MSIRI
Occasional Report No. 32

AGRO-ECONOMIC STUDY ON DIFFICULT AREAS UNDER SUGAR CANE

September 2006

AGRO-ECONOMIC STUDY ON DIFFICULT AREAS UNDER SUGAR CANE

September 2006

Prepared by

J A Tonta, ***Economics Department***
S Ramasamy, ***Agricultural Chemistry Department***

‘ Le problème de l’érosion ici, c’est la misère.’

Louis Buteau
Agronome à Haïti

(Spore No 120, décembre 2005)

FOREWORD

The 36% reduction in the preferential sugar price will adversely affect sugar production in the difficult areas for sugar cane (i.e. land where field mechanization cannot be contemplated with present technologies). Nevertheless, from the environmental and social standpoint, there is need to preserve some of these threatened cane lands.

This project, initiated in April 2005, is the first of its kind to be undertaken by the MSIRI. It aims at identifying these difficult lands taking into account the multifunctional dimension of sugar cane production.

The findings clearly show that the seaward mountain slopes are regions where the abandonment of sugar cane would negatively impact on nearby villages and on other spheres of the economy, namely tourism and fishing. The estimates made for the resulting losses in employment and income within and outside the sugar cane sector are staggering, the more so that a large proportion of those concerned live in villages close to these difficult areas. Necessary steps must be taken to prevent or at least alleviate the social problems which could be detrimental to those concerned.

In this context, a package of recommendations has been formulated with a view to allow sugar cane cultivation on these slopes to continue fulfilling its economic, environmental and social functions.

The implementation of this package will require the sustained efforts of all major stakeholders, especially for the provision of the necessary financial resources for field renewal, the institutions servicing planters for actions relevant to their mandate, and the producers themselves for their collaboration.

I am confident that the contents of this report will be of interest to all parties involved in the process of reforming the sugar cane industry.

I would like to extend my thanks to all those who participated in this study, namely the technical personnel of miller- and large-scale planters, the Farmers Service Corporation, and officers from the Agricultural Chemistry and Economics Departments of the MSIRI.

L J C Autrey
DIRECTOR

TABLE OF CONTENTS

LIST OF TABLES

LIST OF ANNEXES

MAP

EXECUTIVE SUMMARY

PROJECT BACKGROUND AND OBJECTIVES

1. The difficult areas for sugar cane refer to land that cannot be mechanized on account of severe physical and edaphic constraints.

2. Since the beginning of this decade, there has been increased awareness on the environmental, economic, and social dimensions of sugar cane growing in the difficult areas, and on the necessity to preserve at least part of these lands threatened by price reduction.

3. In this context, a project was initiated in April 2005 to identify the difficult areas where the abandonment of sugar cane will give rise to environmental, economic and social problems; and to propose a package of measures (economic and technological) that will support the continuation of cane cultivation on the identified land.

IDENTIFICATION OF DIFFICULT LAND AREAS UNDER SUGAR CANE

4. A two-phase approach was developed for the identification of the difficult land for sugar production.

5. Phase I consisted in localizing, referencing, and quantifying land areas termed as difficult. This process, which involved map work, querying of computerized land databases and on-site visits, yielded a list of fields or blocks of fields totalling 12 341 ha.

6. As per the Phase II, some 4642 ha of cane land were finally identified on the basis of (i) their proximity to environmentally sensitive areas as proposed in the Review of the National Physical Development Plan (April 2003) and (ii) the economic/social risks they represent to nearby villages, the tourism industry and *artisanal* fishing.

7. These 4642 ha (termed as Category A) with a ratio of 55:45 for land moderately to marginally suitable for sugar cane are located on the seaward slopes (generally between 8 and 30%) of three mountain ranges: the Moka-Long Mountain range (Zone N), the Grand Port range (Zone E), and the Black River-Savanne range (Zone S).

8. In 2003/2004, miller- and large-scale planters occupied 1206 ha of these lands. The remaining portion was owned by 3433 small-scale planters (≤ 42 ha). The latter group included 528 *métayers* and 20 planters with plot size exceeding 10 ha.

9. Zone N (728 ha) stretches from Vallée des Prêtres, to D'Epinay through Bon Amour and Congomah. It is some 10-15 km distant from the beaches of the north-west coastal line (*Northern Tourism Zone*). In 2003, some 1247 small-scale planters occupied 91% of the zone.

10. Zone E covers 1394 ha (92% moderately suitable for sugar cane) of the seaward slopes of the Grand Port range. It runs from Quatre Soeurs to Ferney. It is squeezed between the *Eastern Tourism Zone* in the north and the *Mahébourg Tourism Zone* in the south. In 2003, the small-scale planters and *métayers* grew sugar cane on 94% of the mountain slopes of that zone.

11. Zone S (2520 ha) accounts for 54% of the land under Category A. It lies within the *South Coast Heritage Tourism Zone*. It extends from Chamarel, Baie du Cap to Chemin Grenier through Bel Ombre and St. Félix. It is the only zone where all categories of planters are present. In 2004, the miller- and large-scale planters cropped 1060 ha of land. The *métayers* present on the slopes numbered to 364.

12. With the removal of the 4642 ha of Category A from the 12 341 ha identified as per Phase I, there remained some 7699 ha of cane land that were classified into two other categories, namely B and C.

13. Category B (1365 ha) consists of four regions/sites (three on the inland slopes of the same mountain ranges as Category A and one on the flanks of an isolated mountain) dispersed along the eastern to southern edges of the Central Plateau. All these sites have slopes ranging from 8 to 30% (moderate to steep slopes). Fifty eight percent of these lands are owned by miller-planters.

14. Category C is made up of 6334 ha of flat to moderately sloping land (slopes of 0 to 13%). Out of the 4492 ha of land distributed over the humid to superhumid regions of the Central Plateau, 2085 ha were occupied by the smallholders of the ex-tea land and 522 ha by other small-scale growers.

PROFITABILITY ANALYSIS

15. For the 4642 ha of Category A, the Discounted Cash Flow Analysis (DCFA) techniques were used to assess profitability over a cycle consisting of plant cane and seven ratoons.

16. The annual equivalents obtained for a 7-ratoon cycle at two sugar prices were compared.

17. The two sugar prices were the price of MUR 14 658 t^{-1} (after deduction of the average SIFB premium) prevailing for the crop year 2004/2005 and an estimated one of MUR 10 000 t^{-1} likely to represent the final price after the reduction of 36%.

18. The direct costs for plant cane and ratoons (miller- and small-scale planters) pertained to the year 2005.

19. The cane and sugar yields for miller-planters were retrieved from the Land Index database of the MSIRI. For the small-scale planters, the cane yields for the land moderately and marginally suitable for sugar cane were taken to be respectively 72 t ha^{-1} ands 56 t ha^{-1}.

20. The profitability analysis included two sensitivity tests (both performed at the sugar price of MUR 10 000 t^{-1}) that investigated into the effect of changes in costs on initial results.

21. Results showed that at the sugar price of MUR 10 000 t^{-1}, sugar cane would not be profitable on the marginally suitable land. For the moderately suitable land, profitability would be reduced to 19% of the value for 2005.

22. The first sensitivity test showed that with direct costs increased by 20%, the land moderately suitable for sugar cane would no longer be profitable.

23. The second sensitivity demonstrated that under the assumption that planters would not bear the costs for plant cane (a possible policy measure), profitability for the land moderately and marginally suitable for sugar cane would rise to 56% and 52% of their respective level for the year 2005. The profitability figures for *métayers* would be largely inferior to those obtained by independent planters.

CONSEQUENCES OF THE ABANDONMENT OF SUGAR CANE CULTVATION

24. Under a scenario where sugar cultivation on the 4642 ha of Category A would be abandoned, the output losses for sugar and ethanol would be respectively 6% and 7% of the sugar industry's plan for the next decade. As for electricity, the amount given up would account for only 1.3% of the island's demand for the year 2015.

25. The annual income loss for male and female labour (mostly casual) involved on 97% of the land of Category A was estimated to MUR 131.8 million. Manual harvest (cutting and loading) represented 53% of that sum.

26. Regarding the environment, large-scale erosion could pollute the nearby lagoons and cause prejudice to *artisanal* fishing and to the tourism sector.

27. Consequently, in addition to planters and labourers, direct employment for some 1069 coastal fishermen and 6434 employees of hotels and restaurants as well as indirect employment in tourism could be at stake.

ALTERNATIVES TO SUGAR PRODUCTION

28. The exposure of the 2068 ha of land marginally suitable for sugar cane to the deleterious effects of increasing costs on long-term profitability is a source of concern.

29. In this context, the cultivation of other environmentally sustainable perennial crops (e.g., *pejibaye* in association with a cover crop) may represent an interesting alternative to sugar production.

30. The utilization of the sugar cane plant for innovative products of interest to the fast developing tourism industry (beverages, craftwork, etc) is also an avenue that needs to be explored.

RECOMMENDATIONS

31. With the aim of enabling sugar cane to continue fulfilling its economic, social and environmental functions on the seaward mountain slopes, a package of recommendations has been formulated.

32. It consists of a policy support measure in the form of a financial assistance for plant cane and cost rationalization measures with respect to weed control, trashing, trash lining, maintenance of fields roads and drains, protracted ratooning, mechanized loading and planter grouping.

33. The financial assistance (covering all costs incurred from land preparation to the last operation before harvest) will restore profitability for the land moderately and marginally suitable for sugar cane to 56% and 52% of their respective level for the year 2005.

34. The cost rationalization measures will bring the land areas of Category A to a profitability level higher than that obtained with the financial assistance for plant cane.

35. It is recommended that a technical group be set up to examine the prospects for the introduction of environmentally sustainable crop activities as an alternative to sugar production on part of these mountain slopes.

1. INTRODUCTION

1.1 Background to project

In the Sugar Sector Strategic Plan (SSSP) 2001-2005 meant to ensure the efficiency and viability of the sugar industry, mention was made of a reduction of the area under cane from 76 500 ha in 2001 to some 60 000 ha prepared for complete mechanization by the year 2010. The difference of 16 500 ha comprised prime land to be converted to other uses, and the different categories of difficult or marginal land where sugar cane cultivation would not be viable in the long-term. However, in the wake of the implementation of this plan, it was realized that there was need for strategic reasons to maintain an additional area under cane. The latter refer to the difficult areas where total field mechanization is not possible, and where the suitability ratings for sugar cane range from marginally to moderately suitable.

As for the strategic reasons, they find their origin in the concept of multifunctional agriculture. The latter term is used to indicate that in addition to producing food and fibre, agriculture generates other forms of benefits that are of major importance to society as a whole. These range from the maintaining of the vitality of rural areas, environmental protection, production of bio-energy, food safety and food quality, recreation and tourism, etc.

There is no doubt that sugar cane activities in Mauritius (including production on the difficult areas) have these multifunctional characteristics. It is feared that the abandonment of sugar cane growing on these lands may negatively impact on their immediate (geographical) vicinity and/or the island economy. Soil erosion and subsequent sedimentation and eutrophication problems may occur in rivers and lagoons downstream. Ultimately, the tourism industry and *artisanal* fishing could be adversely affected. With respect to the sugar industry, production plans could have to be reviewed downwards. On the social side, a loss of income for those depending directly or indirectly on sugar could lead to the weakening of the socio-economic fabric of the rural/urban regions concerned. There may be also other non-desired effects, which are not known for the time being.

1.2 Project's objective

In the light of the problems likely to be raised by land abandonment, the foregoing project had as objectives:

- to identify the difficult land areas where the abandonment of sugar cane will give rise to environmental, economic and social problems.

- to propose a package of measures (economic and technological) that will support the continuation of cane cultivation on the identified land.

It should be stressed that while the support measures proposed aim at preventing the abandonment of sugar cane, they are not necessarily meant to exclude these lands (or part thereof) from conversion to environmentally and economically sound alternatives.

1.3 Project coverage/outline

The project was made up of the following components:

- identification of the difficult land areas for sugar cane;

- profitability analysis;

- analysis of the consequences of the abandonment of sugar cane cultivation; and

- identification of appropriate support measures to maintain sugar cane cultivation.

The second and third components were executed after the completion of the first one. They covered only one of the three categories of difficult areas identified, i.e., the seaward mountain slopes. Their findings served as basis for the formulation of support measures listed in the fourth component.

In this report, each of the above four components is the subject of a separate chapter.

2. IDENTIFICATION OF DIFFICULT LAND AREAS UNDER SUGAR CANE

2.1 Methodology

The methodology employed for the execution of the first project objective, namely the identification of difficult land areas, was made up of two phases:

- Phase I (preliminary selection in three steps); and
- Phase II (final selection).

2.1.1 Phase I - preliminary selection

The first step consisted in the identification of cane areas, which are classed as marginally suitable for sugar cane (<70 t cane ha^{-1}) as well as those not suitable for mechanization on account of severe physical/edaphic constraints. This exercise was carried out by superimposing the following digital map layers:

- field boundaries of cane land (> 42 ha) for miller- and large-scale planters;
- Sugar Industry Fund Board (SIFB) locality blocks delimiting cane land for small-scale planters (≤ 42 ha);
- mechanization suitability classes (Jhoty *et al*, 2002); and
- land suitability classes for sugar cane (MSIRI, 2005).

The cane areas identified consisted of a list of fields for miller- and large-scale planters, and a list of SIFB locality blocks for the small-scale planters. All cane areas falling under future irrigation projects were not considered.

The important edaphic, climatic and agronomic characteristics of the identified fields were retrieved from the computerized databases of sugar cane land i.e. from the Land Index database (Julien *et al*, 1984).

The next step, particularly applicable to the small-scale planters, entailed the exclusion of cane areas in locality blocks that fall within zones earmarked in the National Physical Development Plan (NPDP) for village, road infrastructure and coastal tourism development (Ministry of Housing and Lands, 2003). Additionally, locality blocks of relatively low cane area (<10 ha), i.e. blocks where housing settlements and other buildings had significantly replaced sugar cane, were excluded.

The third and last step involved field visits to all identified sites so as to ascertain that the data derived from maps, as per steps one and two, were correct, and if needed the necessary amendments were made. The opportunity was also taken to identify other agricultural activities undertaken within the retained SIFB locality blocks.

2.1.2 Phase II – final selection

The data obtained as per Phase I strictly referred to non-mechanized sugar cane land (flat to steeply sloping) that are moderately (S2) or marginally suitable (S3) for sugar cane. As the whole process under this current phase consisted in identifying the regions/sites that represent the highest environmental and economic/social risks, recourse was made to the following selection criterion/hypothesis:

- the location of the regions/sites with respect to (i) environmentally sensitive areas and (ii) areas of natural beauty as proposed in the NPDP (Ministry of Housing and Lands, 2003); and

- the economic/social risks (e.g., employment losses) that sugar cane abandonment in these regions/sites could represent to the nearby villages, tourism industry and *artisanal* fishing.

2.2 Results

2.2.1 Introduction

With the application of the criterion/hypothesis of Phase II to the 12 341 ha of flat to steeply sloping land identified as per Phase I, there emerged three categories (A, B and C) or groups of difficult areas.

Category A, which is the principal focus of the project, represents the seaward slopes of the island's mountain ranges. It accounts for some 4642 ha of land where cane abandonment could adversely affect other spheres of the economy, namely tourism and *artisanal* fishing.

The two other groups (B and C) too are exposed to environmental, economic and social problems. In contrast to Category A, they are considered as those with little or no direct incidence on lagoon-based activities. Category B (1365 ha) essentially covers the inland slopes of mountains of Category A. The last category represents the flat to moderately sloping land (6334 ha).

Sub-section 2.2.2 reports on the seaward slopes of Category A. Information on Categories B and C are summarized in sub-section 2.2.3.

The geographical location of the three categories of difficult areas is shown in Map 1.

2.2.2 Category A: seaward mountain slopes

The 4642 ha of sugar cane land under Category A (Table 1) are found on the seaward slopes (generally between 8 and 30%) of the three most important mountain ranges of the island; the Moka-Long Mountain range, the Grand Port range and the Black River-Savanne range. For the purpose of the report, they are respectively referred to as Zones N, E and S.

Table 1. Difficult areas for sugar cane (Category A: seaward mountain slopes)

ZONE	FACTORY AREA	LOCATION	LAND UNIT[1]	AREA[2] (ha)			NO OF PLANTERS		
				MILLER-	LARGE-SCALE	SMALL-SCALE	MILLER-	LARGE-SCALE	SMALL-SCALE
N	Ex-Beau Plan	N Industrie/Beau Fond	10.2 10.1	68			1		
Slopes of Moka - Long Mountain range		SIFB Loc Blocks	10.2 4.3			358			617
	Belle Vue	SIFB Loc Blocks	10.2 10.1			302			630
	Sub Total			**68**		**660**	**1**		**1247**
E	Beau Champ	Ferney	9.2 10.2	45			1		
Slopes of Grand Port range		Littoral/G Port	3.1 3.2 9.2	33					
		SIFB Loc Blocks[3]	9.2 10.2			839			825
	Riche En Eau	SIFB Loc Blocks	10.2 11.1			477			429
	Sub Total			**78**		**1316**	**1**		**1254**
S	Ex-Bel Ombre	Bel Ombre 1	10.2 10.1	218			1		
Slopes of Black River-Savanne range		Bel Ombre 3	10.2 10.1	174					
		Choisy estate	11.1		218			1	
		Exil	8.2 8.1		68			1	
		Baie du Cap	11.1 8.1		95			1	
		SIFB Loc Blocks[3]	10.2 11.1			728			325
	St Félix	Cascade	10.2 10.1	55			1		
		Goburdun	10.2	132					
		Luchon	5.4 10.2	100					
		SIFB Loc Blocks[3]	10.2			732			617
	Sub Total			**679**	**381**	**1460**	**2**	**3**	**942**
	Total			**825**	**381**	**3436**	**4**	**3**	**3443**
	Grand Total			**4642**					

Small-scale planter : (≤ 42 ha)

The term miller stands for an estate with either operational or closed mill.

[1] Most important land unit(s) : (Arlidge, E. Z. and Wong You Cheong, Y., 1975). *Notes on the land resources and agricultural suitability map of Mauritius, 1:50 000)*

[2] Data for the year 2003 for small-scale planters and 2003/2004 for miller- and large-scale planters

[3] Includes *métayers*

In 2003/2004, the miller[1]-, and large-scale planters together occupied 1206 ha of cane land, the small-scale planters (≤ 42 ha) and the *métayers* accounted for 3436 ha or 74% of the total. For these 4642 ha, the ratio of moderately to marginally suitable land is 55:45.

The cane area and number of small-scale-planters for all SIFB locality blocks identified are detailed in Annex 1.

A comprehensive description of the Zones N, E and S is given below.

2.2.2.1 The Moka-Long Mountain range (Zone N)

Zone N stretches from Vallée des Prêtres to D'Epinay through Bon Amour, Crève Coeur and Congomah. The landform is dissected and the slope profile ranges from rolling and moderately sloping (8 to 20% slopes) to steeply sloping (20 to 30% slopes) with some areas of steep slopes greater than 30%. At Vallée des Prêtres, the slopes are mostly above 13%. Annual precipitation ranges from 1400 to 1900 mm with Vallée des Prêtres receiving the lowest amount.

The land units 10.1 and 10.2 (Arlidge and Wong You Cheong, 1975) predominate in this zone and the main soil types being the *Low Humic Latosols, Humic Latosols* and *Mountain Slope Complexes* (Parish and Feillafé, 1965); with a strongly eroded phase of the three soil types for the steep slopes. At Vallée des Prêtres in the ex-Beau Plan factory area, the major soil type is *Dark Magnesium Clay*, which is highly exposed to erosion.

Of the three groups of mountainous regions falling under category A, Zone N is the one with the lowest intensity of river/drainage systems. The zone harbours the tributaries of Rivière Citron and Rivière du Tombeau.

Zone N is some 10-15 km distant from the beaches of the north-west coastline. The latter forms part of the *Northern Tourism Zone* defined by the Ministry of Tourism.

[1] The term miller stands for an estate with either an operational or closed mill.

For Zone N, land areas marginally suitable for sugar cane slightly outnumber those classified as moderately suitable.

In 2003, the most common sugar cane variety was *R 570*. In that year, the small-scale growers numbering 1247 and with plots smaller than 10 ha in size, harvested 660 ha of land or 91% of the total of 728 ha identified as difficult for sugar cane. The 68 ha of land managed by the miller-planter are practically enclosed within the small-scale planter locality blocks. Pineapple is mainly grown in the localities of Bon Amour, Crève Coeur and Congomah.

2.2.2.2 The Grand Port range (Zone E)

Zone E covers the seaward sloping land of the Grand Port range. It is bordered on one side by the following mountains: Chat, Bambou, and des Créoles, and on the other side by the coastal villages of Quatre Soeurs, Petit/Grand Sable, through Bambous Virieux to Ferney. Most of the land slopes fall between 8 to 30% (moderate to steep). An insignificant portion of the upper cultivated slopes is in excess of 30%.

Near Quatre Soeurs and Anse Jonchée, the flat stretch of land extending from the foot of the mountain slopes (on which sugar cane is grown) to the shorelines is only a few metres wide. On account of their proximity to the mountain slopes, most of these villages are exposed to flooding in periods of high rainfall.

Annual precipitation in the zone lies between 1700 and 2400 mm with the regions around Ferney being the most humid.

The *Mountain Slope Complexes* are the dominant soil types of Zone E. At Ferney, *Humic Latosols* are also present.

An intensive network of rivers/drainage systems cuts through Zone E. The main rivers

flowing to the sea between Petit Sable and Anse Fauvrelle (near Petit Bel Air) are Rivière Nyon, Rivière Champagne and Rivière des Créoles.

Zone E is located between two tourism development zones. In its north lies the *Eastern Tourism Zone* (from Roches Noires to Grande Rivière Sud Est) where the priorities are to maintain luxury and high quality hotels and to promote integrated environmental protection and improvements. In its south, the *Mahébourg Tourism Zone* (Mahébourg and Grand Port Waterfronts and Blue Bay areas) is being developed. For the latter, the key objectives are to maintain high luxury hotels in the Blue Bay area whilst making environmental protection a priority, and to encourage high quality small hotel development in Mahébourg. As regards the coastal part of Zone E, there is currently the emergence of restaurants, guesthouses and places of interest to visitors.

Zone E represents 30% of the 4642 ha of Category A. Some 1316 ha of land (839 ha and 477 ha for the factory areas of Beau Champ and Riche En Eau, respectively) were cropped by 1254 small-scale planters. The latter figure comprised 11 individuals (cultivating more than 10 ha of land) whose total plot area amounted to 132 ha. The small-scale growers also included 164 *métayers* (165 ha) found in the region of Ferney/Montagne des Créoles.

At Ferney, the 45 ha of land belonging to the miller-planter were adjacent to the small-scale planter SIFB locality blocks.

Practically 92% of these 1394 ha are moderately suitable for sugar cane. The marginally suitable portion (an aggregated area of 107 ha belonging to the small-scale growers) is found around Vieux Grand Port and Rivière des Créoles.

In 2003, *R 570* was still the most widespread variety among the small-scale growers.

During field visits, onion plantations were observed on the flat land adjacent to the sea (Petit Sable and Grand Sable). On the slopes, the presence of vegetables (creepers, okra, etc.) in fullstand was noted.

2.2.2.3 The Black River-Savanne range (Zone S)

Zone S starts from Chamarel and extends southward to the coastal village of Baie du Cap. From there, it stretches eastward to Chemin Grenier through Bel Ombre and St Félix. The dissected landform has slope profile ranging from rolling and moderately sloping (8 to 20% slopes) to steeply sloping (20 to 30%) with some areas of steep slopes above 30%. At Chamarel, the landform is uniformly dissected and the slopes are in the range of 13 to 30%. Annual precipitation is in the bracket of 1400 to 3100 mm. The higher part of St Félix (Goburdhun and Malaisé) is the most humid.

The *Mountain Slope Complexes* are the predominant soils in the St Félix factory area. In the ex-Bel Ombre factory area, the soils are the *Mountain Slope Complexes, Humic Ferruginous Latosol, Latosolic Brown Forest* and *Lithosols*. The *Humic Ferruginous Latosols* are mainly found in the region of Chamarel.

Not less that five rivers flow through the cane perimeter of Zone S. The main rivers are Rivière Baie du Cap, Rivière Jacotet and Rivière des Galets. They flow to the sea between Baie du Cap and Trou d'Esny.

Zone S lies within the Ministry of Tourism's *South Coast Heritage Tourism Zone* that covers an extensive area from Blue Bay to Baie du Cap. It is also bordered on its western side by the *Southwest Tourism Zone*, which includes the Black River Gorges National Park. In the *South Coast Heritage Zone*, the aim is to control development within the *Pas Géometriques* and to encourage high quality small hotel/guest house developments in village centres. Since 2004, three luxury beach hotels have been constructed near Bel Ombre. More hotels together with other tourist amenities/facilities are planned in the regions of Bel Ombre and St Félix.

More than 80% of the difficult land in the St Félix factory area are marginally suitable for sugarcane. In the ex-Bel Ombre factory area, moderately suitable and marginally suitable lands are practically in equal proportion.

Zone S with its 2520 ha shared among the miller-, large- and small-scale planters (inclusive of the *métayers*) corresponds to 54% of 4642 ha of difficult areas under category A.

In 2003, some 1460 ha of land (or 58% of total) were occupied by 942 small-scale planters, including nine individuals owning more than 10 ha of land and with total plot size aggregating to 151 ha. At St Félix, out of the 732 ha surveyed, 154 ha near Luchon were under the responsibility of 150 *métayers*. The SIFB locality blocks of the ex-Bel Ombre factory area had the largest concentration of *métayers* (214 individuals occupying 368 ha of cane land). These *métayers* were concentrated in the regions of Ponama, Montagne Chapeau, Doguet and Bolivar. For the same year, the 364 *métayers* of Zone S represented around 35% of this particular category of sugar cane planters in operation across the island.

Sugar cane variety *R 570* was popular among all categories of planters. For the miller- and large-scale planters, *R 570* was followed by *M 52/78*.

The miller- and large-scale planters of Zone S devote a small portion of their land to pineapple, banana and palmito, etc. In the case of the small-scale planters, mixed vegetables and pineapple were observed in the locality blocks of Mont Blanc and Mare Anguilles.

2.2.3 Other categories of difficult areas

2.2.3.1 Category B: Inland mountain slopes

The 1365 ha of land for Category B (Table 2) covers four regions/sites (three on the inland slopes of mountain ranges and one on the slopes of an isolated mountain) dispersed along the eastern to southern edges of the Central Plateau. All these sites have slopes ranging from 8 to 30% (moderate to steep slopes) and are found in the environmentally sensitive areas as defined by the NPDP. In contrast to Category A (specifically Zones E and S), these sites are smaller in size and they are less close to lagoons. Given the number of rivers and rivulets running across or close to each of these sites, the land of Category B too represent a potential source of pollution for lagoons.

Table 2. Difficult areas for sugar cane (Category B: inland mountain slopes)

REGION	FACTORY AREA	LOCATION	LAND UNIT[1]	AREA[2] (ha)			NO OF PLANTERS		
				MILLER-	LARGE-SCALE	SMALL-SCALE	MILLER-	LARGE-SCALE	SMALL-SCALE
Slopes of Grand Port range	Beau Champ	Olivia	10.2	20			1		
		Belle Rive	10.2	15					
	Riche En Eau	Cent Gaulettes	3.4 3.3	230			1		
		SIFB Loc Blocks	10.2 11.1			165			215
	Ex- Rose Belle	Le Val	10.2	169			1		
	SubTotal			**434**		**165**	**3**		**215**
Slopes of Black River-Savanne range	Union	Combo	3.1 3.2	254			1		
		Bois Chéri & Philippe Ltd	5.4 5.6	107					
	Sub Total			**361**			**1**		
Slopes of Montagne Blanche (Isolated landmass)	Beau Champ	SIFB Loc Blocks	10.2 11.1			176			275
	FUEL	SIFB Loc Blocks[3]	10.2 11.1			229			264
	Sub Total					**405**			**539**
	Total			**795**		**570**	**4**		**754**
	Grand Total			**1365**					

Small-scale planter : (≤ 42 ha)

The term miller stands for an estate with either operational or closed mill.

[1] Most important land unit(s) : (Arlidge, E. Z. and Wong You Cheong, Y., 1975). *Notes on the land resources and agricultural suitability map of Mauritius, 1:50 000)*

[2] Data for the year 2003 for small-scale planters and 2003/2004 for miller- and large-scale planters

[3] Includes *métayers*

The four sites mentioned above are:

- 35 ha of miller-planter's land at Olivia and Belle Rive (inland flanks of Montagne Bambous from the Grand Port range);

- 564 ha of land for miller-, and small-scale planters at Le Val and Cent Gaulettes (bordered by Montagne Laselle and Montagne des Créoles from the Grand Port range);

- 361 ha of miller-planters' land in Union-St Aubin factory area (close to Piton Savanne, Piton Capote and Piton Poule from the Savanne mountain range); and

- 405 ha of small-scale planters' land along the flanks of Montagne Blanche (an area of natural beauty).

The *Mountain Slope Complexes* are the dominant soil types for Category B. The *Humic Latosols* and the *Humic Ferruginous Latosols* are both present at Combo and Cent Gaulettes. Nearly 90% of the land in category B are moderately suitable for sugar cane. While at Olivia and Belle Rive, annual rainfall is in the bracket of 2000-2500 mm, elsewhere it exceeds 3000 mm.

In 2003, the small-scale planters (754 registered individuals including the 41 *métayers*) were not the major occupants of Category B. Approximately 71% of the 570 ha harvested, were located in the FUEL and Beau Champ factory areas.

For the miller-planters who represented 58% of total land of Category B, the annual sugar cane crop was mainly met from the following varieties: *M 695/69, M 52/78, R 570* and *M 3035/66.*

Pineapple, banana and mixed vegetables were common in the SIFB locality blocks situated on the slopes of Montagne Blanche.

2.2.3.2 Category C: Flat to moderately sloping land

Category C (Table 3) covers 6334 ha of flat to moderately sloping land (slopes of 0 to 13%). Nearly 70% of these lands are distributed over the humid to superhumid regions of the Central Plateau. The remaining portion (subhumid to humid regions) is principally spread in the coastal regions of the north-east to east.

The humid to superhumid regions

The land identified in the humid to superhumid regions of the Central Plateau extend through the factory areas of FUEL, Riche En Eau, ex-Rose Belle, ex-Britannia, ex-Highlands and Mon Désert Alma. The annual rainfall in these regions normally exceeds 3000 mm. The ratio of land moderately suitable to marginally suitable for sugar cane is practically one to one.

A complex array of rivers and rivulets run across these lands and lead to the sea in the east and south. Some of these rivers are feeders for existing lakes and reservoirs. The catchment areas for the Grande Rivière Sud Est river lie within the regions of Dubreuil, Bety and Rivière du Bois.

For the year 2004, the ex-tea land with its 2085 ha of sugar cane and 2300 smallholders accounted for 57% of the population of small-scale growers of Category C. Miller-planters and SIT Land Holding claimed 42% of the 4492 ha of the cane land of the Central Plateau.

The subhumid to humid regions

The subhumid to humid regions of Category C amount to 1842 ha. The factory areas of ex-Constance and Mon Loisir bear a sizable proportion of these lands. Given their edaphic characteristics, these difficult areas automatically formed part of the initial land data set subjected to the selection process of Phase I but they poorly satisfied the selection criterion/hypothesis of Phase II. They were inserted in Category C for information purposes only. They are not further commented upon in this report.

Table 3. Difficult areas for sugar cane (Category C: flat to moderately sloping land)

REGION	FACTORY AREA	LOCATION	LAND UNIT[1]	AREA[2] (ha)			NO OF PLANTERS		
				MILLER-	LARGE-SCALE	SMALL-SCALE	MILLER-	LARGE-SCALE	SMALL-SCALE
Humid to Superhumid (Ex-tea land)	FUEL	SIFB Loc Blocks	6.3 6.5			381			387
	Riche En Eau	SIFB Loc Blocks	6.3			357			437
	Ex-Rose Belle	SIFB Loc Blocks	6.3 6.4			242			273
	Ex-Highlands	SIFB Loc Blocks	5.3 6.3			461			505
	MDA	SIFB Loc Blocks	6.3			644			698
	Sub Total					**2085**			**2300**
Humid to Superhumid (East, Centre & South)	Ex-Rose Belle	SIFB Loc Blocks	5.6 6.3			175			156
	MDA	Beau Bois	5.5 6.2	66			1		
		Bonne Veine	5.4 6.3	605					
		Helvetia	5.2	22					
		Valetta	5.6 6.4	62					
		SIFB Loc Blocks	10.3 11.1			112			163
	FUEL	Bel Etang	5.6 5.4	96					
		Sans Souci	6.3 6.4	304					
	Ex-Britannia	St Avold	5.4 3.4	61			1		
		St Avold (SIT Land Holding)	5.4 5.6 3.1		669			1	
		SIFB Loc Blocks	5.4 5.6			235			466
	Sub Total			**1216**	**669**	**522**	**2**	**1**	**785**
Sub-humid to Humid (North-east to East)	Ex-Beau Plan	N Industrie- Amitié	2.1 2.3	42			1		
	Belle Vue	SIFB Loc Blocks	2.1 3.1 10.2			37			84
	Mon Loisir	Plaine des Roches	1.6	73			1		
		SIFB Loc Blocks	1.4 1.6			78			173
	Ex-St. Antoine	North	1.6 1.4	225			1		
		South	1.4	48					
	MDA	SIFB Loc Blocks	10.1			12			5
	Ex-Constance	Belle Mare	1.6 3.5	48			1		
		Argy	1.6 1.4	564					
		SIFB Loc Blocks[3]	1.6			660			681
	Medine	SIFB Loc Blocks	10.1 11.1			55			35
	Sub Total			**1000**		**842**	**4**		**978**
	Total			**2216**	**669**	**3449**	**6**	**1**	**4063**
	Grand Total			**6334**					

Small-scale planter : (≤ 42 ha)

The term miller stands for an estate with either operational or closed mill.

[1] Most important land unit(s) : (Arlidge, E. Z. and Wong You Cheong, Y., 1975). *Notes on the land resources and agricultural suitability map of Mauritius, 1:50 000)*

[2] Data for the year 2003 for small-scale planters and 2003/2004 for miller- and large-scale planters

[3] Includes *métayers*

3. PROFITABILITY ANALYSIS

3.1 Introduction

The objective behind the above analysis was to highlight for the 4642 ha of land under Category A, the change in profitability that would result from a reduction of the sugar price by 36%.

For sugar cane, which involves repetitive cycles consisting of an initial investment followed by a flow of benefits over several years, the annual equivalent as obtained from the Discounted Cash Flow Analysis (DCFA) technique is an appropriate means to assess profitability.

In this analysis, the annual equivalent (representing the effective average annual cash flow in present value terms) of relevance was the one achieved at the end of a 7-ratoon cycle.

3.2 Materials and Method

3.2.1 Materials

The following agronomic and financial parameters were required:

- cane and sugar yields (t ha^{-1});
- direct costs for the establishment of plant cane, ratoon maintenance, and harvest and transport;
- revenue prices for sugar, molasses and bagasse; and
- discount rate (or cost of capital).

3.2.1.1 Cane and sugar yields

Small-scale planters

In order to draw a representative yield curve for small-planters, historic data pertaining to at least the past four years, are needed. Such data is not easily obtainable from the small-scale growers, as most of them do not keep records of the productivity of their fields. In that context, two alternative approaches for estimating their yields, were successively tried.

The first one consisted in retrieving the yield performance for the years 2001 to 2004 from the SIFB database for small-scale planters. In this database, annual planters' yields are stored on a locality block basis. For planters with multiple plots (within and outside a given locality block), their different yield figures are aggregated into a single one.

With the elimination of planters with multiple plots, and plots with missing information from the data set for the year 2001, the size for all the 80 locality blocks of Zones N, E and S was reduced. Within a given zone, the magnitude of the reduction was not the same for all locality blocks. Further, for each locality block, there was still high level of variation for plot size and productivity (t ha^{-1}). Given that the resulting data set would not lend itself to conventional statistical treatment, the process of determining planters' yield from the SIFB database was abandoned. Annex 2 summarizes the profile of these 80 locality blocks after the exclusion of the above-mentioned items.

The second option, which was retained, assumed that the long-term average yields for these small-scale planters would be equivalent to the production potential for their lands adjusted downwards by a correction factor. The production potential referred to the upper limit of the sugar cane yield ranges observed on the land moderately and marginally suitable for sugar cane[2].

As for the correction factor, it reflected the yield differential that normally exists between non-miller (mostly small-scale and large-scale planters) and miller-planters. It was obtained by

[2] See *MSIRI Annual Report 2004*, p 60

expressing the average yield for non-miller planters (2000-2004) for the geographical sectors north, east and south as a percentage of the corresponding value for miller-planters. The worked out figure turned out to be 80% (Annex 3).

Thus, for all small-planter locality blocks found on moderately suitable land, the yield was taken to be 72 t ha^{-1} (80% of the upper limit of 90 t ha^{-1}). In the case of the marginally suitable land, the calculated value was 56 t ha^{-1}. The adjusted figures for these two land suitability classes did not markedly differ from those obtained from the non-normal SIFB data set for the year 2001 (65 and 50 t ha^{-1}).

Miller-planters

For miller-planters, cane and sugar yields averaged for the 2001-2004 period were retrieved from the Land Index database of the MSIRI.

3.2.1.2 Direct costs

The direct costs (MUR ha^{-1}) for establishment of plant cane and maintenance of ratoons (Table 4), accounted for all machine (plant cane only), material, labour and transport expenses incurred prior to harvest. Harvest cost (MUR t^{-1}) consisted of total outlays for cutting, loading and transport.

The participation of the Farmers Service Corporation (FSC) was enlisted for the construction of the direct cost budgets for the small-scale planters. FSC officers from the centres of Solitude/D'Epinay, Beau Champ and St Félix gathered the necessary data from selected planters found on the seaward mountain slopes of their respective zones.

For miller-planters, the required information were directly obtained from the estates.

Table 4. Direct costs

Zone	Land[1] suitability Class	Planter	Coverage (ha)	Direct costs		
				Plant cane	Ratoons	Harvest
				MUR x 10^3 ha^{-1}		MUR t^{-1}
N	S2	Small-scale	271	72.1	24.4	290
	S3	Small-scale[2]	287	69.3	24.4	290
	S3	Small-scale[3]	103	75.3	29.9	313
E	S2	Small-scale[4]	1209	72.6	24.8	275
	S2	Miller-	45	88.4	19.8	330
S	S2	Small-scale	440	67.9	25.9	329
	S3	Small-scale[4]	1020	67.9	25.9	329
	S2	Miller-	509	68.4	17.6	330
	S3	Miller-	170	66.3	18.9	365
Mean	S2	confounded	-	71.1	23.4	306
	S3	confounded	-	68.5	25.1	325

[1] S2 and S3 refer to land respectively moderately and marginally suitable for sugar cane
[2] S3 locality blocks at Vallée des Prêtres excluded.
[3] Locality blocks of Vallée des Prêtres only
[4] Includes métayers

3.2.1.3 Revenue prices (sugar and co-products)

Two sugar prices were used to illustrate the change in profitability. The first represented the price for the crop year 2004/2005 viz MUR 14 658 t^{-1} (after deduction of the average SIFB premium). The second referred to an estimated net price of MUR 10 000 t^{-1} that would be applicable as from 2009/2010 after the phased reduction of 36%.

The prices for molasses (about 0.03 t recovered from one tonne of sugar) and bagasse for 2004/2005 were respectively MUR 912 and MUR 77 t^{-1} (Sources: Mauritius Molasses and Annual Report of the Mauritius Sugar Syndicate for the year 2004/2005). The same prices were assumed to prevail in 2009/2010.

3.2.1.4 Discount rate

The discount rate normally represents the cost of capital, i.e. the rate at which money can be borrowed from commercial banks. For this study, a discount rate of 0.095 was assumed for all producer groups.

3.2.2 Method

3.2.2.1 Calculation of annual equivalents

The above involved the following steps:

- calculation of cash flow (difference between total revenues and direct costs) for each cane category (plant cane to 7^{th} ratoon);

- conversion of cash flow into present value at the selected discount rate of 0.095;

- computation of the Net Present Value (NPV); and

- conversion of NPV to an annual equivalent.

A positive annual equivalent would indicate a profit situation. However, the latter would be a partial indicator of profitability given the exclusion of overhead fixed costs (whose sizes vary with planter category) from the calculations.

3.2.2.2 Sensitivity analysis

Sensitivity analysis involves variation in the key parameters used in the study (sub-section 3.2.1) and interpreting their effects on the initial results. For the sugar price of MUR 10 000 t^{-1}, two tests applicable to the direct costs were carried out.

The first test (ST_1) implied that the direct costs for establishment of plant cane, ratoon maintenance, and harvest and transport were higher by 20%.

The second test (ST_2) hypothesized a situation (a policy measure) where the direct costs for plant cane (from land preparation to the last cultural operation before harvest) would not be borne by planter.

3.3 Results

3.3.1 Effect of change in sugar price

At the sugar price of MUR 14 658 t^{-1} (after deduction of the SIFB premium) and the cost conditions for the year 2005, the annual equivalents for the land moderately suitable for sugar cane varied between MUR 33.1 x 10^3 and 46.7 x 10^3 ha^{-1} (Table 5). The high figure for the miller-planter in Zone E was mainly due to the high average yield for plant cane and seven ratoons (87 t ha^{-1}).

The annual equivalent averaged over the land marginally suitable (confounding zone and planter category) for sugar cane was MUR 19.0 x 10^3 ha^{-1}. The latter value was a little more than half of that for the land classed as S2.

With the direct costs unaltered and the sugar price lowered to MUR 10 000 t^{-1}, dramatic changes would occur. For the S2 land, the mean annual equivalent would be reduced to MUR 6.5 x 10^3 ha^{-1} or to 19% of the value at the initial sugar price. For the S3 land, the mean annual equivalent would turn negative thereby clearly indicating that yields of the order of 56 t ha^{-1} would not be profitable.

Thus, with respect to the land classed as S3, the unprofitable areas would be as follows: 390 ha for Zone N (small-scale planters), 107 ha for Zone E (small-scale planters), and 1571 ha for Zone S (all categories of planters).

Table 5. Annual equivalents

Zone	Land[1] suitability class	Planter	Yield (t ha^{-1})		Annual equivalents (MUR x 10^3 ha^{-1})			
					Sugar price (MUR t^{-1})		Sensivity Analysis	
			Cane	Sugar	14 658	10 000	ST_1	ST_2
N	S2	Small-scale	72	7.9	38.7	10.0	-0.9	23.3
	S3	Small-scale[2]	56	6.1	23.2	0.8	-9.0	13.6
	S3	Small-scale[3]	56	6.1	16.2	-6.1	-17.3	7.8
E	S2	Small-scale[4]	72	7.7	33.6	4.8	-7.2	18.1
	S2	Miller-	87	9.5	46.7	12.3	-0.7	28.5
S	S2	Small-scale	72	7.7	33.1	5.2	-6.3	17.7
	S3	Small-scale[4]	56	6.0	18.3	-3.5	-13.9	9.0
	S2	Miller-	70	7.3	35.8	9.3	-0.8	21.9
	S3	Miller-	53	5.6	18.2	-2.0	-11.4	10.2
Mean	**S2**	**confounded**	**72**	**7.7**	**34.8**	**6.5**	**-4.9**	**19.6**
	S3	**confounded**	**56**	**6.0**	**19.0**	**-2.7**	**-13.0**	**9.9**

[1] S2 and S3 refer to land respectively moderately and marginally suitable for sugar cane

[2] S3 locality blocks at Vallée des Prêtres excluded.

[3] Locality Blocks of Vallée des Prêtres only

[4] Includes *métayers*

ST_1 - 20% increase in production cost (sugar price of MUR 10 000 t^{-1})

ST_2 - Planters do not bear the cost for plant cane (sugar price of MUR 10 000 t^{-1})

3.3.2 Sensitivity analysis

The first sensitivity test (ST_1) hypothesized that in 2009 when the sugar price of MUR 10 000 t^{-1} would be operational, the direct costs would have undergone an increase of 20% (or an annual increase between 4 and 5% over the base year of 2005).

Under this scenario, the profitability profile of the land areas under Category A would further worsen. Losses would be expected everywhere. Whereas for the moderately suitable land, the new annual equivalent would be brought down to MUR -4.9×10^3 ha^{-1}, that for the marginally suitable land would be a double-digit figure (MUR -13.0×10^3 ha^{-1}).

The second sensitivity test (ST_2) investigated into the outcome of a hypothetical policy measure meant to improve profitability. This test gave quite interesting results as it showed that if planters were relieved from the direct costs for plant cane (from land preparation to the last operation before harvest), the profitability profile would drastically change.

For the moderately and marginally suitable land where the average costs were respectively MUR 71.1 X 10^3 ha^{-1} and 68.5 X 10^3 ha^{-1}, positive annual equivalents would be expected. Thus, the new mean annual equivalent for the land classed as S2 would rise to MUR 19.6 X 10^3 ha^{-1}, and to MUR 9.9 X 10^3 ha^{-1} for the S3 land. In relative terms, they would represent 56% and 52 % of those obtained at the initial sugar price of MUR 14 658 t^{-1}.

3.3.3 The *métayers*

On account of the land rental (payable in terms of kg sugar t^{-1} cane), the *métayers* are expected to generate lower revenue than independent small-scale planters of the same zone.

This rent which was not considered in the foregoing analysis, varies with regions. In Zone E (Ferney), the maximum is 17 kg sugar t^{-1} cane. In Zone S (across factory areas of ex-Bel Ombre and St Félix), it ranges between 13 and 21 kg sugar t^{-1} cane.

For these *métayers*, new annual equivalents were calculated on the basis of a rent of 17 and 13 kg sugar t^{-1} cane respectively for Zones E and S. It was observed that as per sensitivity test ST_2, these annual equivalents would be MUR 4.5 x 10^3 ha^{-1} for Zone E and MUR 1.2 x 10^3 ha^{-1} for Zone S.

These figures are largely inferior to the mean for the S2 and S3 land. They suggest that additional measures may be necessary in order to maintain their interests in the growing of sugar cane on the mountain slopes.

4. CONSEQUENCES OF THE ABANDONMENT OF SUGAR CANE CULTIVATION

4.1 Introduction

The objective of this Chapter was to briefly highlight the various issues likely to be raised with the potential abandonment of sugar cane on the 4642 ha of seaward mountain slopes of Category A.

Within the multifunctional dimension of the sugar cane industry, emphasis was laid on: -

- physical production losses (cane, sugar and co-products);

- employment and income; and

- effect on tourism and *artisanal* fishing.

4.2 Production losses

Table 6 details the physical output (cane, sugar, electricity and ethanol) that could be lost from the land of Category A.

The loss in annual sugar output would be equivalent to 32 490 t (from 301 100 t of cane) with Zone S owing to its size (2 520 ha) accounting to nearly 50% of the total. These 32 490 t would represent around 6% of the production level of 550 000 t of sugar projected for the next decade. At the price of MUR 10 000 t^{-1}, the value of sugar foregone would be around Euro 8 million.

Zone S could be a source of concern for the single centralized mill that would be operational in the South of the island. With a hypothetical abandonment of cane growing on its slopes, the cane throughput at the mill would be potentially reduced by 156 000 t.

Table 6. Production losses

Zone	Land suitability class	Planter	Area (ha)	Production losses				Value (MUR x 10^6)			
				Cane (t x 10^3)	Sugar (t x 10^3)	Electricity (GWh)	Ethanol (l x 10^6)	Sugar	Electricity	Ethanol	TOTAL
N	S2	Small-scale	270	19.5	2.14	2.54	0.15	21.4	4.4	2.0	27.9
	S3	Small-scale	390	21.8	2.37	2.83	0.16	23.7	5.0	2.3	31.0
	S2	Miller-	68	4.8	0.54	0.63	0.04	5.4	1.1	0.5	7.0
Sub-Total			**728**	**46.1**	**5.06**	**6.00**	**0.35**	**50.6**	**10.5**	**4.8**	**65.9**
E	S2	Small-scale	1209	87.0	9.55	11.32	0.65	95.5	19.8	8.9	124.2
	S3	Small-scale	107	6.0	0.66	0.78	0.04	6.6	1.4	0.6	8.6
	S2	Miller-	78	5.9	0.65	0.77	0.04	6.5	1.3	0.6	8.4
Sub-Total			**1394**	**99.0**	**10.86**	**12.87**	**0.74**	**108.6**	**22.5**	**10.1**	**141.3**
S	S2	Small-scale	440	31.7	3.39	4.12	0.22	33.9	7.2	3.1	44.1
	S3	Small-scale	1020	57.1	6.12	7.43	0.40	61.2	13.0	5.5	79.7
	S2	Miller-	509	35.6	3.72	4.63	0.25	37.2	8.1	3.4	48.7
	S3	Miller-/large-scale	551	31.6	3.34	4.11	0.22	33.4	7.2	3.0	43.6
Sub-Total			**2520**	**156.0**	**16.57**	**20.28**	**1.09**	**165.7**	**35.5**	**15.0**	**216.2**
TOTAL			**4642**	**301.1**	**32.49**	**39.15**	**2.18**	**324.9**	**68.5**	**30.0**	**423.3**
TOTAL	**S2**	**confounded**	**2574** *(55)*	**184.6** *(61)*	**19.99** *(62)*	**24.00** *(61)*	**1.35** *(62)*	**199.9** *(62)*	**42.0** *(61)*	**18.5** *(62)*	**260.4** *(62)*
	S3	**confounded**	**2068** *(45)*	**116.5** *(39)*	**12.50** *(38)*	**15.14** *(39)*	**0.83** *(38)*	**125.0** *(38)*	**26.5** *(39)*	**11.4** *(38)*	**162.9** *(38)*
TOTAL	**confounded**	**Small-scale**	**3436** *(74)*	**223.1** *(74)*	**24.24** *(75)*	**29.01** *(74)*	**1.63** *(75)*	**242.4** *(75)*	**50.8** *(74)*	**22.4** *(75)*	**315.5** *(75)*
	confounded	**Miller-/large-scale**	**1206** *(26)*	**78.0** *(26)*	**8.25** *(25)*	**10.14** *(26)*	**0.55** *(25)*	**82.5** *(25)*	**17.7** *(26)*	**7.6** *(25)*	**107.8** *(25)*

( ) % total

As regards the production of electricity, the 4642 ha of Category A have a potential of 39 GWh (worth MUR 68.5 million) for export to the national grid. This figure was arrived at on the assumption that future power plants would be capable to generate 130 KWh from one tonne of cane. The amount of electricity reduction would account for only 1.3% of expected demand of the island for the year 2015.

In the case of fuel ethanol (1 t of molasses = 240 litres of ethanol), the volume at stake would be equivalent to 2.18×10^6 litres (or approximately 7% of the industry's objective for 2015). At a price of US \$ 0.44 l^{-1}, gross returns would be MUR 30.0 million.

Thus, the aggregated gross receipts from sugar, electricity and ethanol would be equal to MUR 423.3 million. The share of electricity and ethanol in that sum would be respectively 16% and 7%.

Out of these MUR 423.3 million, the largest portion (75%) would be attributed to the small-scale planters.

It is also of interest to note that if all the land classed as S3 were to move away from sugar cane, the reduction in physical output (cane, sugar, electricity and ethanol) for Category A would range from 38 to 39%.

4.3 Employment and income

4.3.1 Labour utilization

Table 7 pictures the quantity of labour (mandays and womandays) demanded on a semester basis for sugar cane cultivation on 4506 ha (97%) of the mountain slopes of Category A. These figures were calculated under the assumption that the cane cycle would consist of plant cane and seven ratoons.

Table 7. Labour utilisation

Zone	Planter	Coverage (ha)	Mandays				Womandays			
			Jan-Jun	Jul-Sept	Total	Mean	Jan-Jun	Jul-Sept	Total	Mean
N	Small-scale	660	14440	8720	23160	**35**	12940	29080	42020	**64**
Sub-Total		***660***	***14440***	***8720***	***23160***	**35**	***12940***	***29080***	***42020***	**64**
E	Small-scale	1316	13820	13670	27490	**21**	38150	68300	106450	**81**
	Miller-	78	600	890	1490	**19**	2100	90	2190	**28**
Sub-Total		***1394***	***14420***	***14560***	***28980***	**21**	***40250***	***68390***	***108640***	**78**
S	Small-scale	1460	0	12810	12810	**9**	101050	70030	171080	**117**
	Miller/large-scale	992	6670	6590	13260	**13**	13190	6320	19510	**20**
Sub-Total		***2452***	***6670***	***19400***	***26070***	**11**	***114240***	***76350***	***190590***	**78**
TOTAL	**confounded**	**4506**	**35530**	**42680**	**78210**	**17**	**167430**	**173820**	**341250**	**76**
TOTAL	**Small-scale**	**3436**	**28260**	**35200**	**63460**	**18**	**152140**	**167410**	**319550**	**93**
	Miller-/large-scale	**1070**	**7270**	**7480**	**14750**	**14**	**15290**	**6410**	**21700**	**20**

The demand for female labour for each semester considered all the different field operations performed in plant cane and ratoons during the periods referred to. A similar approach was adopted for male labour but for the second semester (July to December), harvest (cutting and loading) was not included as its interpretation in terms of mandays ha^{-1} is not straightforward. Comments on the harvest operation is deferred to sub-section 4.3.2.

A major feature of sugar cane growing on these mountain slopes is the heavy dependence on female labour (cf 78 210 mandays and 341 250 womandays). This is because women are normally affected to labour intensive cultural operations such as scum application, placement and covering of setts, weeding, trashing and trash lining. It is worth noting that out of these 341 250 womandays, some 85 000 were annually spent on manual weeding (Annex 4).

For the small-scale planters, the variation in labour requirement (per unit area) between zones was mainly due to gender preference for a particular field operation and to date of planting.

For Zones N and E where sugar cane is planted between December and February and harvested at the age of 10-11 months, the mean number of mandays required per hectare (total mandays for the year/total area under cane) would be respectively 35 and 21. An explanation for this large difference was that in Zone N, earthing up (plant cane only) and weeding (plant cane and ratoons) were done by men whereas in Zone E, these operations were reserved for women.

In Zone S where sugar cane is mostly planted between July and September, the annual quantity of male labour used was practically half that of Zone E. This was because in the former zone, tasks normally allocated elsewhere to men at the land preparation stage (e.g., rock removal and rectification of furrows) were being done by women.

In the case of miller- and large-scale planters where cane burning has enabled the suppression of trashing and trash lining, the mean annual demand per hectare (ratoons and

plant cane confounded) for female labour was much lower than that for small-scale planters (cf 20 and 93 womandays). The mean number of mandays per hectare (14) was slightly lower than that of small-scale planters (18).

On the basis of information given above, it is clear that if sugar cane cultivation on the mountain slopes of Category A were to be abandoned, it is female labour that would be the major loser, the more so in Zone S.

4.3.2 Labour income

In practice, the labour (male and female) supplied is made up of two distinct groups, i.e., casual labour (daily paid) that are hired by all categories of planters but mostly by the small-scale ones, and the permanent labourers (enjoying higher wage rates and fringe benefits) servicing the miller- and large-scale planters.

Table 8. Labour income

Zone	Area[1] (ha)	(MUR x 10^6)				Zone % Total	Harvest % Total Male
		Female	Male				
		FO[2]	FO[2]	Harvest	Total		
N	660	5.5	5.0	9.9	**20.4**	**15**	**66**
E	1394	14.3	6.3	23.7	**44.3**	**34**	**79**
S	2452	25.2	5.7	36.2	**67.1**	**51**	**86**
Total	**4506**	**45.0**	**17.0**	**69.8**	**131.8**	**100**	**80**
% Total	**-**	**34**	**13**	**53**	**100**		

[1] *97% of total area of 4642 ha.*
[2] *Field operations other than harvest*

For simplification purposes, it was assumed that for all three zones of Category A, labour would be paid on a daily basis (weighted wage rate of MUR 217 for men and MUR 132 for women) for the field operations performed in plant and ratoons prior to harvest. As for harvest (cutting and loading), which is paid on a per tonne basis, the weighted value across all zones was MUR 239 t^{-1} cane.

As per assumptions made above, the value of income derived in 2005 by male and female labourers for 4506 ha of mountain slopes, would be MUR 131.8 million (Table 8). This sum included MUR 69.8 million for the harvest (cutting and loading) of some 291 760 t cane by male labour. For the latter, the harvest operation would account for 80% of their total earnings. Female labour (341 250 womandays) represented 34% of the MUR 131.8 million spent by planters on wages.

The transport of cane to the mill was not considered in the above analysis, as it was not possible to extract the 'income element' for owners, drivers, helpers, etc. from the cost practised per tonne of cane. With the inclusion of this 'income element', the overall sum likely to be lost with the abandonment of sugar cane would be larger than MUR 131.8 million.

Given the magnitude of the income for labour, it would not be presumptuous to assert that it is the vitality of villages found close to the three zones, which would be adversely affected in the event sugar cane was abandoned. With a deterioration of the standard of living for these labourers (the exact number in terms of households is not known), it is in turn the small trades and businesses of the villages concerned that would be hit.

4.4 Effect on tourism and *artisanal* fishing

From the environmental standpoint, there are definite linkages between sugar cane growing on the one side and *artisanal* fishing and tourism on the other side.

It is being increasingly recognized that green backdrop scenery as offered by the cane fields on the mountain slopes, is an invaluable asset to the tourism industry. Moreover, the soil conservation measures practised for the cultivation of the perennial sugar cane plant prevents the large-scale pollution of the nearby lagoons through soil erosion. This enables the promotion of lagoon-based economic activities in the tourism sector and the continuation of *artisanal* fishing.

It is apprehended that if the cane plots were to be left bare or replaced by a less stable crop, the process of soil erosion would be accelerated. Consequently, with the disruption of the beach-lagoon-reef equilibrium, heavy prejudices would be caused to the *artisanal* component of the fishing industry and to the tourism sector. What would be the magnitude of these damages? Would they be localized or regional?

Unfortunately, there are no answers to these questions as currently there are no validated scientific information on soil erosion on these mountain slopes. The only scientific data available pertains to the two sites (Bel Ombre and St Félix) close to the mountain slopes of Zone S. A project initiated in 2001 showed that at Bel Ombre (altitude 59 m), soil loss on bare plots would on average be around 25 t ha^{-1} yr^{-1} in contrast to less than 5 t ha^{-1} yr^{-1} for plots under a standing sugar cane crop (MSIRI, 2005). At St Félix (altitude 329 m) where very little soil erosion occurred, the soil loss on the bare plots was several folds higher than that for the cropped ones.

It may be inappropriate to extrapolate these results to all the mountain slopes of Category A. But given the large difference between bare and planted plots, it is certain that in the event sugar cane were removed from these slopes, the nearby lagoons would be affected.

As regards the lagoons, they have over the past years been increasingly subjected to both reversible and irreversible coastal erosion. Baird & Associates Coastal Engineers Ltd (2003) prioritised a list of sites exposed to coastal erosion, and for which remedial measures are being implemented. All three Zones of Category A bear at least one of these coastal sites. In Zone S, Rivière des Galets is a priority site and the medium priority ones are Baie du Cap

and Riambel. In Zone E, Quatre Soeurs, Petit Sable, Bambous Virieux and Pointe d'Esny are all medium priority sites. Pointe aux Piments off Zone N is a low priority beach.

Given the existing natural and anthropogenic pressures on the beach-lagoon-reef systems, additional ones resulting from large-scale cane abandonment may render the lagoons less favourable for water-based economic activities.

Table 9. Employment statistics for *artisanal* fishing and tourism (2005)

District	Fishermen		Hotel employees	
	No.	% Total	No.	% Total
Port Louis	113	5	426	2
Pamplemousses (Zone N)	361	16	3942	20
Rivière du Rempart	421	18	2341	12
Flacq	328	14	5068	26
Grand Port (Zone E)	515	22	1385	7
Savanne (Zone S)	193	8	1107	6
Black River	395	17	5038	26
Total	**2326**	**100**	**19 307**	**100**

Sources: Ministry of Agro Industry & Fisheries (Fisheries Division) and Central Statistical Office

Tourism and *artisanal* fishing are two economic activities of importance in the three Zones of Category A. In 2005, the number of registered coastal fishermen operating in Zones N, E and S were respectively 361, 515 and 193 (Table 9). In the case of tourism, some 6434 individuals (33% of total) were employed in hotels and restaurants of these three zones. Thus, tourism together with *artisanal* fishing accounted for 7503 direct jobs.

Moreover, the tourism sector ensures employment in other areas such as agriculture, transport, retail shopping and entertainment, etc. Unofficial sources state that the level of indirect employment in the tourism sector is about twice that of its direct counterpart. These

indirect jobs (especially the village-based ones) too will be adversely affected by a slowing down of the core activities of the hotels.

It is not intented in this report to quantify the likely total employment (direct and indirect) losses in tourism and *artisanal* fishing. The aim is simply to draw attention firstly to the fact that for the villages in specifically Zones E and S, every single percentage of job losses in tourism and *artisanal* fishing will further aggravate the unemployment problem that might have already been created by cane abandonment. Secondly, with employment losses in several economic spheres, the socio-economic structure of these villages would undergo at least a partial collapse with the low-income households enduring greatest sufferings.

5. ALTERNATIVES TO SUGAR PRODUCTION

5.1 Justification

Alternatives to sugar production were not included in the terms of reference of the study. However, the long-term decline of sugar cane profitability on the marginally suitable land that represents 45% of Category A, provides enough justification for briefly covering this topic.

To recall, these marginally suitable land owing to their lower yield level than the moderately suitable ones will not be profitable at a sugar price of MUR 10 000 t^{-1}. A policy measure in the form of financial assistance covering the cost for plant cane (sub-section 3.3.2) will partly compensate for the revenue losses.

However, with the annual increase in manual cost of production, there will be a point in time when the spectre of non-profitability will resurface. Consequently, the only two options available will be either to augment the amount of financial support allocated to the crop or to replace it by profitable alternatives. From the economic point of view, it is definitely the second option that will be more plausible.

There is also another justification that has economic, social and political dimensions. It refers to the current process of converting land to uses other than sugar production. On the marginally suitable land of Zone S, all categories of planters, namely the miller-, large-, small-scale and the *métayers* are present. The miller- and large-scale planters have already started replacing part of their land under cane by the cultivation of palmito, deer rearing, tourist amenities, etc. In clear, they are shifting from a poorly profitable sugar cane crop to more lucrative activities. Under such circumstances, it can be expected that in the medium- to long-term, the small-scale planters will lose interest in sugar cane cultivation and inevitably opt for alternative crop activities.

5.2 The scope for alternative crop activities

5.2.1 The selection criteria

Alternative crop activities for these mountain slopes should have the same multifunctional role as sugar cane. Consequently, their identification and selection should necessarily satisfy the following criteria listed in order of importance:

- environmental sustainability;
- agronomic sustainability;
- economic viability;
- capacity to absorb part of the agricultural labour displaced, and
- potential contribution to development (e.g., small-businesses).

These criteria provide a holistic approach to project evaluation and selection. Environmental sustainability is by far the most important criterion. It is of note that the *Environmental Protection Act 2002* requires any project within or adjoining the environmentally sensitive areas (mountain slopes included) to first obtain an Environmental Impact Assessment licence prior to is implementation.

Agronomic sustainability refers to the long-term yield stability for the selected crops.

Economic viability ensures that projects will not rely on policy support measures for annual profitability but it is not excluded that it can be entitled to public funds for take-off.

The last two criteria aim at preventing the socio-economic degradation of the villages concerned.

5.2.2 Prospects

In the Agricultural Land Suitability Map (Arlidge and Wong You Cheong, 1975), it is mentioned that conditional upon improvements such as erosion control and terracing, these mountain slopes are either moderately or highly suitable for forestry, fodder for livestock, livestock grazing, food crops and mixed cropping.

On economic and/or environmental grounds, none of the above activities may be currently appropriate for these slopes. Forestry, fodder for livestock and deer ranching (small-scale planters) may not be economically viable. In addition to technical difficulties, livestock grazing (cattle, goat and sheep) may expose these lands to soil erosion. Food crops and mixed cropping are short-term enterprises that are agro-chemically intensive. They are thus associated with high risks of soil erosion and pollution of the rivers and lagoons downstream.

However, there may exist environmentally friendly perennials other than sugar cane that can be profitably exploited on these seaward mountain slopes. For example, the large-scale cultivation of the new palm species (*pejibaye*) in association with a cover crop should be encouraged. On a very small scale, other possibilities exist, e.g., 'bambou fataque' (*Thysanolaena maxima*). The challenge for agricultural research institutions and other parties is to identify the appropriate plant species capable of creating value addition.

This brief analysis of prospects will be incomplete without mentioning the utilization of the sugar cane plant for products of interest to the tourism industry. The constant increase in tourist arrival provides the necessary incentives to develop a wide spectrum of innovative products ranging from the use of the standing cane crop for the preparation of beverages to craftwork. These new products have to be rapidly identified. Such exercise will require a lot of creative thinking and interaction with professionals from the tourism industry.

6. SYNTHESIS

6.1. Profitability

On the basis of the costs prevailing for the year 2005, and a likely sugar price of MUR 10 000 t^{-1}, sugar cane would not be profitable for the 2068 ha of land marginally suitable for sugar cane (45% of Category A).

As for the moderately suitable land (2574 ha), profitability would be reduced to 19% of that obtained at a sugar price for the crop year 2004/2005 (MUR 16 150 t^{-1}). With costs increasing at the rate of 4-5% per year, these lands too would turn non-profitable in a time span of four to five years.

As shown in a sensitivity test, profitability for both the moderately and marginally suitable land would be restored to respectively 56% and 52% of their respective level for the year 2005 if planters were relieved from the costs for plant cane (from land preparation to the last operation before harvest).

The above observations clearly indicate that without support, sugar cane cultivation would not be profitable on these mountain slopes.

6.2 Multifunctional role

Category A has a production potential of around 32 500 t of sugar (roughly 6% of industry's target for the year 2015). It is not felt that long-term industry plans would be jeopardized if these mountain slopes were to move away from sugar cane as these losses would most probably be compensated by productivity gains elsewhere.

However, it is from the social and environmental angles that difficulties will arise. The cultural operations performed on 97% of these slopes (harvest excluded) each year require

some 341 000 womandays and 78 000 mandays. With the inclusion of the manual harvest, the total income foregone by labour would be equivalent to MUR 131.8 million.

Regarding the environment, the apprehensions are that if the slopes were to be left bare following the abandonment of sugar cane, large-scale erosion could pollute the nearby lagoons (more specifically in Zones E and S). With the disruption of beach-lagoon-reef equilibrium, it is the water-based economic activities such as *artisanal* fishing and tourism that could be adversely affected. Ultimately, it is the livelihood of some 1069 coastal fishermen and 6434 employees of hotels and restaurants as well as those indirectly involved in *artisanal* fishing and tourism that could be at stake.

Thus, the overall social effect of land abandonment could be the deprivation of income for the following households: planters, sugar cane labour and those directly and indirectly involved in tourism and *artisanal* fishing. As a large proportion of these households inhabit the villages within or close to the three zones of Category A, the socio-economic fabric of these villages could eventually be weakened.

6.3 Alternatives to sugar production

With the declining profitability for the 2068 ha of land marginally suitable for sugar cane, other perennial crops that are environmentally sustainable and economically viable appear as valuable options for the small-scale planters. In that context, there is need to encourage the cultivation of the new palm species (*pejibaye*) in association with a cover crop and to identify of other appropriate plant species.

The utilization of the sugar cane plant for the development of innovative products (e.g., beverages, craftwork, etc) of interest to the fast expanding tourism industry is an avenue that should be explored.

6.4 The way to recommendations

The seaward mountain slopes of Category A represent a case where the social and environmental factors may take precedence over economic ones for justifying the cultivation

of a crop that will turn from profitable to non-profitable as a result of the downward revision of the sugar price. It therefore follows that the continuation of sugar cane on these slopes is conditional on the availability of support measures.

An acceptable package of support measures is normally one that reconciles the technical, economic, social, environmental and political aspects of cane growing on these slopes. The formulation of such a package is not straightforward owing to the numerous questions the future of cane growing on these slopes gives rise to. Some of the main questions are:

- For how long can sugar cane cultivation be maintained through support measures?
- In the long run, what shall be the effect of these support measures on these regions, on the industry and on the national economy?
- Given the decline in sugar cane profitability, is it not preferable to look for other crop activities that are environmentally sustainable and economically viable?
- What are the views of the concerned planters as regards the future?

The recommendations that are thus made apply to the continuation of sugar cane on both the land moderately and marginally suitable for sugar cane and they certainly take into account the above questions. They necessarily have to be reviewed in the light of technological innovation and changes in the economic environment.

7. RECOMMENDATIONS

7.1 Introduction

In this chapter, section 7.2 deals with the economic and technical recommendations for maintaining sugar cane on the mountain slopes. The package of recommendations was constructed on the basis of findings from chapters three and four. Section 7.3 summarizes the likely effects of these recommendations on profitability.

In section 7.4, the focus is on alternatives to sugar cane production.

7.2 Recommendations for sugar cane

7.2.1 Financial assistance for plant cane

In the light of results obtained in sub-section 3.3.2, it is recommended that a policy measure in the form of a financial assistance (to recur at each replantation cycle) be provided to all categories of planters to enable them to cover costs for plant cane. The latter costs cover the material, machine and labour expenses incurred from land preparation to the last operation before harvest.

This policy measure will restore profitability to around 53% of that achieved for the crop year 2004/2005. It will allow the adoption of sugar cane varieties that may be superior to the popular *R 570*. Further with its application to both the moderately and marginally suitable land for sugar cane, it will ensure employment for casual labour for at least eight years.

However, there is a problem of environmental importance that is associated with this financial assistance. In practice, it seems advisable that by 2009 when the reduced sugar price will be fully operational, all the old and poor performing fields will have been renewed. Such plan implies that over the short span of 3-4 years, land areas put to plant cane each year will be larger than under normal replanting conditions. Under such circumstances, there may be increased

risks for soil erosion on these slopes. This environmental threat should retain the attention of decision-makers when planning for replantation on these slopes.

As regards the cost implications for the implementation of this replantation programme, the exact amount to be disbursed is not known for the time being. On the basis of data for 2005, the total outlays for these 4642 ha corresponded to MUR 326 million. But with the exclusion of land areas already and to be converted to other uses, and cost rationalization measures to be proposed for selected cultural practices performed in plant cane, the final overall expenditure is expected to be less than these MUR 326 million.

7.2.2 Cost rationalization for plant cane and ratoons

7.2.2.1 Weed control

For the three zones of category A, the average cost for weed control (plant cane and ratoons) was MUR 7931 ha^{-1} with the manual component reaching MUR 4970 ha^{-1}. It is not known whether the high cost for manual weeding was due to special weed problems on these slopes or to small-scale planter's strategies to ensure the loyalty of casual labour.

It is imperative that ways and means be developed to bring down the cost for weeding. In that respect, it is recommended that research and extension study the weed ecology of these slopes and expose planters to the latest techniques applicable to weed control.

7.2.2.2 Trashing and trash lining

The small-scale planters claimed that they have recourse to trashing (average cost of MUR 3466 ha^{-1}) because it helps to control rodents and accidental fires. With the abandonment of this practice, the net savings will be the cost of trashing less the costs for rodent control and the increased cost for harvesting cane with trash.

Concerning trash lining, the cost varied between MUR 2100 and 2900 ha^{-1}. Its replacement by trash blanketing will automatically decrease the total cost for ratoon maintenance.

7.2.2.3 Maintenance of roads and drains

All planters on the mountain slopes annually allocate labour for the maintenance of the roads adjacent to their plots and to the drains running across their fields. The costs for these two important operations were highly variable but rarely less than MUR 1000 ha^{-1}.

In the quest for reducing the cost of production at field level, it is suggested that the Road Mending Scheme managed by the FSC contributes to the financing of these two above items.

7.2.2.4 Protracted ratooning

For analytical purposes, it was assumed that for the seaward mountain slopes, the cane cycle would consist of plant cane and seven ratoons. In fact, in each zone of Category A, many planters have longer cane cycles.

In the context of a falling sugar price, the practice of prolonging the cane cycle beyond the 7^{th} ratoon is a laudable one. Moreover, as the frequency of land tillage is reduced (in contrast to a cycle of seven ratoons), the risks for soil erosion are minimized.

Protracted ratooning should be further encouraged but it necessarily has to be balanced against the opportunity cost of not introducing a higher yielding variety at a given point in time. In that respect, the notion of optimum cane cycle should be distilled among the small-scale planters. Further, given the benefits associated with protracted ratooning, it becomes obvious that new sugar cane varieties introduced on these slopes should be ones that generate profitable net returns beyond the 7^{th} ratoon. In that context, new vigorous canes (high quality/high fibre content) may represent an interesting option for the mountain slopes.

7.2.2.5 Mechanized loading

With the aim of cutting down the total cost of harvest, the possibilities for introducing mechanized loading on these slopes should be explored.

It is believed that a small and light mechanized loader can fulfil this task. In turn, it increases the prospects for a cost-effective transportation of cane to the mill. However, its economic performance is subject to an organization of harvest that meets its basic requirements (e.g., the minimum tonnage to be loaded daily). In the case of the small-scale planters, this can only be achieved through collective action. In that respect, it is suggested that planters be canvassed in the same way as for the establishment of the so-called production areas.

7.2.2.6 Planter grouping

There is no doubt the proposals for cost rationalization listed in paragraphs 7.2.2.1 to 7.2.2.5 are fully effective when the small-scale planters are integrated in planter organizational structures that favour collective management. But what is the appropriate grouping structure for these planters?

Since the late 1980's, the concept of grouping has been promoted in view to improve the efficiency and productivity of the small-scale planters. But regretfully, its expansion has been severely constrained by insurmountable socio-economic problems.

In order to avoid the difficulties encountered elsewhere, an innovative approach to grouping (farmer-first-approach) is proposed for these difficult areas. It contrasts sharply with the conventional transfer of technology model where there is the danger that the planter remains a passive recipient of technology. A basic tenet of this approach is that it recognizes that the planters too have strategies for survival under adverse conditions (e.g., managing the low sugar price). Institutions servicing them should give top priority to the solutions proposed by the planters themselves.

It is recommended that for the mountain slopes, funds be made available for the acquisition of the services (contract basis) of a sociologist and an agricultural economist in view to promote planter grouping as per the farmer-first-approach. Given their respective field of expertise, these two professionals will definitely complement each other for the reconciling

of the planters' views and aspirations with the institutional aspects of grouping (incentives, extension, etc).

7.3 Effects of recommendations on profitability

The cost rationalization measures are meant to bring the seaward mountain slopes to a profitability level higher than that initially obtained with the financial assistance for plant cane.

Measures proposed for weed control, trashing and trash lining will give positive results in the short-term. The remaining ones may take a longer time to become fully effective.

With respect to manual weeding, trashing and trash lining, the aggregated costs ranged between MUR 10 500 and 11 300 ha^{-1} each year. Under the hypothesis that for these three cultural practices, partial savings of at least MUR 5000 ha^{-1} could be immediately realized, interesting changes would occur.

Thus, for the land moderately suitable for sugar cane, profitability averaged over a 7-ratoon cycle would rise to 68% of the level for 2005 (cf 56% with the financial assistance for plant cane only). In the case of the marginally suitable land, the corresponding figure would be 74%. As for the *métayers*, the average net revenue per ha would improve significantly but it would be largely inferior to that obtained by independent planters.

On the basis of the above observations, it is evident that another higher level of profitability would be reached with the full application of all the items pertaining to cost rationalization. For the time being, the quantum cannot be determined given a few unknowns associated with some measures (e.g., planter grouping).

However, it should be stressed that despite these improvements, the land marginally suitable for sugar cane would remain exposed to the adverse effect of annual increase in cost of

production on profitability. In practice, the cost rationalization measures will have the effect of lengthening the time taken for sugar cane to become non-profitable.

A last point concerning the effect of the package of recommendations on profitability is with respect to labour. While it would improve profitability of planters and also help towards avoiding environmental problems resulting from the abandonment of sugar cane, it would inevitably be at the detriment of female casual labour. For the 3436 ha of land managed by the small-scale planters and *métayers*, the immediate savings of at least MUR 5000 ha^{-1} as mentioned in the third paragraph would imply a net loss of around 137 000 womandays.

7.4 Alternatives to sugar production

In the light of comments made in chapter five, it is recommended that a technical group be set up in view to devise a consensual framework for the development of alternatives to sugar production on the mountain slopes that are marginally suitable for sugar cane. The alternatives comprise environmentally sustainable perennial crops of economic importance and sugar cane-based products attractive to the tourism industry.

The framework will necessarily cover the environmental, technical, economic and social implications of the introduction of the identified alternatives on the mountain slopes. It will be of prime relevance to institutions involved in agricultural research and to decision-makers.

The technical group will consist of sugar industry stakeholders including representatives of small-scale planters operating on the slopes of Category A, and all other interested parties (agricultural and non-agricultural institutions, commercial agents, individuals, etc).

Given that the time lapse between the identification of a new crop/product and its release for commercial application may be several years (e.g., 6 years for *pejibaye*), it is suggested that the establishment of this technical group be given early attention. The sooner the new technologies are available, the better it will be for their intended recipients.

8. CONCLUSIONS

The approach adopted for the conduct of the foregoing project has led to the achievement of both stated and non-stated objectives. First, it has enabled the listing of all the land areas termed as difficult for sugar cane growing in Mauritius. Second, it has allowed the identification of those land areas (seaward mountain slopes) where sugar cane abandonment will give rise to environmental, economic and social problems. Third, it has promoted a better understanding of the multifunctional role played by sugar cane.

The seaward mountain slopes, which are the principal focus of the study, represent nearly one third of the total land areas identified. The different analyses performed have amply demonstrated the adverse consequences of sugar cane abandonment in these regions. There is no doubt that the policy measure in the form of a financial assistance for plant cane as contained in the package of recommendations formulated will be a key element for preventing or at least mitigating environmental, economic and social damage.

Moreover, it is certain that if the recommendations are implemented, the preservation of sugar cane on these seaward mountain slopes will positively contribute to the objective of the Multi Annual Adaptation Strategy Action Plan 2006-2015, which is to maintain a crop, whose importance with respect to the production of renewable and environmentally friendly energy, and creation of value addition will significantly rise in the coming years.

REFERENCES

Arlidge, E. Z., Wong You Cheong, Y. (1975). Notes on the land resources and agricultural suitability map of Mauritius, 1:50 000. Réduit: Mauritius Sugar Industry Research Institute. 138 p.: 7 figs, 4 pl., 15 tbls. (*Occ. Pap. Maurit. Sug. Ind. Res. Inst., 29*) (+Map in two parts accompanied by legend (17 p.))

Baird, W.F., & Associates Coastal Engineers Ltd. (2003). *Study on coastal erosion in Mauritius, Volume 1: Final Technical Report*. Prepared for Ministry of Environment, Mauritius by W.F. Baird & Associates Coastal Engineers Ltd in collaboration with Reef Watch Consultancy Ltd, Mauritius and Dr. Micheal Risk. 405 p. (ENV/RM/5/1/1)

Jhoty, I., Ramasamy, S., Baggonauth, D., Tulloo, P.K. (2002). Suitability of cane land for mechanization. Réduit: Mauritius Sugar Industry Research Institute. 11 p.: 3 figs, 2 appen. (incl. 1 map, scale 1:200 000). (*Occ. Rep. Maurit. Sug. Ind. Res. Inst.; 29*)

Julien, M. H. R., Deville, J., Govinden, N., Lim Shin Chong, L. C. Y. (1984). The analysis of characteristics of cane lands in Mauritius – An essential tool for agricultural development. *Revue agric. Sucr. Ile Maurice* 63:163-177. (Published in 1987)

Ministry of Housing and Lands (2003). Review of the National Physical Development Plan (NPDP), Final Report: Vol. I Development Strategy and Policies. Port Louis: Ministry of Housing and Lands, Government of Mauritius. 244 p.

MSIRI (2005). Environmental and natural resources management. *Rep. Maurit. Sug. Ind. Res. Inst*. 2004:61.

MSIRI (2005). Environmental and natural resources management. *Rep. Maurit. Sug. Ind. Res. Inst.* 2004:62.

Parish, D. H., Feillafé, S. M. (1965). Notes on the 1:100 000 soil map of Mauritius. Réduit: Mauritius Sugar Industry Research Institute. 43 p.: 5 col. pl., 1 map. (*Occ. Pap. Maurit. Sug. Ind. Res. Inst., 22*)

ACKNOWLEDGEMENTS

This project necessitated the collection of data for the construction of direct cost budgets for plant cane and ratoons. In this respect, we are indebted to the managers and technical personnel of Deep River Beau Champ Ltd, Cie Sucrière de Bel Ombre Ltée, St Félix SE Co Ltd, Baie du Cap Estate Ltd and Ramphul Estate. The collaboration of the managers and staff of the FSC Centres of Solitude/D'Epinay, Beau Champ and St Félix is acknowledged.

We are thankful to the temporary Research Assistants, Ms O Chummun and Mr Y Levantard who were successively involved in the compilation of project data.

We are appreciative of the assistance of Mr P K Tulloo of the Agricultural Chemistry Department of the MSIRI for data processing and map preparation.

We are grateful to the Director and Heads of Agricultural Chemistry, COWA, Food Crops and Mechanization Departments of the MSIRI for their suggestions.

Annex 1. List of small-scale planter locality blocks (Category A: seaward mountain slopes)

Zone N

Ex-BEAU PLAN FACTORY AREA

LOCALITY BLOCKS				Land suit	No of planters	Area (ha)
D	0	1	Bon Amour	S3	20	20
D	0	2	Bon Amour	S3	27	13
D	0	3	Bon Amour / Ilot	S3	49	21
E	1	2	Camp La Boue	S2	99	68
F	1	1	Montagne Jacquots	S2	61	33
F	1	3	M Jacquots/Crève Coeur	S2	34	19
F	1	4	Crève Coeur	S2	36	14
F	2	1	Crève Coeur	S2	31	10
F	2	2	Crève Coeur / Rivalland	S2	31	12
G	5	1	Robinson	S2	79	27
G	5	2	Robinson	S2	37	19
I	2	1	V des Prêtres - (lower)	S3	9	10
I	2	2	V des Prêtres - (lower)	S3	4	5
I	2	3	V des Prêtres - (lower)	S3	5	10
I	4	1	V des Prêtres - (upper)	S3	40	37
I	4	2	V des Prêtres - (upper)	S3	43	33
I	4	3	V des Prêtres - (upper)	S3	12	8
Total					**617**	**358**

Small-scale planters (plot size > 10 ha)	0	0

BELLE VUE FACTORY AREA

LOCALITY BLOCKS				Land suit	No of planters	Area (ha)
J	2	2	D'Epinay / Jouvence	S3	49	24
J	2	3	D'Epinay / Mare Marot	S3	32	21
J	2	4	Bon Amour	S3	53	40
J	2	6	B Amour / P des Calebasses	S3	124	48
K	1	1	Congomah	S3	151	72
K	2	1	Eau Bouillie	S2	26	11
K	2	2	Les Mariannes	S2	25	16
K	3	1	Congomah	S2	101	42
K	3	2	Congomah	S3	69	27
Total					**630**	**302**

Small-scale planters (plot size > 10 ha)	0	0

S2 and S3: Land respectively moderately suitable and marginally suitable for sugar cane

Annex 1(contnd). List of small-scale planter locality blocks (Category A: seaward mountain slopes)

Zone E

BEAU CHAMP FACTORY AREA

LOCALITY BLOCKS				Land suit	No of planters	Area (ha)
D	2	01	Deux Frères	S2	32	13
D	2	02	Anse Cunat	S2	169	122
D	2	03	Quatre Soeurs	S2	98	57
F	2	01	Bambous Virieux	S2	68	116
F	2	02	Bambous Virieux	S2	58	101
F	2	03	Bambous Virieux	S2	4	26
G	0	01	Petit Sable	S2	77	53
G	0	02	Petit Sable	S2	35	78
G	0	03	Grand Sable	S2	107	69
G	0	04	Grand Sable	S2	13	37
N*	0	01	Ferney/M des Créoles	S2	164	165
Total					**825**	**839**

Small-scale planters (plot size > 10 ha)	7	80

RICHE EN EAU FACTORY AREA

LOCALITY BLOCKS				Land suit	No of planters	Area (ha)
D	1	02	R des Créoles	S2	10	16
D	1	03	R des Créoles	S2	94	49
E	0	01	Vieux Grand Port	S3	121	66
E	0	02	B des Amourettes / B Vue	S3	51	41
G	1	01	Anse Jonchée	S2	44	47
G	1	02	Anse Jonchée	S2	38	52
H	1	01	Anse Jonchée	S2	29	97
H	1	02	Anse Jonchée	S2	19	49
H	1	03	Bambous Virieux	S2	23	60
Total					**429**	**477**

Small-scale planters (plot size > 10 ha)	4	52

* Includes metayers

S2 and S3: Land respectively moderately suitable and marginally suitable for sugar cane

Annex 1(contnd). List of small-scale planter locality blocks (Category A: seaward mountain slopes)

Zone S

UNION/BEL OMBRE FACTORY AREA

LOCALITY BLOCKS				Land suit	No of planters	Area (ha)
4*	0	02	St Martin	S3	38	88
4	1	01	Beenessreesingh I & R	S3	15	66
4	1	03	Soc Lavilléon	S3	1	23
4	1	04	Lenoir & others	S3	6	33
4	1	05	Chamarel	S3	12	14
6*	1	01	Baie du Cap/St Martin	S2	31	129
L*	1	01	Ponama	S2	32	43
L*	1	02	Montagne Chapeau	S2	27	35
L*	1	03	Dambry	S2	26	35
L*	1	04	Le Milourd	S2	4	14
L*	1	05	Casa	S2	31	32
L*	1	06	Pilot	S2	32	40
L*	1	07	Pilot	S2	18	16
M*	0	01	Doguet	S2	13	36
M*	0	02	Nacoda / Sentier Goyaves	S2	3	3
M*	1	01	Metayers Union	S3	17	60
M*	1	02	Metayers Union	S3	12	31
M*	1	03	Metayers Union	S3	7	29
Total					**325**	**728**

Small-scale planters (plot size > 10 ha)	5	77

* Includes metayers

SAINT FELIX FACTORY AREA

LOCALITY BLOCKS				Land suit	No of planters	Area (ha)
A	2	02	Rivière Patates	S2	51	57
A	2	03	Jurançon	S3	77	68
A	2	04	Providence	S3	8	17
C	3	02	Mont Blanc	S3	7	56
C	3	03	P Longanes / Mont Blanc	S3	81	89
C	3	04	Mont Blanc/Mare Anguilles	S3	8	19
C	4	01	Chamouny / P Longanes	S3	114	77
C	4	02	Mare Anguilles	S3	29	64
D	0	01	Cascade Chazal (1)	S3	41	30
G	0	01	Gavarny	S3	24	69
G	0	02	Fleuriot	S3	15	19
G	0	03	Providence	S3	9	10
M*	0	01	Chazal	S3	40	46
M*	0	2	Cascade (2)	S3	49	49
M*	0	03	Goburdhun	S3	44	43
M*	0	04	Malaisé	S3	20	20
Total					**617**	**732**

Small-scale planters (plot size > 10 ha)	4	74

* Includes metayers

S2 and S3: Land respectively moderately suitable and marginally suitable for sugar cane

Annex 2. Profile of SIFB small-planter locality blocks for difficult areas (Category A)

Zone	Initial[1]				Final[2]						
	Land suitability class	No of locality blocks	No of planters	Total area (ha)	No of planters	Total area (ha)	Plot size (ha)		Cane productivity (t ha^{-1})		
							Min	Max	Min	Max	Weighted Mean
N	S2	11	560	271	267	147	0.06	3.02	14	139	64
	S3	15	687	389	355	202	0.05	3.59	8	145	55
E	S2	18	1082	1207	708	653	0.04	4.22	3	155	70
	S3	2	172	107	118	61	0.04	4.07	10	148	65
S	S2	11	268	440	96	143	0.11	4.12	13	150	45
	S3	23	674	1020	366	403	0.02	4.18	6	143	46
TOTAL		**80**	**3443**	**3434**	**1910**	**1609**					

WEIGHTED MEAN (t ha^{-1})	**S2**	**65**
	S3	**50**

[1] Initial : retained as difficult areas

[2] Final : After elimination of planters with multiple plots, and plots with missing information (2001 only)

S2: Land moderately suitable for sugar cane

S3: Land marginally suitable for sugar cane

Annex 3. Yield differential between miller- and small-scale planters

Year	North			East			South			MEAN		
	Cane yield (t ha^{-1}) Planter		Non miller-% Miller-	Cane yield (t ha^{-1}) Planter		Non miller-% Miller-	Cane yield (t ha^{-1}) Planter		Non miller-% Miller-	Cane yield (t ha^{-1}) Planter		Non miller-% Miller-
	Miller-	Non miller[1]-		Miller-	Non miller[1]-		Miller-	Non miller[1]-		Miller-	Non miller[1]-	
2000	61.2	47.8	78	80.2	65.1	81	83.5	60.9	73	75.0	57.9	77
2001	75.9	62.5	82	89.2	72.2	81	89.0	65.8	74	84.7	66.8	79
2002	62.1	53.2	86	75.3	59.9	80	77.8	57.8	74	71.7	57.0	80
2003	74.6	67.5	90	80.2	63.2	79	81.4	60.3	74	78.7	63.7	81
2004	84.6	76.3	90	79.4	63.7	80	84.4	61.5	73	82.8	67.2	81
MEAN	**71.7**	**61.5**	**85**	**80.9**	**64.8**	**80**	**83.2**	**61.3**	**74**	**78.6**	**62.5**	**80**

[1] Non miller-planter: group consisting mainly of small-scale planters ≤42 ha) followed by large-scale planters.

(Source: MSIRI Annual Reports, 2000-2004)

Annex 4. Annual labour utilization by field operation (excluding harvest) on mountain slopes of Category A

		Mandays[1] x 10[3]				Womandays[1] x 10[3]			
Field Operation	**Cane Category**	**Zone N 660 ha**	**Zone E 1394 ha**	**Zone S 2452 ha**	**Total[2] 4506 ha**	**Zone N 660 ha**	**Zone E 1394 ha**	**Zone S 2452 ha**	**Total[2] 4506 ha**
Land preparation	PC	4.16	7.39	1.70	**13.24**			22.36	**22.36**
Planting	PC	0.72	1.63	3.61	**5.96**	6.24	12.72	19.01	**37.98**
Earthing up	PC	1.31			**1.31**		4.60	1.56	**6.15**
Chemical weed control	PC + RAT	6.49	12.62	6.77	**25.87**				
Manual weed control	PC + RAT	5.84		2.04	**7.88**		10.65	74.35	**84.99**
Recruiting	PC + RAT	0.56	0.01	0.20	**0.77**		1.16	3.55	**4.71**
Trashing	PC + RAT					18.17	46.10	34.70	**98.97**
Road repair	PC + RAT	2.96	7.08	9.63	**19.67**				
Maintenance of drains	PC + RAT	1.11	0.14	1.53	**2.78**	1.10		4.65	**5.76**
Burning	PC + RAT		0.07	0.60	**0.66**				
Fertilizer application	RAT		0.05		**0.05**	2.85	5.81	8.31	**16.96**
Trash lining	RAT					13.66	27.62	22.09	**63.37**
Total		**23.16**	**28.99**	**26.06**	**78.21**	**42.02**	**108.64**	**190.59**	**341.25**

[1] Planter category confounded [2] 97% of total area of 4642 ha

[3] Includes application of scum and fertilizers; and preparation, planting and covering of setts

PC: plant cane RAT: ratoon

Map 1 : Difficult areas under sugar cane in Mauritius

Legend

- MP / SP — Category A: Seaward mountain slopes - 4 642 ha
- MP / SP — Category B: Inland mountain slopes - 1 385 ha
- MP / SP — Category C: Flat to moderately sloping land - 6 334 ha

Note: MP = Miller- and large-scale planters
SP = Small-scale planters

Factory Area Boundary

Rivers

Main roads

Scale 1: 200 000

B Vue FA
Ex-Beau Plan FA
Ex-Constance FA
FUEL FA
Mon Desert Alma FA
Ex-Highlands FA
MDIA FA
Medine FA
Beau Champ FA
Riche-En-Eau FA
Ex-Rose Belle FA
Mon Tresor FA
Ex-Britannia FA
Savannah FA
Ex-Bel Ombre FA
St Felix FA
Union St Aubin FA
M Loisir FA

MAURITIUS SUGAR INDUSTRY RESEARCH INSTITUTE
Agricultural Chemistry Department
P K Tulsee, S Ramasamy
June 2006