane crop	56 550	92 700
	Ratoon crop	20 650	46 300

* - Irrigation costs amount to MUR 13 000 ha^{-1}

Table AP 2 – Cost of production under rainfed and irrigated conditions

Cash inflow

The planter is paid for the total amount of molasses and bagasse produced from his cane consignment but only 78% of the proceeds from sugar. Of the latter 6% is paid as cess to finance research, marketing and other services supplied. The extraction rates and selling prices of sugar and by-products are given in Table AP 3 and the cash inflow for the rainfed and irrigated systems are given in Table AP 4.

	Extraction rate (% cane)	Selling price (MUR t^{-1})
Sugar	11	18 000
Molasses	3	550
Bagasse	30	40

Table AP 3 – Extraction rates and prices @ October 2005

	Rainfed	Irrigated
Cane yield (t ha^{-1})	45	100
Sugar Proceeds		
Sugar produced (t ha^{-1})	4.95	11
Gross proceeds (MUR ha^{-1})	89 100	198 000
Milling costs (MUR ha^{-1})	19 602	43 560
Cess (MUR ha^{-1})	5346	11 880
Returns from sale of sugar (MUR ha^{-1})	64 152	142 560
Molasses proceeds		
Molasses produced (t ha^{-1})	1.35	3
Returns from sale of molasses (MUR ha^{-1})	742.5	1650
Bagasse proceeds		
Bagasse produced (t ha^{-1})	13.5	30
Returns from sale of bagasse (MUR ha^{-1})	540	1200
TOTAL	**65 435**	**145 410**

Table AP 4 – Cash inflow on a per hectare basis

3. Budget of the Irrigation Authority

The Irrigation Authority is the body that will be responsible for the supervision laying of laterals and infield pipelines, the centre-pivot system, as well as for the running of the system throughout the life of the project. Electricity for running the system will be purchased from the Central Electricity Board and water will be purchased from the Central Water Authority.

Land planning:

The project area is flat, 2 to 8% slope with a few spots where the slope reaches 14%. Thus land planning measures will not be necessary. However, troughs and holes will have to be filled and compacted along the wheel tracks where required. In some cases, elevated wheel track will have to be constructed.

Derocking

The project area is characterised by the presence of many surface rockpiles that occupy up to 18% of the area (Jhoty and Ramsamy, 2003). Intensive derocking would free additional land but the cost may be prohibitive and rock disposal may become problematic due to mismatch with the construction industry. Since the implementation of the centre-pivot system is not hampered by the derocking status, only removal of rockpiles that lies along the pivot wheel tracts will be undertaken in the project.

Laying of laterals and infield pipes to centre of pivot

In this project only the cost of installing infield lines will be included. It is assumed that the cost of installation of laterals to bring water to the limits of the project area will be borne by the government and the latter would cost about 41 000 MUR ha^{-1}.

Electricity supply

The necessary cables protected in pipes will be laid in the same trenches dug for the infield pipelines. Connection will be made to the national grid at the closest point and if need be, one or two poles will be installed.

Cost of installation of irrigation system

The cost of installation is based on that of a centre-pivot of radius 340m, the most cost-efficient option. A detailed worksheet is given in Appendix ----. A summary is presented in Table AP 5 below, taking into consideration the ratio centre-pivot to semi-solid set system of 0.79:0.21 The cost of installation is 154 785 MUR ha^{-1}.

	Center pivot	Semi solid set
Supply and commissioning of center pivot system	65 500	
Supply and installation of infield pipelines	44 000	
Cut and fill and removal of rocks along wheel track	7 000	
Electricity supply and miscellaneous expenses	5 000	

TOTAL	**121 500**	**280 000**

Table AP 5 – Summarised costs of installation of irrigation system (MUR ha^{-1})

Repayment of investment costs

In the project it is assumed that the participating small planters will pay for the capital investment of 154 785 MUR ha^{-1} by contracting a loan of 155 000 MUR ha^{-1} at the start of the scheme and repayment will be made over 15 years. Even if, the small planter would have "acquired" the equipment, operation and maintenance will remain under the responsibility of the Irrigation Authority. Three scenarios have been tested for interest rates, namely, 3%, 6% and 9%, the latter being the present interest rate being claimed on irrigation investments. The yearly repayment would thus amount to 12 813 MUR ha^{-1}, 15293 MUR ha^{-1} and 17773 MUR ha^{-1} respectively

Table - Repayment of investment loan

Interest rate (%)	3	6	9
Total interest (MUR ha^{-1})	37200	74400	111600
Total repayment (MUR ha^{-1})	192200	229400	266600
Yearly repayment (MUR ha^{-1})	**12813**	**15293**	**17773**
Total interest (USD ha^{-1})	1240	2480	3720
Capital (USD ha^{-1})	5167	5167	5167
Total repayment (USD ha^{-1})	6407	7647	8887
Total interest (million USD)	**1.616**	**3.231**	**4.847**
Capital (million USD)	**6.732**	**6.732**	**6.732**
Total repayment (million USD)	**8.348**	**9.964**	**11.579**

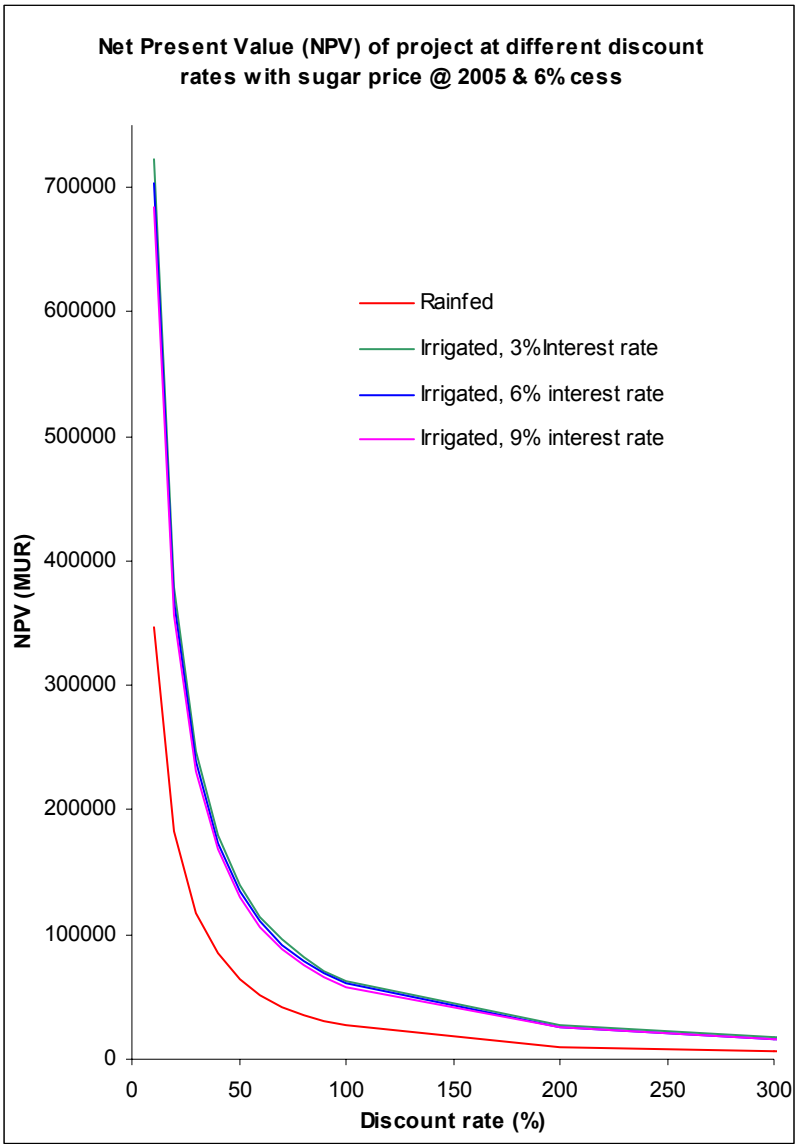
3. Feasibility of project

The returns from irrigated production are higher than rainfed production at both discount rates of 10% and 20% as well as at the three interest rates for loan repayment tested. The project is feasible.

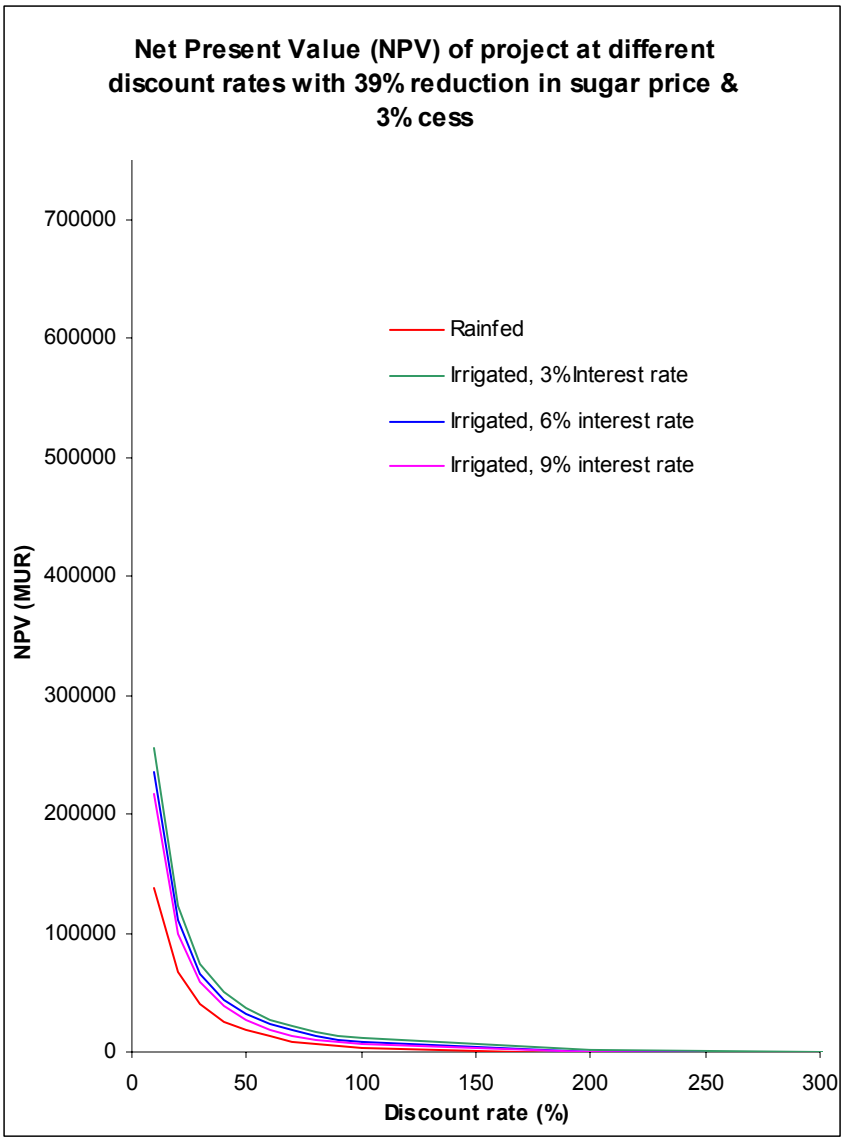
Table - Returns in irrigation investment for whole project

		Returns (million USD)		
	Loan repayment (million USD)	At 2005 value	At discount rate of 10%	At discount rate of 20%
Rainfed		1.750	0.629	0.330
Irrigated with interest rate = 3%	0.557	3.705	1.307	0.687
Irrigated with interest rate = 6%	0.664	3.638	1.272	0.666
Irrigated with interest rate = 9%	0.772	3.570	1.238	0.645

NPVs at all other discount rates tested confirm the above conclusion (Figure below)



Should the preferential sugar price be reduced by 39% and cess brought down to 3%, the resulting NPVs (Figure below) show that the profitability of the system will be reduced but the trend remains the same – irrigated production remaining dominant.



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