



Integrated Assessment of Trade Related Policies on Biological Diversity in the Agricultural Sector in Mauritius

**INTEGRATED ASSESSMENT STUDY
Country Report**



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Preface

In July 2005, the United Nations Environment Programme (UNEP) launched an initiative to undertake integrated assessments (IA) of trade-related policies and biodiversity in the agricultural sector with the aim of supporting the implementation of the Convention on Biological Diversity (CBD). The overall objective of the initiative was to build capacity in national institutions and government departments to assess, design, and implement policies that maximize development gains from trade-related policies in the agricultural sector, while minimizing the impact on agricultural biodiversity. The initiative was in direct response to Decision VI/5 of the CBD Conference of the Parties, which called for the assessment of the impacts of trade liberalization on agricultural biological diversity.

This initiative specifically aimed to identify the potential impacts of the EU-ACP Economic Partnership Agreements (EPA) concluded between the European Union (EU) and Africa, Caribbean and Pacific (ACP) countries. Six ACP countries, including Jamaica, Mauritius, Cameroon, Papua New Guinea, Madagascar and Uganda, participated in the initiative by undertaking national-level assessment projects,.

Building on its earlier work on IA, UNEP began this initiative with the development of a *Policy Assessment Manual on Agriculture, Trade and Biodiversity*, and placed particular emphasis on biodiversity impacts and opportunities. The Manual, which was prepared to assist a wide range of stakeholders, contains materials that explore the linkages between trade policies, the agricultural sector, ecosystem services and biodiversity, and provides a step-by-step approach to conducting an IA that incorporates biodiversity.

The six country studies applied the Manual and, by identifying the impacts of trade-related policies in the agricultural sector on biodiversity in a national context, aimed to support the further development of effective methodologies.

Throughout this UNEP initiative, focus has been placed on the impacts of trade-related policies in the agricultural sector, national policy responses, and the impacts of those policies on biological diversity. The specific objectives of the country projects were to:

1. Encourage a better understanding of the linkages between trade, development and biodiversity;
2. Build national, institutional and governmental capacities to conduct IA whereby the environmental, social and economic impact of trade-related policies in the agriculture sector are assessed, with particular attention on the protection of biological diversity;
3. Enhance capacity of government policy makers, decision makers in the private sector, and civil society, to develop and implement integrated approaches to national policy, which balance trade, development and biodiversity goals;
4. Develop and refine methodologies for assessing agricultural biodiversity and indicators based on specific circumstances within countries, and assessing the contribution of agricultural biodiversity (and its use) to poverty alleviation;
5. Enable ACP countries to integrate the sustainable management of biodiversity and other natural resources in their negotiation and implementation of the EU-ACP EPAs; and

6. Enhance civil society's engagement in IA and policy-making processes relating to the implementation of both the CBD and the EPAs.

The ACP countries that participated in the initiative received technical and financial support through UNEP to conduct their IAs. Further funding is being provided to assist the countries involved follow up on the results of the studies and further develop and implement the policy recommendations that they developed. This step towards implementation provides an opportunity to reinforce the expected outcomes of the IAs, further strengthen capacity, inter-institutional coordination and stakeholder involvement at the national level, to ultimately help ensure that trade liberalization occurs in a way that supports sustainability and strengthens the implementation of the CBD.

Financial support for the initiative was provided by the European Commission and the Swedish International Development Cooperation Agency.

The United Nations Environment Programme

The United Nations Environment Programme (UNEP) is the overall coordinating environmental organization of the United Nations system. Its mission is to provide leadership and encourage partnerships in caring for the environment by inspiring, informing and enabling nations and people to improve their quality of life without compromising that of future generations.

In accordance with its mandate, UNEP works to observe, monitor and assess the state of the global environment, improve the scientific understanding of how environmental change occurs, and in turn, how such change can be managed by action-oriented national policies and international agreements. UNEP's capacity-building work thus centers on helping countries strengthen environmental management in diverse areas that include freshwater and land resource management, the conservation and sustainable use of biodiversity, marine and coastal ecosystem management, and cleaner industrial production and eco-efficiency, among many others.

UNEP, which is headquartered in Nairobi, Kenya, marked its first 35 years of service in 2007. During this time, in partnership with a global array of collaborating organizations, UNEP has achieved major advances in the development of international environmental policy and law, environmental monitoring and assessment, and the understanding of the science of global change. This work also supports the successful development and implementation of the world's major environmental conventions.

In parallel, UNEP administers several multilateral environmental agreements (MEAs) including the Vienna Convention's Montreal Protocol on Substances that Deplete the Ozone Layer, the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal (SBC), the Convention on Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade (Rotterdam Convention, PIC) and the Cartagena Protocol on Biosafety to the Convention on Biological Diversity as well as the Stockholm Convention on Persistent Organic Pollutants (POPs).

Division of Technology, Industry and Economics

The mission of the Division of Technology, Industry and Economics (DTIE) is to encourage decision-makers in government, local authorities and industry to develop and adopt policies, strategies and practices that are cleaner and safer, make efficient use of natural resources, ensure environmentally sound management of chemicals, and reduce pollution and risks for humans and the environment. In addition, it seeks to enable implementation of conventions and international agreements and encourage the internalization of environmental costs.

UNEP DTIE's strategy in carrying out these objectives is to influence decision making through partnerships with other international organizations, governmental authorities, business and industry, and non-governmental organizations; facilitate knowledge management through networks; support implementation of conventions; and work closely with UNEP regional offices. The Division, with its Director and Division Office in Paris, consists of one centre and five branches located in Paris, Geneva and Osaka.

Economics and Trade Branch

The Economics and Trade Branch (ETB) is one of the five branches of DTIE. ETB seeks to support a transition to a green economy by enhancing the capacity of governments, businesses and civil society to integrate environmental considerations in economic, trade, and financial policies and practices. In so doing, ETB focuses its activities on:

1. Stimulating investment in green economic sectors;
2. Promoting integrated policy assessment and design;
3. Strengthening environmental management through subsidy reform;
4. Promoting mutually supportive trade and environment policies; and
5. Enhancing the role of the financial sector in sustainable development.

Over the last decade, ETB has been a leader in the area of economic and trade policy assessment through its projects and activities focused on building national capacities to undertake integrated assessments – a process for analysing the economic, environmental and social effects of current and future policies, examining the linkages between these effects, and formulating policy response packages and measures aimed at promoting sustainable development.

This work has provided countries with the necessary information and analysis to limit and mitigate negative consequences from economic and trade policies and to enhance positive effects. The assessment techniques and tools developed over the years are now being applied to assist countries in transitioning towards a green economy.

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Acronyms and abbreviations

ACP	Africa, Caribbean, and Pacific countries
AREU	Agricultural Research and Extension Unit
BOD	Biological oxygen demand
CBD	United Nations Convention on Biological Diversity
CTSAv	Centrale Thermique de Savannah
DO	Dissolved oxygen
EBA	Everything but Arms
EIA	Environmental impact assessment
EIS	Environment Information System
EPA	Economic Partnership Agreement
ERS	Early Retirement Scheme
ESA	Eastern and Southern African Region
ETB	Economics and Trade Branch
EU	European Union
FORIP	Field Operations Regrouping and Irrigation Projects
FSC	Farmers Service Corporation
FUEL	Flacq United Estates Limited
GDP	Gross domestic product
GMO	Genetically modified organism
GMP	Good Management Practices
GWh	Gigawatt hour
IA	Integrated assessment
IRS	Integrated resort schemes
IUCN	International Union for Conservation of Nature
LDC	Least Developed Country
LMC	Landell Mills Commodities International
MAAS	Multi Annual Adaptation Strategy
MAIFPS	Ministry of Agro-Industry, Food Production and Security
MOFEE	Ministry of Finance and Economic Empowerment
MOU	Memorandum of Understanding
MSA	Mauritius Sugar Authority
MSIRI	Mauritius Sugar Industry Research Institute
MSS	Mauritius Sugar Syndicate
MUR	Mauritian rupees
NBSAP	National Biodiversity Strategy and Action Plan
NEAP	National Environment Policy and Action Plan
NGO	Non-governmental organization
NIASS	National Invasive Alien Species Control Strategy
NPCS	National Parks and Conservation Service (Mauritius)
NSC	National Steering Committee
PIC	Project Implementation Committee
RTC	Regional Training Centre
SEA	Strategic Environment Assessment
SIDS	Small Island Developing State
SLM	Sustainable Land Management
SME	Small- and medium-sized enterprise
SOCDL	Strategic Options for Crop Diversification and Livestock Sector
SPMPC	Sugar Planters Mechanical Pool Corporation
TCH	Tonnes of cane per hour
UNCCD	United Nations Convention to Combat Desertification
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change

VRS Voluntary Retirement Scheme
WCMC World Conservation Monitoring Centre
WTO World Trade Organization

Executive Summary

The United Nations Environment Programme (UNEP), in collaboration with the Convention on Biological Diversity (CBD), launched a five-year initiative in 2005 to support the implementation of country studies in six Africa, Caribbean and Pacific (ACP) countries, including Mauritius. The studies aim to build national capacities to understand, examine and assess the environmental, social and economic impact of trade-related policies in the agricultural sector and emphasize the protection of biological diversity and the promotion of sustainable development. They are intended to increase the understanding of factors that lead to biodiversity loss, and to support the implementation of the CBD.

Mauritius is a small island state with a rich biodiversity and an agricultural sector dominated by sugar cane production for the export market. At present, it faces a real challenge due to changes in international trade policies and agreements covering the agricultural sector. Mauritius, along with other ACP countries, is losing its longstanding and generous trade preferences associated with sugar, as a result of reforms to the European Union's (EU) Sugar Protocol. The dismantling of the Sugar Protocol has led to a 36 per cent drop in the price of sugar, over four years between 2006 and 2010. The economic losses associated with the new trading regime are expected to have a significant impact on Mauritius, given that the revenue from activity under the Sugar Protocol was important for stimulating economic development, promoting diversification, and supporting services throughout the country. Structural shifts in the economy that occur as a result of the new trading regime for sugar will have an important impact on the environment and in particular biodiversity as activities in the sugar industry have a disproportionate impact on biodiversity in Mauritius, given that sector's dominant role in the economy.

This country study on "Integrated Assessment of Trade-Related Policies on Biological Diversity in the Agricultural Sector" was undertaken between April 2007 and November 2008. It focuses on the accelerated restructuring programme for the sugar sector in Mauritius, the Multi-Annual Adaptation Strategy (MAAS), 2006-2015. The MAAS was developed in response to the decision to reform the EU sugar regime. This integrated assessment (IA) examines the economic, social, and environmental impacts of the MAAS, with particular attention paid to impacts on biodiversity. It considers existing policies (*ex post* assessment) and possible future trade measures and policy options (*ex ante* assessment).

The IA employs the methodology described in the Policy Assessment Manual on Trade, Agriculture and Biodiversity, developed by UNEP in collaboration with the World Conservation Monitoring Centre and the Secretariat of the Convention on Biological Diversity.¹ The methodology includes several elements such as, conducting a thorough literature review, participating in multistakeholder meetings, consulting experts, undertaking a field survey and focus groups, scenario building, root cause analysis and risk assessment. A capacity building workshop was organized to train relevant stakeholders in the approach and methodology associated with IAs that examine trade policies. Relevant stakeholders and specialists were also consulted to refine the methodology and the indicators.

¹ The IA was developed using the draft manual (June 2007) with the working title "Incorporating Biodiversity into Integrated Assessment of Trade Policies in the Agriculture Sector."

The following two scenarios were employed in this assessment:

1. Sustaining sugar cane production under current conditions taking into account the MAAS. This aims to achieve intensification, increasing value added and optimizing the use of by-products to restructure and sustain the sugar sector on suitable land. This scenario involves the increased production of direct-consumption sugar, centralization and factory closures, reorganization in the labour market, implementation of the Field Operations Regrouping and Irrigation Projects (FORIPs), and increasing the use of by-products through increased electricity and ethanol production.
2. Moving out of sugar cane production in marginal areas where cultivation is not profitable. Three different options were examined under this scenario to assess the likely impact of changes in land use. These were: abandonment, conversion to other agricultural uses, and conversion to non-agricultural uses.

Under the first scenario, a number of impacts were identified. Implementing several of the policies associated with the MAAS (such as movement to higher value-added production, such as direct-consumption sugar) would require investment and upgrading but could maintain the competitiveness of the Mauritian sugar industry by reducing the costs of production and improving yields and revenues. The impacts of factory closures and centralization depends on the effectiveness of the social programmes under the MAAS for early retirement and re-training, but could have a positive impact on the environment as a result of the elimination of discharges into water and emissions into the air from older and less efficient factories. Investment in the remaining factories could increase efficiency and modernize equipment. Moreover, movement towards increasing ethanol production could have positive impacts in some areas, allowing the industry to fully capture the value added, providing consumers with cheaper energy, and eliminating the negative impacts on air of burning fossil fuels. On the other hand, sub-sectors in the industry, such as molasses production, could suffer. Overall, from a social perspective, there would be pressure on the programmes under the MAAS, such as the voluntary early retirement scheme, and re-training programmes, to avoid increasing poverty and transform the workforce to take on more skilled positions. There are likely to be negative impacts on rural communities, and a loss of around 40 000 jobs. Moreover, the regrouping of small-scale sugar cane planters into larger blocks that are mechanized and planted with only one sugar cane variety, would destroy the habitat of many natural enemies and predators and reduce crop biodiversity.

Faced with the current changes in trade policies and the subsequent development of the MAAS, the IA identified several impacts on the environment and on biodiversity. On the seaward side of the island, any conversion of marginal lands to food crop production could increase soil manipulation and the use of agrochemicals. These changes in agricultural practices would increase the risk of soil erosion and water pollution with negative impacts on aquatic biodiversity in the lagoons and neighbouring rivers. Similarly the conversion of sugar cane land to integrated resorts with golf courses would have detrimental environmental impacts on the environment and biodiversity, due to the heavy use of agrochemicals.

Under the second scenario, and the three alternative courses, the results of the IA showed that all three choices pose challenges and opportunities for biodiversity and sustainability. Abandonment presents sustainability challenges from an economic, social and

environmental perspective as a result of, *inter alia*, loss of raw materials for ethanol and electricity production, negative impacts on rural communities, potentially accelerated soil erosion and risk of invasive species, although there could be a gain for biodiversity over the long term through increasing plant and animal diversity. Conversion to other agricultural uses would involve additional investment and training and could lead to a higher demand for pesticides (with negative impacts on land and water). On the other hand, production of food crops and livestock could help meet demand in the local market. Conversion to non-agricultural uses could bring about higher economic returns and foreign investment, as well as benefits for rural communities, but development would have to be undertaken consistent with the results of an environmental assessment to ensure the conservation of biodiversity and prevent further degradation of the land and water resources.

The policy recommendations developed from this study have been proposed to guarantee the sustainability of the sugar industry and to enhance conservation and sustainable use of biodiversity in the agricultural sector. The major challenge facing the sugar industry is its need to diversify to value-added sugar and export direct-consumption sugar. This requires the adoption of modern technology, capacity building for growers to comply with existing standards, enforcement of standards of cane quality supplied to factories and the upgrading and empowering of existing laboratories with necessary skills and equipment to provide accredited testing services. The IA also found that there is an urgent need to develop an inventory of local agro-biodiversity and to undertake capacity building initiatives with respect to valuation techniques for assessing the benefit of ecosystem services. The changes that have been initiated will have to be monitored closely for future necessary actions. The IA contains the following specific recommendations:

- Shift from the export of raw sugar to refined direct-consumption sugar (EEC Grade II).
- Accelerate the adoption of good management practices.
- Expand research on good management practices.
- Increase capacity building with respect to extension services and the dissemination of knowledge about good management practices.
- Develop incentives to encourage environmentally sustainable food crops and fruit production systems.
- Support small farmers in marginal areas in the case of abandonment of sugar cane production to prevent land degradation.
- Reward efforts to promote sustainability.
- Regulate the movement of goods that are harmful to local biodiversity.
- Establish incentives to further encourage small farmers to regroup under FORIP.
- Develop public awareness-raising activities.
- Integrate strategies for the sustainable use and conservation of biodiversity into relevant sectoral or cross-sectoral plans, programmes and policies.
- Promote partnerships among stakeholders to build capacity to manage agricultural biodiversity.
- Undertake capacity building in biodiversity valuation techniques.
- Undertake an inventory of existing agricultural biodiversity.
- Compensate farmers for conserving local species.
- Respect conditions for investment related to environmental protection and biodiversity conservation.

The findings of the IA have been useful to create an awareness of the likely impacts of trade policies on local biodiversity and natural resources. The recommendations from this study should contribute to the development and implementation of an integrated policy action plan that seeks to balance national priorities and goals related to trade, economic growth, social well-being, the environment, and biodiversity.

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1 Introduction

The Mauritius country project on the “Integrated Assessment of Trade-Related Policies on Biological Diversity in the Agricultural Sector” was undertaken by the Ministry of Agro-Industry, Food Production and Security (MAIFPS) and was implemented by the Agricultural Research and Extension Unit (AREU). The integrated assessment (IA) focused on the economic, social and environmental impacts of changes in the sugar cane industry due to the loss of trade preferences following the reform of the European Union’s (EU’s) Sugar Protocol.

Under the Sugar Protocol, Mauritius had an annual quota of 507 000 tonnes of sugar, with net foreign exchange earnings of US\$300 million. The dismantling of the Sugar Protocol will lead to a 36 per cent drop in the price of sugar, over four years, between 2006 and 2010. As the holder of the largest quota under the Sugar Protocol, Mauritius will be the most affected by the falling price of sugar. The sector accounts for 17 per cent of foreign exchange earnings and up to 4.5 per cent of gross domestic product (GDP). A loss of €895 million is expected over the nine-year implementation period for the new sugar regime. The losses associated with the new regime will have a significant impact on Mauritius, particularly given that the revenue generated by trade under the Protocol was important for stimulating economic development, promoting diversification, and supporting services throughout the country. The economy will also likely undergo structural change as the agricultural sector moves away from its almost exclusive dependence on sugar and become more diversified.

In light of the challenges facing the sugar industry, the Government of Mauritius developed the Multi-Annual Adaptation Strategy, 2006-2015 (MAAS) to encourage competitiveness and ensure the commercial viability and sustainability of the industry in the face of eroding trade preferences. The reforms under the MAAS aim to restructure the sugar industry, to improve efficiency, and to encourage the production of high value-added sugar, by-products, and energy. Employment in the sugar sector is also declining sharply and the MAAS includes programmes to assist workers to either retire or to re-train. The MAAS is financed through the EU’s ‘accompanying measures’ that have been negotiated in conjunction with the Economic Partnership Agreements (EPA) between the EU and the Africa, Caribbean and Pacific (ACP) countries. The EPAs are the cornerstones of the new trade regime.

This IA examines the impact of the MAAS and other relevant national policies, on economic, social, and environmental sustainability in the sugar sector in Mauritius, with an emphasis on biodiversity and ecosystem services. It examines impacts on both small and large sugar cane producers.

The specific objectives of the IA are the following:

- 1) to build national capacities to identify and quantify environmental, social and economic effects of trade-related policies that affect the agricultural sector, with an emphasis on biodiversity;
- 2) to build capacity at the national level to encourage sustainable trade in the agricultural sector;
- 3) to improve the understanding of factors that lead to both the loss of biodiversity and the protection of biodiversity, that are associated with trade-related and other policies, and which have an impact on the agricultural sector;

- 4) to develop and refine biodiversity indicators and methodologies for conducting IAs;
- 5) to enhance the capacity of policy makers to develop and implement an integrated national response, following an IA, to promote sustainable trade, the protection of biodiversity, and stakeholder participation; and
- 6) to support the implementation of the United Nations Convention on Biological Diversity (CBD).

Chapter 2 contains an overview of the agricultural sector and the sugar industry in Mauritius, highlighting the importance of the industry to the Mauritian economy. It also examines the current state of trade negotiations that will have an impact on the future of the industry, and in particular the reform of the Sugar Protocol, which will lead to an erosion of the preferences that Mauritius had previously enjoyed. Nevertheless, through the new EPA there are opportunities to mitigate the impacts of the loss of these historic preferences.

Chapter 3 presents an overview of biodiversity in Mauritius. It notes the high levels of endemism on the island, and the very wide range of terrestrial and aquatic biodiversity which provide vital ecosystems services, and play an important role supporting the tourism industry. However, there are several threats to this rich biodiversity, which include threats from invasive species, limited stocks of freshwater, land degradation, human activities, and climate change. Activities in the sugar industry can have a disproportionate impact on biodiversity in Mauritius, given its dominant role in the economy.

Chapter 4 introduces the efforts by the Government of Mauritius to address the threats to biodiversity, through both national policies and international environmental agreements. It highlights the different departments and organizations on the island that have a role in protecting biodiversity, and that should be coordinated to ensure that the approach to policy making is one that contributes to sustainable development. Mauritius has designed and implemented a national sustainable development strategy aimed at promoting its economic and social development, while ensuring the sustainable management of its natural resources. This strategy must be implemented in a cohesive fashion by all relevant actors both inside and outside of government.

Chapter 5 examines, in detail, the MAAS and other national policies aimed at assisting the sugar industry and its workers to adapt to the new trading reality and to safeguard the future of the industry. Among the key elements of the MAAS that are examined are the need to reduce production costs, generate additional revenue (through value added and the production of direct-consumption sugar), use by-products (such as for the production of energy), and contribute to poverty alleviation (through voluntary retirement and re-training programmes). It also examines the key components of the Field Operations Regrouping and Irrigation Projects (FORIP), which is aimed at small- and medium-sized growers and seeks to promote mechanization and, through land regrouping, create larger lots to help growers take advantage of economies of scale.

Chapter 6 presents the complex relationship between the sugar industry and sustainability, and in particular biodiversity and ecosystem services. It places an emphasis on the important role of the sugar industry with respect to providing social services (such as housing and health care) to rural communities. The production of sugar cane also provides important environmental services, such as sequestering carbon. However, production is also associated, *inter alia*, with negative air quality, waste disposal challenges and negative

impacts on water quality as a result of effluents, which affect terrestrial and aquatic biodiversity.

Chapter 7 contains the assessment of the sugar industry, and presents a range of positive and negative impacts within and among the various scenarios that were considered. The analysis was conducted based on two main scenarios. The first scenario was based on sustaining sugar cane production under current conditions (taking into account the MAAS), which would involve the increased production of direct-consumption sugar, centralization and factory closures, “rightsizing” the labour market, implementing FORIPs, and increasing the use of by-products through electricity production and ethanol production. The second scenario that was examined involved moving out of sugar cane production in marginal areas where it is no longer profitable. Under this scenario, the following three alternative courses of action are considered: abandonment of land under sugar cane cultivation, conversion to other agricultural uses, and conversion to non-agricultural uses.

In Chapter 8, policy recommendations are presented that could enhance sustainable trade between Mauritius and the EU under the EPA. These recommendations range from encouraging a value-added approach to the industry, to adopting and disseminating good practices, supporting small growers in marginal areas, and encouraging awareness of, and rewarding, practices that support a move towards sustainability.

Finally, the technical report included in Annex 3 provides details related to the individuals and organizations that made up the project team and the national steering committee that guided the work. It also presents a summary of the stakeholders involved and the meetings that were held over the course of the project. Further, it provides additional details related to the methodology, including the major challenges that faced the project team, along with specific achievements.

2 Agriculture and the sugar industry in Mauritius

2.1 The agricultural sector in Mauritius

Agriculture has historically been the backbone of the Mauritian economy and is dominated by sugar cane monoculture. In 1970, agricultural products represented around 97 per cent of all exports. This figure had declined to around 38 per cent in 2006. The contribution of agriculture to the economy has also decreased; from 23 per cent in the late 1970s to just over 5 per cent in 2006. Mauritian agriculture is still dominated by sugar production, which accounts for around 50 per cent of all agriculture and makes up about 62 per cent of all agricultural exports. Food crops account for around 20 per cent, livestock for 14 per cent, and fisheries for 4 per cent, while tea, tobacco, flowers, fruits and forestry account for the remaining 4 per cent of the contribution of agriculture to GDP. The harvested area dedicated to each crop is presented in Table 1.

Table 1: Area harvested under different commodities in 2006

Crop	2006		
	Area planted (ha)	Area harvested (ha)	% Arable land
Sugar cane	70 801	66 732	85.3
Food crops	4 400	7 207	5.5
Tea	688	287	0.84
Tobacco	350	345	0.44

Source: MOFEE (2008).

Agriculture occupies around 43 per cent of the island's land resources (around 80 000 hectares), with sugar cane accounting for 85 per cent of this total area (see Table 2). Taking into account both large and small establishments, in 2006 the agricultural sector employed some 48 100 workers of which over half were involved in the production of sugar cane. The figures in Table 3 indicate the numbers of workers in the largest establishments.

Table 2: Land use in Mauritius: 1995, 2005, and 2007

Use	1995		2005		2007	
	ha	%	ha	%	ha	%
Sugar cane plantations ¹	76 840	41.2	72 000	38.6	68 523	
Tea plantations ²	3 660	1.9	674	0.4	709	
Tobacco plantations						
Forests, shrubs and grazing lands	57 000	30.6	47 200	25.3	47 176	
• State-owned land			22 200		22 176	47.05
• Private land			25 000		25 000	3.0
Other agricultural activities	6 000	3.2	8 000	4.3		
Infrastructure	4 000	2.1	4 500	2.3		
Inland water resource systems	2 600	1.4	2 900	1.6		
Built-up areas	36 400	19.5	46 500	24.9		
Abandoned cane fields			4 726	2.5		
Total	186 500	100	186 500	100		

Notes: ¹MAIFPS (2007a); ²MAIFPS (2008). Source: MOFEE (2006).

Table 3: Employment in the agricultural sector (large establishments)

Sector	2006	
	Number	%
Sugar cane ¹	13 797	63.76
Tea ²	286	1.32
Tobacco ³	140	0.65
Fishing ⁴	963	4.45
Flowers ⁴	367	1.70
Other agricultural activities ⁴	6 083	28.12
Total	21 636	100

Notes: ¹sugar cane planters cultivating ten hectares or more; ²tea planters cultivating two hectares or more; ³all tobacco planters cultivating flue-cured variety only; ⁴establishments with ten or more employees. Source: MOFEE (2006).

Historically, Mauritius has secured its food supply indirectly, by focusing on sugar cane as a mono-crop. As a crop, sugar cane offers several advantages including its bioclimatic adaptability, and economic, marketing, and strategic benefits. It has generated enough foreign currency to more than cover the cost of importing most of Mauritius's food requirements.

Food crop production is growing in Mauritius and in 2006 it occupied around 7 207 hectares (see Table 1). The production of fresh fruits and vegetables amounted to some 106 902 tonnes in 2006 and Mauritius is self sufficient with respect to most fresh vegetables. Government policy is to attain self sufficiency in several food crops for the domestic market (including potatoes, onions and vegetables) and to exploit crops with potential for export (including anthurium, pineapple and litchi) (MAIFPS 2007b). Food crop production involves some 10 900 growers producing on permanent gardens and on rotational and sugar cane interlines to supply the domestic market. Local demand for tropical fruits and flowers is increasing as a result of increasing demand from consumers and from the growing tourism industry.

Other sectors are facing challenges, or are in decline. The tea sector, which covers some 688 hectares and 286 small growers, is no longer profitable. Production in the sector is directed towards the domestic market. The tobacco sector is also in decline, now covering only around 249 hectares (MOFEE 2008). The livestock sector faces several socio-economic and environmental constraints, particularly with respect to waste management and disease. Mauritius is self sufficient in poultry and eggs, but in 2007 it produced only 6 per cent of its meat requirements (excluding poultry) and 3 per cent of its milk requirements. Production of pork stood at 55 per cent of Mauritius' domestic demand prior to outbreak of African swine fever in October 2007.

The dismantling of the Sugar Protocol means that the sugar industry will face major challenges. While reforms are being implemented to improve its competitiveness and to move towards the production of high value-added sugar products and by-products (including energy), it is clear that one effect will be that the agricultural sector in Mauritius will become more diversified.

2.2 The sugar industry in Mauritius

Sugar cane has been the predominant large-scale commercial crop in Mauritius for over 100 years. Being the most important agricultural product it has contributed to Mauritius's economic and social development. Sugar cane covers over 40 per cent (over 70 000 hectares) of the island, representing 85 per cent of the total cultivated area. Sugar cane production ranges from between 5 and 5.5 million tonnes. From this, 500 000 to 650 000 tonnes of sugar and 150 000 to 180 000 tonnes of molasses are produced. At present, between 425 and 450 gigawatt-hours (GWh) of electricity generated from bagasse (the fibre left after the milling of cane stalks) is directed to the public grid. In 2007, around 24 per cent of Mauritius's total energy requirement was met from bagasse (see Table 4).

Table 4: Fuel inputs for electricity production

Fuel	2005		2006		2007	
	Quantity (Ktoe)*	%	Quantity (Ktoe)	%	Quantity (Ktoe)	%
Fuel oil	208.4	34.2	217.5	32.2	193.8	27.3
Diesel oil	2.1	0.4	2.6	0.4	2.8	0.4
Kerosene	18.4	3.0	1.9	0.3	1.1	0.2
Coal	211.2	34.7	286.9	42.5	342.6	48.4
Bagasse	168.9	27.7	165.9	24.6	168.4	23.8
Total	609.0	100.0	674.8	100.0	708.7	100.0

Notes: *kilotonne of oil equivalent. Source: Energy and Water Statistics (2007).

In Mauritius, the sugar industry contributes significantly to the national income, export earnings, and levels of foreign exchange. Products derived from sugar cane account for between 4 and 5 per cent of the national income and contribute around 25 per cent to the net foreign export earnings. Sugar cane also supplies around 20 per cent of Mauritius's energy needs through the production of electricity from bagasse. The industry directly employs about 4 per cent of the island's total workforce and is a source of revenue for some 28 000 small growers (those owning fewer than 10 hectares) along with the sugar estates and a handful of large planters. Revenue from sugar has always been used as a means to safeguard food security in Mauritius so any threat to the industry could have far-reaching effects beyond the sector itself.

2.3 Phasing out the trade preferences under the EU sugar regime

In the past, a large share of the production from Mauritius's sugar industry was exported to the EU under the preferences in the Cotonou Agreement. The Cotonou Agreement was a non-reciprocal trade agreement and its Parties had secured a waiver under the World Trade Organization (WTO) to operate under that regime. On 31 December 2007 the waiver expired, along with the commodity protocols, including the Sugar Protocol. With respect to the Sugar Protocol, however, the Parties agreed to review its compatibility with WTO rules, with a view to safeguarding the benefits it offered. In 2001 the EU adopted the Everything but Arms (EBA) initiative, which eliminated tariffs on almost all imports to the EU from the world's forty-eight least developed countries (LDCs). Sugar, rice and bananas from LDCs were to be fully liberalized by 2009.

In addition to changes under the Cotonou regime, in November 2001 the WTO adopted the Doha Declaration in which WTO Members agreed to work towards fundamental reforms in agricultural trade, including the phasing out of export subsidies and substantive reductions in domestic support. The WTO Framework Agreement of 1 August 2004 called for an end to all forms of export subsidies in all sectors (including sugar) and for reductions in import tariffs, both of which would require a substantial reform to the EU sugar regime. These measures will have adverse consequences for Mauritius.

In 2003, through the WTO, Australia, Brazil and Thailand challenged the legality of the EU's sugar regime. The WTO upheld the complaint, and the ruling was confirmed by the WTO's Appellate Body in April 2005. On 24 November 2005, the EU's agriculture ministers reached an agreement on a reform package for the sugar regime to take effect in conjunction with the 2006-2007 crop. The price support reduction proposed by the European Commission required a drop from 39 per cent to 36 per cent, to be implemented over four years (rather than two).

The reforms in the EU have significant implications for the world's sugar market, and in particular for the EU's former colonies that had benefited from preferential access to the EU market for over 1.3 million tonnes of sugar. The ACP saw their guaranteed minimum price for raw sugar decline from €524 to €335 beginning in 2008. While the EU offered some adjustment assistance, the ACP deemed it inadequate and protested against the significant erosion of the preferential trading arrangement.

Under the new EPA, and with the end of the Sugar Protocol, Mauritius has had to adjust to the 36 per cent drop in sugar prices over four years (ending in 2009) and also faces increasing competition from other producers with access to the EU market. To be a cost-

competitive supplier in the new trading environment Mauritius must substantially reduce the costs of production in the sugar industry and explore avenues for diversification within the sugar cane sub-sector.

In response, and to increase its competitiveness, the Government of Mauritius, in consultation with stakeholders, developed the MAAS Action Plan in April 2006, which covered the period 2006-2015. The MAAS was presented to the EU in the context of the “accompanying measures” attached to the Sugar Protocol. The European Commission, the Member States of the EU, and the European Parliament commended the MAAS and agreed that a substantial amount of “accompanying measures” be earmarked for the adaptation process in Mauritius. The country will receive roughly €245 million between 2006-2007 and 2013-2014.

The MAAS contained bold measures to be achieved in the sugar industry and aimed to ensure the long-term viability and sustainability of the industry and enable it to continue to fulfil its role in meeting national economic, environmental and social goals. The total cost of the projects contained in the MAAS has been estimated at 25 billion Mauritian rupees (MUR) (€675 million). Most projects (representing €585 million, or 87 per cent of the total cost), should be completed between 2005 and 2010 to allow the industry to prepare for the impact of the reduced price.

With the implementation of the MAAS, it has been estimated that sugar production would stand at around 520 000 tonnes from a harvested area of 63 000 hectares, with 20 per cent of total production coming from regrouped plantations of small sugar cane growers. This level of production would be sufficient to ensure that the country fulfils its commitments under the Sugar Protocol and the US Global Import Quota. The negotiation of the EPA with the EU is expected to be completed in 2009. In the meantime, Mauritius has been seeking additional trading partners.

In June 2008, Südzucker, Europe’s largest sugar company, and the Mauritius Sugar Syndicate (MSS), the marketing arm of the sugar industry in Mauritius, signed a long-term partnership agreement starting in 2009 and ending in 2015, for the annual supply of some 400 000 tonnes of cane sugar to the EU market. The MSS decided to establish a commercial partnership with Südzucker on the basis of its market strength and its outstanding infrastructure. Südzucker meets the future requirements of the MSS, which will be able to manage its European market activities from Mauritius without the need to build up its own sales and marketing organization in Europe. The MSS will market about 80 per cent of its production under the terms of its commercial partnership with Südzucker. Consistent with the partnership agreement, containers of direct-consumption sugar would be shipped directly from Mauritius. The local sugar factories have already begun to retrofit their plants to manufacture and package direct-consumption sugar for export.

2.4 The World Trade Organization

The WTO negotiations on agriculture are viewed from three perspectives: exports of agricultural products (in particular sugar), the domestic market, and food procurement. Mauritius is a Preference Dependent Single Commodity Exporter and a Net Food Importing Developing Country, and faces the additional constraints associated with being a Small Island Developing State (SIDS). These characteristics have shaped its negotiating strategy. As a beneficiary of long-standing preferences, the issue of trade preferences is vital for

Mauritius. The Mauritian strategy is to lock in achievements from the July 2008 mini-Ministerial Meeting, namely: a longer time frame for tariff reduction on sugar and ensuring that sugar is not included on the list of tropical products.

2.5 The ACP-EU EPA negotiations

Mauritius negotiated the EPA as part of the Eastern and Southern African region (ESA) configuration of ACP countries.² The main areas of negotiations were market access, development, fisheries, agriculture, services, trade facilitation, technical barriers to trade and other trade-related issues. However, negotiations in most ACP regions (including the ESA configuration) fell behind the schedule that had initially been agreed with the European Commission.³

Therefore, Mauritius together with four other ESA countries (Madagascar, Comoros, Seychelles and Zimbabwe) initialled an interim EPA with the European Commission on 4 December 2007 with respect to trade in goods, development, fisheries, and other areas where progress had been achieved.⁴ The main objective the interim agreement was to preserve Mauritian market access to the EU market, prevent any trade disruptions, and identify new areas for exports to the EU. In 2000, the EU and the ACP had agreed to negotiate the EPAs, which moved away from the traditional, non-reciprocal trade relationship between the ACP and the EU towards one based on reciprocity, as required under WTO rules. Failure to conclude a WTO-compatible agreement, particularly with respect to trade in goods, following the expiration of the WTO waiver would have left Mauritian exporters to trade under the Generalized System of Preferences scheme, with more stringent rules than those in the Cotonou Agreement. Mauritius does not qualify for duty free access under the EU's EBA initiative.

As of 1 October 2009, the ACP countries that supply sugar to the EU will trade under a new arrangement for sugar, under which the ACP countries will be subject to an overall threshold of 3.5 million tonnes. The EU has agreed to grant a minimum level of market access for 2009-2010 of 1 380 000 tonnes, 1 450 000 tonnes for 2010-2011 and 1 600 000 tonnes for the 2011-2012 to 2014-2015 period, for non-LDC ACP countries, provided that total ACP exports do not exceed 3 500 000 tonnes. Any additional tonnage would be subject to special safeguard measures.

3 Biodiversity in Mauritius

Mauritius has a land area of 1 865 km² and as a SIDS it is characterized by the inherent vulnerabilities linked to its small land area and population, distance from major markets, limited natural resources, and environmental vulnerability. Given the limited availability of land, further economic development involves balancing the conservation of terrestrial and marine environments, with further economic development in sectors such as tourism, agriculture, and industry.

² This configuration included: Burundi, DR Congo, Comoros, Djibouti, Ethiopia, Eritrea, Kenya, Madagascar, Malawi, Rwanda, Seychelles, Sudan, Uganda, Zambia and Zimbabwe.

³ Negotiations were not completed by the target date of 31 December 2007 in all the regions except for the Caribbean region, where a full EPA was completed on 15 December 2007.

⁴ Zambia recently concluded market access negotiations with the European Commission.

The island of Mauritius faces several threats, including from invasive species, low storage and retention capacity of freshwater, pressures on endemic species, solid waste and wastewater management, land degradation, protection of coastal and marine resources, impacts of human activities (such as tourism), climate change, and rising sea levels. The integration of the environmental, social and economic dimensions in the development of policies at the national level (with a long-term time horizon) poses a challenge and will require increased coordination among stakeholders from government, civil society and the private sector.

Biodiversity of Mauritius is characterized by a high level of endemism by virtue of the age and isolation of the main islands. However, its original rich diversity of flora and fauna has been severely altered by human activities and the introduction of several alien species during the 400 years since the island was first settled. Much of the remaining biodiversity on the island is now recognized internationally as being either vulnerable or threatened.

At one time, Mauritius was covered with native forest and was the home of the flightless Dodo (*Raphus cuculatus*). Its abundance of black ebony trees and a large number of palms were exploited by settlers. Forests were also cleared to make room for agriculture, roads and settlements. Deforestation and conversion to wide areas of agricultural land has led to the loss of habitats and a wide range of terrestrial biodiversity. Some plants introduced inadvertently to the island have become weeds while others that were introduced to control previously imported pests, have themselves become pests, displacing native plants.⁵ The regeneration of native species has been compromised by exotic predators such as rats, monkeys, birds, deer and pigs. The landscape has been altered significantly with only small and fragmented areas of primary and secondary habitat remaining, which are now under severe pressure from invasive alien species. The indigenous vegetation has declined in numbers and in genetic diversity and many species are now threatened with extinction. Loss of this biodiversity would represent a significant loss to the global community. The national inventory process of the local biodiversity is incomplete and limited by lack of resources.

Mauritius's high levels of endemism and species diversity per unit area have led to its classification by the International Union for Conservation of Nature (IUCN) as a Centre of Plant Diversity. However, notwithstanding 25 years of conservation activities, Mauritius is ranked third, by the IUCN, of countries with the greatest number of threatened plant species.⁶ Mauritius is also high on the global list of countries with the greatest number of plant and bird species threatened with extinction. Native forests now cover less than 2 per cent of Mauritius and are confined to the south-west of the island. Some 700 species of indigenous plants occur in Mauritius, of which 300 are endemic and 70 are thought to be already extinct. Furthermore, of the 44 known species of endemic land vertebrates, 21 are now extinct and many are critically endangered.

⁵ These include, for example, privet (*Ligustrum robustum* var. *walkerii*), goyave de Chine (*Psidium cattleianum*), poivre marron (*Schinus terebinthifolius*).

⁶ Hawaii and the Canary Islands are ranked first and second, respectively.

3.1 Agro-biodiversity and forest biodiversity

Crops and livestock that were introduced by the early settlers have developed traits that suit them to their specific environment. There has also been regular introduction by research institutions and commercial enterprises, of new crop varieties and breeds, which have been widely adopted by the farming community. These plant varieties and breeds are now part of the agricultural biodiversity of Mauritius and agriculture depends increasingly on these new crop varieties to increase yields and quality of produce. Despite the fact that most agricultural biodiversity has been introduced, some significant local varieties and breeds have continued to develop.⁷ However, knowledge of these local varieties is limited and their traits and characteristics have not been properly catalogued.

The focus of modern agriculture on relatively few crop species and the strong reliance on inputs such as chemical fertilizers and pesticides and high-yielding hybrid crop varieties has led to a decline in the local agro-biodiversity. The substitution of traditional local varieties for genetically uniform, high-yielding, varieties has resulted in the gradual erosion of genetic diversity of several crop species (such as the local red onion and traditional pulse crops).

In Mauritius, local agro-biodiversity is dominated by sugar cane, the most important commercial crop. Sugar cane has become the dominant commercial crop because of its suitability to the local climate (for example, its ability to withstand cyclones), soil, and topographic conditions. Important biodiversity associated with sugar cane include species that live in the cane thrash and the sugar cane ecosystem generally, and also aquatic species found in the rivers and streams close to sugar cane fields.⁸

Biotechnology is well developed in the sugar sector and there is considerable ongoing investment in the country. Mutation breeding is being undertaken to improve local varieties of anthurium, colocasia, tomatoes and bananas. The Government of Mauritius is also planning to develop a biosafety framework, including legislation on genetically modified organisms (GMOs), and public education.

Much of the livestock in Mauritius was introduced during its colonization, and its present day 'local' breeds are descended from these introductions. Over time, indiscriminate cross-breeding of exotic and local breeds has led to the genetic erosion of livestock species.⁹

3.2 Terrestrial and forest biodiversity

The native terrestrial biodiversity in Mauritius is confined mainly to marginal lands unsuitable for agriculture, such as steep mountains and valley slopes, or to marshy and rocky soils. Native forests have also survived on a few isolated mountain peaks. Around 47 per cent of higher plants (311 of 671 species of indigenous flowering plants), 60 per cent of birds and 80 per cent of reptiles are endemic. With 94 per cent of its endemic flora

⁷ These include the local red onion (*Touppille*), local tomato variety *Quatre carée*, local garlic, local cabbage, white cucumber, small chillies, and the white palm (*Dictyosperma album* var. *album*).

⁸ These include flora: weeds, lianas; edible and non edible mushrooms; and fauna: quail, hare, mongoose, rats, giant African snails, *perdrix*, *condé*, *tourterelle*, *tendrac*, parrot; and aquatic fauna: eels, shrimps, *chevrette*, *carp*, *cabot*, *tilapia*.

⁹ The *Creole* cattle and 'local' goat were characterized phenotypically and a nucleus of both is being maintained, with the objective of eventually using them in breeding programmes.

classified as threatened, Mauritius has one of the highest levels of threatened flora in the world. Seven of its indigenous species have been classified as extinct; 155 of its flowering plant species are listed as critically endangered;¹⁰ 93 species are endangered; and 241 species have been classified as vulnerable. Among the many threats to Mauritius's terrestrial biodiversity are ranching of non-native deer, invasive alien species and damage by fire.

Mauritius's forests cover an area of around 2 000 km² and account for 14 per cent of the total land surface area. Of this, approximately 30 per cent is subject to plantation forestry, which consists of plantations of exotic species, land used for deer ranching, and natural forest, most of which is badly degraded. In Mauritius, 47 per cent of the forested land area is owned by the state. Exotic plantations cover 11 816 hectares of land. The most common species are *Pinus elliottii* and *P. taeda*, (65 per cent), *Eucalyptus tereticornis* (16 per cent) and *Cryptomeria japonica* (13 per cent). In 2003, it was decided that half of the total plantation area would be set aside for protection of ecosystem services (such as water catchments and soil protection). *The Forest and Reserves Act* (1983) governs the management of forest resources and designates the power to declare national forests, nature reserves, mountain reserves, river reserves and road reserves. Forest resources are exploited in several ways, including the following:

- *Timber exploitation:* In 2004, 6 858 m³ of timber and poles were produced from state forests. There was also some extraction of wood, in the form of privet (*Ligustrum robustum* var. *walkeri*) and *goyave de Chine* (*Psidium cattleianum*) stakes and firewood. In 1995 the amount of wood used for cooking was equivalent to 81 000 tonnes of petroleum products, meeting about 10.2 per cent of local needs. This has declined dramatically, however, and by 2000 less than 5 per cent of fuel consumption was met with firewood.
- *Deer ranching:* The *Rusa* deer introduced from Java (*Cervus timorensis*) is reared for hunting purposes on large farms and estates. The national herd is estimated to number about 70 000. In 2004, 12 000 head of deer, valued at MUR53 million, were taken during the hunting season (1 June to 30 September) (Mauritius Deer Farming Cooperative Society Ltd. 2005). The venison is consumed exclusively in the local market.
- *Wild fruit collection:* Many introduced fruit tree species have naturalized, or become invasive in the forests of Mauritius. For example, the *goyave de Chine* is available for about four months of the year and guava picking is a popular Mauritian pastime. Fruit is also collected for sale but there are no reliable figures with respect to its economic significance.
- *Nature-based tourism:* Guided visits on quad bikes or jeeps to admire the scenery and wildlife, or canoeing trips on rivers, and abseiling down waterfalls are amongst new activities available.
- *Palm hearts:* The endemic palm (*Dictyosperma album* var. *album*) is cultivated in plantations on marginal lands for palm cabbage. This local trade is valued at an estimated MUR20 million. Although in the past palm cabbages were exported (mainly to Reunion Island), this trade has stopped, as local demand from hotels and restaurants exceeds supply.

¹⁰ Seventy-nine taxa are represented by 10 or fewer known individuals in the wild and 10 taxa are represented by only a single known individual.

- *Traditional use:* A few communities have earned their living for generations from the sale of traditional remedies using native species collected from the forest. However, this is a dying trade and much traditional knowledge passed down orally is being lost. In addition, several of the plant species used are critically endangered, sometimes due to over harvesting. There are about 100 native plant species with medicinal properties in Mauritius and Rodrigues in addition to some 500 introduced species. Other species have been found to contain active ingredients for pesticides. The Vacoas leaves (*Pandanus utilis*) are used for making baskets, mats, and hats. Forest resources that are exploited illegally include ferns and orchids.

There are no communal forests and no communities living within, or dependent upon, the forests. Because of the rising value of land in Mauritius, owners of private forests are more inclined to convert their forestlands to more profitable land use, such as ecotourism and integrated resorts, than to develop further agro-forestry. As a result, biodiversity in Mauritius is among the most threatened in the world.

3.3 Coastal, marine and freshwater biodiversity

The coastline in Mauritius is 322 km long and almost entirely surrounded by an extremely rich ecosystem with wetlands, mangroves, and a coral reef, which encloses a 243 km² lagoon. The marine biodiversity is a valuable resource and generates income through tourism and fisheries, providing direct and indirect employment for some 45 000 people (MOFEE 2005) and a livelihood for 2 256 registered fishermen (MAIFPS 2005). The coastal and marine areas also provide important recreation resources for the Mauritian population. Some dolphins reside in Mauritian waters and are being used as a tourist attraction. Two marine national parks and six fishing reserves have been proclaimed, to protect and conserve the habitat and nursery grounds for juvenile fish. The principal threats to biodiversity in the marine ecosystems come from over fishing, reclaiming of wetlands for hotel and residential developments, sand mining (a practice that was banned in October 2001), beach erosion, and invasive marine species.

Freshwater bodies on the mainland of Mauritius are made up of approximately 2 000 hectares of reservoirs, rivers and streams. The introduction of exotic fish species, such as Tilapia (*Oreochromis* spp.), has affected all of the island's freshwater bodies, and has resulted in significant changes in freshwater biodiversity. Habitat degradation from human activities (such as washing clothes in rivers and contamination from agrochemicals) has had further negative impacts on freshwater biodiversity.

Lagoon fisheries account for 1 per cent of GDP and provide a livelihood for some 2 500 registered fishermen. Tourism is one of the most important economic sectors in Mauritius, and its success depends heavily on the quality of the coastal zone, including its marine biodiversity. Any degradation of this resource as a result of unsustainable use, pollution, erosion, over fishing or conflicting uses, would have a severe negative impact on the Mauritian economy.

3.4 Invasive alien species

At present, invasive alien species are considered to be the most serious threat to Mauritian native terrestrial biodiversity. For example, the *goyave de Chine* is an aggressive alien species which has displaced native species in the high lands and yet provides a poor habitat for most native animal species.¹¹ Invasive alien plants also increase native plant mortality and reduce growth rates, contributing further to the gradual degradation of endemic biodiversity.

The invasive alien animal species were introduced either as a source of food or as predators.¹² Several of these species pose a severe threat to native vegetation and contribute to the poor regeneration of species, despite efforts at *in situ* conservation.¹³ Alien species also threaten endemic bird species.¹⁴

To prevent the further entry of invasive alien species onto the island, and to counter the threat to endemic biodiversity posed by existing alien species, a National Invasive Alien Species Control Strategy (NIASS) has been prepared by the National Parks and Conservation Service (NPCS) of the Ministry of Agro-Industry in collaboration with relevant national stakeholders. It includes more effective border controls to minimize the risk of introducing new invasive alien species, an effective monitoring system to detect new outbreaks of pests, and the development of improved control methods for established alien species.

3.5 Traditional knowledge

The knowledge of traditional farmers has long been an essential component of the sustainability of farming and natural resources management. However, with increasing use of modern agriculture and the adaptation of new improved varieties, traditional genetic resources are in rapid decline along with the associated traditional knowledge. At present, no inventory exists of traditional knowledge within the farming community. There is an urgent need to gather and preserve valuable traditional knowledge and to preserve agrobiodiversity, which together can contribute to sustaining yields under adverse conditions.

4 National and international policies and projects related to sustainability and biodiversity

Like all SIDS, Mauritius has unique characteristics and vulnerabilities that constrain its biodiversity conservation. It is small in size with a narrow resource base, ecologically fragile, susceptible to natural disasters (cyclones, seasonal droughts and coastal erosion), climate change and vulnerable to international trade policies and economic shocks. Faced with major challenges with respect to land use and planning, waste management, and

¹¹ The *goyave de Chine* can reach densities of up to about seven million stems at or above 1.3 m high per km².

¹² These include monkeys (*Macaca fascicularis*), rats (*Rattus rattus* and *Rattus norvegicus*), wild pigs or boar (*Sus scrofa*), deer (*Cervus timorensis*), fruit bats (*Pteropus niger*) and the Indian mongoose (*Herpestes auropunctatus*).

¹³ For example, rats (*Rattus* spp.) have been documented to destroy up to 60 per cent of the seed crop of Bois Colophane (*Canarium paniculatum*, Burseraceae).

¹⁴ For example, the Pink Pigeon (*Columba mayeri*) is constantly at risk from feral cats (*Felis catus*).

recycling, Mauritius is placing increasing effort on protecting and restoring its wealth of biodiversity for future generations.

The principle challenges being addressed in Mauritius are the protection and restoration of the wealth of biodiversity, the promotion of valuable economic and social uses for these natural resources, and the strengthening of regional and international collaboration. Over the past decade, there has been a growing awareness of the need to conserve the indigenous flora and fauna of Mauritius and tremendous progress has been achieved, with several organizations fully involved in the conservation and sustainable use of biodiversity resources. In recent years, several national projects have been initiated to monitor or promote sustainability and the conservation of biodiversity. Table 5 summarizes some of the national projects related to biodiversity.

Table 5: Features of national ongoing projects related to biodiversity

Project	Main features	Responsible authority
Sustainable Consumption and Production	A National Programme and action plan on sustainable consumption and production has been developed and one of its priority areas is the development of a national eco-labelling framework for agricultural and food products.	Ministry of Environment and National Development Unit
Setting up of an Environment Information System (EIS)	The EIS involves monitoring a set of environmental indicators including water quality, land use, soil fertility, degradation of forest land, coastal and marine pollution and exploitation, marine biodiversity, ecosystems, wetlands, threatened plant and animal species and invasive plant species.	Ministry of Environment and National Development Unit
Information systems for optimized data management to increase the efficacy of biodiversity conservation efforts in Mauritius and Rodrigues	This project involves the production of a database for the management and conservation of biodiversity, for rapid information on rare biodiversity species and quantification of the extent and rate of decline in local biodiversity species, as well as identification of priority areas for <i>in situ</i> plant conservation.	Mauritius Wildlife Foundation
Capacity Building for Sustainable Land Management (SLM) in Mauritius	Capacity building for SLM in appropriate government and civil society institutions, user groups and mainstreamed into government planning and strategy development through: <ul style="list-style-type: none"> • developing expertise in environmental and natural resource economics; • Enhancing capacities for sustainable pasture management and sustainable agriculture; and • planning, developing, and promoting strategies for SLM alternatives to sugar cane cultivation through the identification of land use alternatives and analysis of ecological sustainability. 	Forestry Services, Ministry of Agro-Industry, Food Production and Security

As a result of current economic challenges that are increasing the environmental vulnerability of the country (including reduced guaranteed sugar prices, rising prices and the end of the WTO's Multi-Fibre Agreement) the Government of Mauritius has placed environmental concerns high on its development programme to consolidate the economy

and develop new areas of growth, such as integrated resort schemes (IRS), the marine industry and the pharmaceutical industry.

Mauritius is a signatory to 18 international treaties and conventions on the environment (see Annex 1) and was the first country to sign the CBD in Rio de Janeiro in 1992. Over the years, Mauritius has developed and implemented national strategies, policies and action plans for different priority sectors of the economy (see Annex 2). These policies are to guide the public and private sectors on how to meet the obligations to different international conventions. As a signatory to the CBD, Mauritius has undertaken to implement its resolutions. This is evident in the national policies for agriculture, environment, land-use planning, water management, and infrastructure. The division of tasks among different ministries and institutions is presented in Table 6.

Table 6: Institutions and organizations responsible for biodiversity

Institution or organization	Areas of interaction
Ministry of Environment and National Development Unit	Preservation of natural resources, environmental impact assessment, environmental quality, wetlands, coastal ecosystems
Ministry of Renewable Energy and Public Utilities	Energy, water and waste
Central Water Authority, Ministry of Renewable Energy and Public Utilities	Fresh water quality monitoring and distribution
Ministry of Housing and Land	Physical planning policy
Department of Local Government	Shore development and beaches
Ministry of Tourism, Leisure and External Communications	Coastal hotels
Beach Authority	Shore development

The Government of Mauritius is committed to pursuing sustainable development. The country has designed and implemented a national sustainable development strategy aiming at promoting its economic and social development, while ensuring sustainable management of its natural resources. Sustainable development priorities have been given to the energy and environment sector (the new national environment policy).

5 The MAAS 2006-2015

5.1 Background to reform in the sugar sector

Following the erosion of the preference with respect to sugar, the sharp reduction in price, and rising energy prices, the Government of Mauritius prepared the MAAS 2006–2015 to help adjust to the lower price and increased competition. The MAAS was deemed a necessary response to avoid the decline of the sugar industry. While this IA assess the economic, environmental and social impacts of the MAAS, it is clear that the absence of any policy intervention would have led to negative impacts on sustainability for the following reasons:

- The sugar industry plays an important role in providing a livelihood in rural areas of Mauritius, and as a provider of housing, healthcare, education and training, recreational facilities, technical and financial assistance in many communities.

The rapid decline of the industry would have important socio-economic impacts on the island, including the loss of up to 40 000 jobs.¹⁵

- As producers move away from sugar, there could be an increase in the incidence of unsustainable and unmanaged land use in marginal production areas, leading to increased land degradation and erosion and to pollution where crops dependent on more agrochemicals were introduced.
- It is likely that the use of fossil fuels would increase as opportunities for co-generation were reduced (due to a lack of bagasse). In addition, the production of ethanol as a potential fossil fuel substitute would be less commercially viable if the molasses necessary to produce the ethanol had to be imported.
- There would be a risk of over-development on parts of the island, if prime commercial land were to be sold. There would be possible direct and indirect environmental and social risks associated with construction activities and the secondary infrastructure needed to service increased development.

Of all cultivated crops, sugar cane is the most efficient at sequestering atmospheric carbon and, as such, provides global environmental benefits consistent with the objectives of the Kyoto Protocol. The Government of Mauritius is committed to the well being of the sugar industry and is ensuring that the Action Plan is fully implemented in a timely manner, particularly since the EU's reduction in the price of sugar is expected to lead to a shortfall in export earnings of €782 million between 2006 and 2015. The actual loss to the economy is much greater when the social and environmental effects of losses in the sugar industry are taken into account.

The reforms contained in the MAAS 2006–2015 safeguard the future of the Mauritian sugar industry. They will also preserve this crop, which from 2015 onwards will be an invaluable asset in terms of the production of renewable environmentally friendly energy, and which has the potential to develop several associated high value-added products including proteins, pharmaceuticals, vaccines, polymers and textiles.

The MAAS was developed through a process of dialogue using a consensus-based, bottom-up approach, involving all relevant stakeholders. It reconciled the long-term economic, social, distribution, energy and environmental considerations associated with the Mauritian sugar industry, allowing the sector to fulfil its multifunctional role. This multifunctional role encompasses both direct and indirect contributions by the sugar industry. These include an economic return for operators; gainful income for employees; net fund flows to the overall economy; food procurement capacity; reduced dependence imported oil; development and stability in the rural areas; protection of the environment; soil and water conservation; prevention of degradation of the landscape; maintenance of the multiplier effect of the sector; and a sustainable agricultural sector. In Mauritius, the only resources that were available to ensure that the industry continues to provide these wide-ranging benefits are the export earnings from the sale of sugar under the Sugar Protocol.

The comprehensive reform undertaken through the MAAS also aims to tap the energy potential of the sugar industry through the generation of electricity from bagasse and coal (a

¹⁵ The impact of reform would also be felt by the poorer segments of society, including the roughly 28 000 small farmers and their dependents, and by the 1 200 or so *metayers* who do not own land that can be used for alternative development or as collateral to gain finance for alternative investments.

complementary fuel to bagasse) and the production of ethanol. Among cultivated crops sugar cane is one of the most efficient converters of solar energy into renewable biomass.

5.2 Objectives of the MAAS Action Plan

The Action Plan contains components and sub-components that respond to the new market environment and address the constraints facing the sugar industry. The main components in the plan are: reducing costs, generating additional revenues, optimally using by-products, focusing on poverty alleviation, reducing debt levels, developing regulations, and promoting synergies. Several of these components are discussed below.

Reducing costs. Cost reduction will be achieved by closing seven of the existing eleven sugar factories. Of the four that will remain, three would produce over 100 000 tonnes of sugar. Other measures that will be taken include adjusting human resources in production entities to reduce labour costs both in absolute and relative terms, facilitating recourse to seasonal labour, substantially reducing overhead costs at the operational, administrative and institutional levels, reducing levels of debt to lower financial charges, and taking full advantage of economies of scale at all levels (from the corporate sector to small- and medium-sized growers).

Generating additional revenue. Additional revenues will be secured through sales of a higher proportion of value-added direct consumption sugars. The goal is to move from the current levels of 15 per cent of total sales to 50 per cent or more, through a bold marketing strategy, eliminating losses incurred by producers on sugar sold in the local market, substantially reducing operating costs in institutions that service the sugar sector, increasing sugar output through the cultivation of high-sucrose cane varieties, and doubling earnings from the optimization of by-products.

Optimally using by-products. The optimization of the use of by-products will lead to the increased production of renewable energy, thereby displacing fossil fuels. Electricity produced from bagasse will increase by 300 million kilowatt-hours (kWh) (300 GWh) and 30 million litres of ethanol (which would be blended with gasoline) would be produced from molasses. Research has begun related to cane varieties with high fibre content.

Focusing on poverty alleviation. The key to a socially acceptable Action Plan is its focus on poverty alleviation. This is achieved through the provision of an attractive financial package available to employees who voluntarily terminate their contracts of employment in the context of labour force adjustments in production entities or factory closures. It also involves providing services aimed retraining, and assisting workers to secure financing to facilitate adaptation. Employees are also offered empowerment and welfare schemes established by the Government. Small growers can benefit from incentives and assistance to enable them to regroup into larger units and thereby increase yields and lower costs of production.

At its core, the Action Plan established the “sugar cane cluster” made up of sub-clusters operating around the four remaining sugar factories. The success of the cluster rests on a few critical factors. In descending order of importance these factors are:

- the operation of efficient and sizeable sugar factories;
- the adequate provision of energy in the form of steam and electricity;
- a reliable and sustainable supply of cane both from large and small growers;

- the operation of efficient and flexible state-of-the-art installations to produce different types of sugar and to optimize the use of bagasse and molasses; and
- the further strengthening of the commonality of interests among all stakeholders.

After implementing the Action Plan, sugar production will reach 520 000 tonnes produced on over 63 000 hectares with 20 per cent of total production coming from small planters in regrouped plantations.

The other key features of the Action Plan include the following elements:

- regrouping small growers (this involves 12 000 hectares of land with yields increasing by 20 per cent and costs decreasing by 20 per cent);
- providing irrigation to over 7 000 hectares;
- a voluntary retirement scheme (VRS) involving the voluntary termination of contracts of employment by roughly 7 200 employees;
- closing seven factories;
- commissioning five 42 megawatt/82 bar and one 35 MW/82 bar bagasse and coal power plants;
- commissioning two ethanol distilleries; and
- an ambitious research programme to develop and release for commercial cultivation high-sucrose and high-fibre content cane to improve both sugar and energy production.

The total cost of the Action Plan, taking into account the reduction of cess¹⁶ and the need to provide debt alleviation, social safety nets, and re-training efforts is MUR25 billion (€675 million). Of this, 87 per cent is expected to be spent prior to the end of 2010. By this time, it is expected that the cost of production would have been reduced significantly, enabling Mauritius to compete in the EU market with ACP, LDC and EU sugar producers, and with EU iso-glucose producers.

5.3 Implementation of the MAAS Action Plan

Projects under the Action Plan have been prioritized for implementation, with respect to funding, and classified according to the following four categories:

1. Projects that have both an economic and social dimension, such as VRS, social costs of factory closure, improving the competitiveness of planters, financial support in difficult areas, cess reduction, providing a social safety net under a revised social aid program, and contributing to the Empowerment Fund.
2. Projects that relate to the energy dimension of sugar cane, including attention to obtaining financing from banks, the local stock exchange and strategic foreign investors. This category includes research in cane biomass, ethanol production and electricity generation, and the possibility of accessing funds from the ACP-EU Energy Facility.
3. Projects related to debt alleviation, taking into account a market-oriented restructuring based on attracting equity.

¹⁶ Cess is a levy of 2 per cent imposed by the Government on revenue obtained from the sale of sugar. This money is used to fund the activities of administrative and research institutions directly involved in the sugar sector.

4. Projects for funding by the corporate sector with respect to factory modernization, land preparation, mechanization, and irrigation.

Following the ranking exercise, an allocation system was developed to determine the sharing mechanism at the project level between accompanying measures, other sources of financing, and producers' funds. Funding for the projects comes from several sources including accompanying measures, the ACP-EU Energy Facility, other ACP-EU funds, bilateral sources, and producer funding.

Preferential commitments under the Sugar Protocol and the US Global Import Quota total some 520 000 tonnes. Currently, the production potential of Mauritius is around 575 000 tonnes produced on roughly 72 000 hectares. Land under cane production is expected drop to around 63 000 hectares in the future as a result of conversion of agricultural land to non-agricultural use (by the corporate sector, large- and medium-sized growers, the Sugar Investment Trust and the State Land Development Company). Small growers (owning less than one hectare) can convert their agricultural land to non-agricultural use without paying land tax if the land is situated in areas where such conversion is permissible. Moreover, it is expected that production will be abandoned in marginal and economically and environmentally difficult areas.

The drop in land area under cultivation is expected to lead to a reduction in cane production from 5.2 million tonnes to 4.75 million tonnes. Nevertheless, sugar production is expected to reach 520 000 tonnes as a result of increasing yields. Increasing yields will come about as a result of increased access to irrigation and improved growing practices, the use of high-yielding varieties and/or ones with higher sucrose content (although gains in this regard could be mitigated by losses resulting from the more extensive use of mechanical harvesting), and by increased cane and sugar yields for small growers that have regrouped to take advantage of economies of scale.

5.3.1 Production of direct consumption sugar

The MAAS emphasizes that Mauritius can only be a competitive supplier to the EU if it moves away from the production and export of raw sugar for refining. The major reform in the EU Sugar Regime and the provisions of the Interim Agreement on the EPAs will have an impact on sales of Mauritian sugar in the EU market in that there would be no safety nets and competition will be fierce. The main features of the new market environment when the Sugar Protocol ends on 30 September 2009 will be the end of guaranteed prices and quotas with respect to sugar entering the EU. The previously guaranteed price under the Sugar Protocol will be replaced by a reference price that will be set by the market, increased competition, and the removal of the preferential treatment that had been enjoyed by ACP countries. Following the end of the Protocol, entry to the EU market for ACP countries and LDCs will be subject to the so-called "double trigger" volume safeguards, which have been agreed to in the interim EPA arrangement. These safeguards will make competition among ACP countries and between ACP countries and LDCs and non-LDCs fierce.

This emerging new commercial environment led the MSS (in consultation with the Mauritius Sugar Authority (MSA)) to commission a study by Landell Mills Commodities International (LMC) which, *inter alia* addressed the competitiveness of Mauritian sugar. LMC compared the eleven most competitive ACP and LDC suppliers with respect to the

supply of raw sugar for refining by traditional refiners and beet factories, and with respect to white sugar for direct consumption. LMC found that Mauritius ranked eighth with respect to raw sugar and second with respect to white sugar.

Importantly, the seven suppliers of raw sugar found to be more competitive than Mauritius have the capacity to supply over 3.5 million tonnes. This is equal to the volume cap in the “double-trigger” safeguard mechanism, which means that Mauritian exports to the EU are potentially at risk under the new trading regime. However, Mauritius has an advantage over other ACP and LDC producers with respect to white sugar for direct consumption, taking into account food standards and just-in-time delivery. Mauritius will therefore focus its attention on the export of white sugar in the future.

At present, levels of white sugar produced in Mauritius that comply with EU food standards are low. To increase levels of production of white sugar, two milling companies in Mauritius commissioned a Brazilian firm, with longstanding experience in white sugar and flexi factories, to undertake a financial and technical feasibility study. The study found that white sugar could be produced and exported. The companies that commissioned the study are investing roughly €50 million in two refineries to produce refined sugar for the EU market.¹⁷ An additional Mauritian sugar company has made plans to upgrade its existing white sugar production to produce sugar for the EU market.¹⁸ From 2009-2010 onwards, these three companies are expected to export roughly 300 000 to 350 000 tonnes of white sugar annually. In addition to meeting the EU standards, these companies must adhere to strict just-in-time delivery schedules.

In the light of these developments the industry has developed a plan in collaboration with the MSS and the MSA to take advantage of opportunities offered with respect to white sugar in the new commercial environment. This plan involves working with Südzucker, a transnational EU company, which is by far the largest sugar producer and supplier in the EU, accounting for some 25 per cent of the EU market. In June 2008, Südzucker and the MSS (the marketing arm of the sugar industry in Mauritius) signed a long-term partnership agreement (running from 2009 to 2015) for the annual supply of some 400 000 tonnes of refined white sugar to the EU. The MSS decided to go ahead with this agreement on the basis of Südzucker’s market strength and its marketing and distribution infrastructure in Europe. The MSS will market around 80 per cent of its production under the terms of the partnership agreement with Südzucker.

Under the agreement, containers of direct consumption sugar would be shipped to Europe directly from Mauritius. Mauritian sugar companies have begun retrofitting existing plants to manufacture and package direct consumption sugar for export.¹⁹

¹⁷ The two companies that commissioned the study are Savannah Société Usinières du Sud and FUEL. They will upgrade production facilities to produce EEC Grade II refined sugar.

¹⁸ That company, Belle Vue, will upgrade its existing white sugar production installations to produce EEC Grade II refined sugar.

¹⁹ The two sugar refining factories (FUEL and Savannah) are adopting a technology that includes the sulphitation of clarified juice followed by the clarification of syrup to produce plantation white sugar of 300 to 600 International Commission for Uniform Methods of Sugar Analysis colour. This sugar will be re-melted prior to its clarification using phosphodefecation, followed by deep-bed filtration and ion exchange to remove colour. Sugar will be crystallised, dried, and conditioned and sent for bagging into one tonne bags or in bulk in-lined containers. The other four factories will adopt conventional cane processing technology to produce raw and specialty sugars.

5.3.2 Centralization and factory closures

In Mauritius, the amount of cane produced annually stands at around 5.2 million tonnes. In 2005 cane was processed in 10 sugar factories where cane-crushing capacity varied between 75 and 310 tonnes of cane per hour (TCH). By 2010, according to the MAAS, almost the same amount of cane will be processed in four factories with cane-crushing capacities of between 190 TCH and 425 TCH. This will be achieved by closing six mills with low TCH in favour of the four where cane-crushing capacity will be increased through a process of centralization in cane-milling activities. Factory closures are part of the strategy of moving towards establishing sub-clusters within the sugar cane cluster.

Five sugar factories have sought permission from the Minister of Agro Industry to cease milling operations and to transfer operations to other sugar factories.²⁰ In November 2007, official permission was obtained with respect to the closure of three sugar factories and for their activities (the canes they were milling) to be transferred to other factories.²¹ The transfer of activities from two of these companies to Savannah enabled it to operate its upgraded factory. The factory had previously been operating at 130 TCH and will now operate at 350 TCH. The higher volume of cane for processing will also allow operation to begin of the 84 MW bagasse and coal power plant at Centrale Thermique de Savannah (CTSav) 1 and 2, optimizing the use of bagasse for electricity generation. It will also allow the commissioning of a modern back-end refinery to produce high quality white sugar (EEC Grade II).

As indicated in the MAAS, Union St Aubin will also be closed and its cane transferred to Savannah enabling the factory to process around 1.7 million tonnes of cane and produce roughly 170 000 tonnes of white sugar. The electricity potential from bagasse would then stand at almost 210 GWh.

Requests for the closure of Mon Loisir, in the North, and Mon Desert Alma, in the Centre-East, were processed early in 2008 and permission was obtained in March 2008. The closure of these two factories was to be effective from the end of the 2007. The procedures concerning the closure of Mon Désert Alma have been completed, while those regarding Mon Loisir are pending and the issue of cane transfer has not been settled.²²

5.3.3 FORIP (small- and medium-sized growers)

In Mauritius, there are two main categories of cane producer: the corporate miller growers (large growers cultivating cane on areas exceeding 25 hectares) and small- and medium-

²⁰ These requests are made pursuant to section 24 of the Cane Planters and Millers Arbitration and Control Board Act.

²¹ The three factories were St Felix, Mon Trésor and Riche en Eau, all situated in the South of the island. The cane was directed from St. Felix to Union St Aubin, and from Mon Trésor and Riche en Eau to Savannah.

²² The cane from these two factories will be used to optimise existing capacity in Belle Vue in the North, and FUEL and Deep River Beau Champ in the East. The plants in the East are relatively more efficient power plants. From an electricity perspective, the more efficient use of bagasse in the power plants associated with these three factories will enable these plants to reduce their coal consumption. Belle Vue operates at a pressure of 82 bars, FUEL at 44 bars (with one very old plant, and one commissioned in 1998) and Beau Champ at 44 bars using a plant, which was first commissioned in Reunion in 1984, dismantled, and reinstalled and commissioned in Mauritius in 1997.

sized growers, including the tenant farmers (*metayers*).²³ These farmers grow cane on areas varying from 0.1 to 25 hectares and own a total of around 20 000 hectares with significant amounts of this acreage on marginal land (see Table 7). These figures underscore the importance of small- and medium-sized growers in providing raw materials to the large processing plants. The sub-clusters would not be economically viable without cane from the small- and medium-sized growers. This relationship has facilitated an agreement on the enhanced equity participation of the smaller producers in sugar mills, distilleries, refineries and power plants, which reflects the common interests among the various stakeholders.

Table 7: Number of planters by category

Category of planters	Acreage (ha)	Number of planters
Small- and medium-sized growers	Up to 1	21 213
	>1 to 5	5 403
	>5 to 10	324
	>10 to 25	98
Corporate millers/large growers	>25 to 100	31
Total		27 069

Source: MAIFPS 2006.

The small- and medium-sized growers operate on small plots, often employing inefficient production methods. They face several challenges in production. For example, their land tends to be unsuitable for mechanization (either partial or complete), they cannot take advantage of economies of scale, inappropriate cane varieties are often cultivated resulting in low yields, cane is not always harvested at the optimal time resulting in lower sucrose content and, when harvested, is often not processed immediately due to delays related to the transport of the cane to the mill and cane delivery quotas. These factors cause a substantial loss in sucrose. Moreover, the smaller growers face high costs of cutting, loading and transport of the cane.

The FORIP was designed with the objective of modernizing and upgrading the production of some 27 038 small- and medium-sized growers to enable them to increase yields of cane and sugar, lower costs of production, and better withstand the shocks associated with the falling prices of sugar. The FORIP is a new policy in Mauritius and is designed to be phased in slowly. To ensure success, a Project Implementation Committee (PIC) had been established, comprising key actors in the sugar sector.²⁴ At the outset the PIC identified steps for project implementation and defined a role for participating institutions, which are presented in Table 8.

²³ A *metayer* is a person who, by agreement with a grower cultivates sugar cane on land which belongs to the grower and, in return, gives the grower a portion of the annual sugar yield from the land, with or without additional payment.

²⁴ The MSA, with the approval of the Government of Mauritius, established the PIC chaired by the MSA and comprising all the service providing institutions in the sugar industry, namely the Mauritius Sugar Industry Research Institute (MSIRI), the Sugar Planters Mechanical Pool Corporation (SPMPC), the Farmers Service Corporation (FSC), and the Irrigation Authority. In addition, the Ministry of Finance and Economic Empowerment (MOFEE) and the MAIFPS are members of the PIC. While the MSA defines policy and disburses funds, all operational matters are decided by the PIC which, since 2006, has met on a fortnightly basis.

Table 8: Role of institutions involved in the PIC

Institution	Role
MSA	Overall monitoring, coordination, and policy formulation.
FSC	Canvassing and interface with growers.
SPMPC	Mechanical equipment service provider.
MSIRI	Technical advice provider, farm planning and certification of works.
IA	Irrigation service provider.
MAIFPS and MOFEE	Ensure followup and reporting to parent ministry.

From an operational perspective, the FORIP has two key requirements. First, the identification of an area of land where operations can be executed on a large scale to create economies of scale and second, the sequenced and properly managed undertaking of a series of operations from de-rocking to the planting of appropriate cane varieties, one application of fertilizers, and two herbicide applications.

The project revolves around the regrouping of planters. In this regard, the PIC had to address several past failures and the resistance of growers to change. The PIC examined the causes of these failures and noted that past projects had been top down and inflexible, and had not involved collaboration among various institutions, including the corporate sector. Therefore, the PIC adopted a bottom-up approach whereby technical solutions were developed in collaboration with the corporate sector and subsequently discussed with growers. Growers were exposed to the gains derived from economies of scales and government incentives and developed a sense of ownership in the project, despite the fact that the regrouping of land led to the loss of the demarcation of individual plots.

It was only when the growers agreed to technical proposals that the PIC moved forward with implementation, which involved de-rocking, levelling, grading, furrowing, application of soil amendment and fertilizers, planting cane, covering cane materials and two herbicide applications. The involvement of the corporate sector (with experience in the development of large tracts of land) and members of the PIC facilitated the proper sequencing and management of the operations.

The next hurdle was addressing the financial contribution of growers to the project and compensation payable to them for loss in revenue. Given limited resources and the extent of land to be covered, the MSA, with the concurrence of Ministry of Agro-Industry, adopted a specific financial package.²⁵

The project is being undertaken in the following two main areas: first, sites with land which is easy to work and that has been developed for mechanization, and second, on more difficult sites, which will be developed to permit the maximum possible level of

²⁵ The financial package included the following elements: partial funding from grants obtained under Accompanying Measures; cost of cane planting material met from the global *cess*; part of the project funded from the sale of rocks to stone crushers; partial funding from contributions from planters participating in the project; the exact amount depending on the complexity of the task to be undertaken and the type of services to be provided; MUR 37 500 per hectare interest free loan payable over three years in case a grower has to forego one crop (applicable in situations when there is recourse to long season virgin plantations); and, at the request of the MSA, the sugar companies engaged in the project have agreed to provide management, supervision, and survey (topographical and cadastral) services free of charge; these services amount to some €750 per hectare.

mechanization. On all sites developed by the PIC, growers accepted the principle of making a financial contribution, which reinforced their commitment to, and ownership of, the project. Levels of contributions were discussed extensively with growers and were specific to the sites to be developed.²⁶

5.3.3.1 Implementing the FORIP

In the Phase I of the FORIP (July 2006 to April 2007) ten projects were undertaken. The level of de-rocking and land preparation enabled full mechanization at all sites except the ones at Congomah and L'Espérance, which were in difficult areas. Some salient features of the 10 pilot-phase projects are presented in Table 9.

Table 9: Features of the pilot phase projects

Location	Total area (ha)	Number of planters	Extent (ha) planted by	
			March 2007	April 2007
Queen Victoria 1	54	27	30	54
Queen Victoria 2	19	12	19	19
Queen Victoria 3	17	10	17	17
Etoile	106	60	35	60
Forbach	35	22	5	35
Kalimaye	26	14	6	26
Congomah	20	46	3	10
Beau Bois	37	20	15	37
Trianon	40	16	15	40
L'Espérance	42	18	5	42
Total	396	245	150	340

Source: MAIFPS 2006.

The first phase of the FORIP was successfully completed in March 2007 over a total of 340 hectares in the small- and medium-sized sector. Important factors that contributed to the success were the synergies among stakeholders, the ownership of the project by growers, the constructive role of the corporate sector, and the adoption of new technologies for specific activities such as de-rocking.

A similar approach was employed during Phase 2 of the FORIP, but new elements were introduced. Changes in Phase 2 included the introduction of new technologies in the small- and medium-sized sector, the coverage of difficult areas, and the introduction of modern and efficient irrigation systems. Phase 2 covered an area of some 850 hectares, including an

²⁶ Figures in the range of €30 to €270/hectare/year payable over seven years were arrived at depending on whether the land is flat and practically rock free or it is land where de-rocking is substantial and land levelling and grading significant. Additionally, it depends on whether the land has been prepared for full mechanization (requiring fine de-rocking), semi mechanization (manual cutting and mechanical loading), or was totally manual in difficult areas.

irrigation component for around 150 hectares. De-rocking on an area of 800 hectares was completed. After the successful completion of the Phase 1, the MSA had deemed it feasible and beneficial to fully integrate an irrigation component into Phase 2, given that irrigation significantly improves and stabilizes cane production in water deficient areas.

Implementation of Phase 2 of the FORIP was undertaken by adopting three approaches. First, a managerial and supervisory role was assigned to sugar companies. Second, the Farmers Service Corporation (FSC) took the lead role with respect to the 'difficult' areas. Third, the MSA, which has technical expertise in modern and efficient irrigation systems, played a lead role. Implementation of Phase 2 was hampered by a severe drought at the end of 2007, which delayed the de-rocking and planting. The drought ended in March 2008, at which time implementation proceeded satisfactorily. However, cane plantations had slowed down production as a result of shortages of fertilizers and cement (needed to amend soils).

During Phase 2 new technologies were introduced that reduced labour costs and accelerated implementation. These technologies included civil engineering equipment to facilitate rock removal and reduce costs, rock shredders (to turn rocks to powder in fine de-rocking), reduced passage of tractors in fields to limit soil compaction, the use of global positioning system to ensure parallelism in cane plantations and the precise location of sprinklers in irrigation systems. However, the most important innovation was the introduction of a radio-controlled automatic irrigation system.²⁷

The combination of the introduction of these technologies with the externalities generated by the regrouping of growers has given rise to several positive developments, which include the following:

- since crop compensation and compulsory acquisitions do not arise, undue delays in the implementation of regrouping projects were avoided (delays of one to two years had been experienced in past projects);
- the initial capital costs were lower because of technological innovations, the quality of design, and the elimination of intermediaries from the procurement process;
- maintenance costs are lower and the equipment used is not sophisticated and can be easily repaired;
- the technology is less demanding in terms of operation and cost but requires some information technology skills to operate;
- wear and tear has almost been eliminated given that the system has a limited number of moving parts;
- the MSA undertook key tasks in-house (such as detailed design, project supervision and implementation) which avoided hiring consultants and significantly reduced costs;
- water is being applied in an efficient and selective manner (for example, watering at night), and cane yields from areas that have adopted this system are higher than yields where other systems (such as drip or centre pivot) are used;
- growers pay for water based on actual use rather than as a fixed charge; and
- growers are trained to run the system and no longer require the support of the Irrigation Authority.

²⁷ Following discussions, the financial contributions from growers was set at MUR30 000 per hectare with respect to acquiring the irrigation technology.

Phase 3 of the FORIP (July 2008 to June 2010) will cover an area of around 1 700 hectares and will include the new irrigation system in some areas.²⁸

Out of the 20 000 hectares under production by small- and medium-sized growers, some 15 000 hectares will ultimately be covered by the FORIP. Upon completion, these 15 000 hectares are expected to yield an incremental cane production of some 400 000 tonnes (roughly 45 000 tonnes of sugar). Bagasse from the incremental cane will enable the generation of 50 GWh of electricity and the production of 12 000 tonnes of molasses with the potential to produce 3 million litres of ethanol.

5.3.4 VRS and centralization

The voluntary termination of their employment contracts by employees in the cane-milling sector following a factory closure has been a regular feature in the sugar industry since 1994, when the St Antoine factory closed. At that time, employees were entitled to cash compensation. Since then, following the closure of the Mount Sugar factory, the package has become more attractive. Experiences gathered as a result of these factory closures culminated in the development of a Blue Print on Centralization of Sugar Milling Operations in Mauritius (hereafter, the Blue Print).

The Blue Print, which was approved by the Government in 1997, established guidelines addressing the technical, social and environmental issues that have to be fulfilled prior to permanent cessation of milling activities at a given factory. These included packages for the workers and the growers. The package for the workers most affected by the factory closure included compensation in cash and in kind.²⁹ By 2005, six factories had been closed under the provisions of the Blue Print and seven more factories are expected to close using the same guidelines.

In 2001, the corporate miller growers initiated action for manpower rightsizing in the cane-growing sector in an attempt to bring down costs of production in the fields. They implemented a VRS for employees in the cane-growing sector, adopting a similar principle of compensation (in cash and in kind) to workers in the field.³⁰ Some 8 000 employees in the sector (well over the 5 000 employees anticipated) opted for this offer.

In order to relieve the producers of the high costs incurred in implementing the provisions of the Blue Print and the VRS, they were offered the opportunity to convert agricultural land and sell it with minimal payment of land taxes, which enabled them to recoup their

²⁸ This new irrigation system has been presented to the Agence Française de Développement and the European Investment Bank. Both have indicated their intention to follow its progress and eventually participate in funding such projects. The MSA has, in meetings with the Ministry of Finance and Economic Development and MAIFPS, pointed out that it can also execute projects under an African Development Bank and/or Arab Bank for Economic Development in Africa loan.

²⁹ The cash compensation is equivalent to 2.5 months per year of service and the in-kind compensation is in the form of a plot of land varying between 540 m² and 720 m² provided with necessary infrastructure. The employee is also entitled to other benefits and children of employees are entitled to university scholarships in specified areas of study.

³⁰ Two categories of workers were defined on the basis of age; a male worker having more than 55 years and a female worker of over 50 years old were offered two months cash compensation per year of service with the possibility of drawing an early pension. The younger workers were entitled to 1.25 months of compensation. The package also included a plot of land of 7 hectares, with infrastructure.

costs. In addition, in 2001, the Bank of Mauritius provided concessionary financing through a line of credit to assist producers implementing the VRS. This line of credit amounted to €60 million but the total cost incurred was €85 million. The shortfall was made up by the corporate sector.

Adoption of the attractive social packages in the Blue Print (for cane milling) and the VRS (for cane growing) has facilitated the modernization of the sugar industry. The success of the Blue Print and the VRS has led to the proposal of further packages, in particular a new VRS – the VRS 2. The VRS 2 includes a re-training programme prior to retirement of an employee.³¹ An Early Retirement Scheme (ERS) has also been introduced in the cane-milling sector for the sugar factories that remain in operation in the context of the cane sub-cluster.

As of October 2008, a total of 7 254 employees representing 18.2 per cent of the employees in the sugar industry, had accepted the VRS 2, the ERS or the Blue Print. Of these, 4 277 employees expressed their intention of enrolling in training schemes, of which 1 865 had already been enrolled in such schemes. As of October 2008, 812 employees had been re-employed or had become self employed.

5.3.5 Re-training and alternate employment

Early in 2007, in anticipation of the implementation of VRS 2, the MSA in collaboration with the Mauritius Sugar Producers Association and the Regional Training Centre (RTC), had established the modalities for launching the training schemes.³² Roughly 65 per cent of the employees (4 700) who had accepted VRS 2 or ERS offers, expressed an interest in enrolling in training courses. The MSA and the sugar companies, in collaboration with the Empowerment Programme, also engaged themselves in ensuring that a maximum number of employees would be re-deployed. As of mid-April 2008, roughly 800 employees had been re-employed in other sectors of the economy.

The schemes discussed above have two main components: cash compensation and the provision of land with infrastructure. Roughly 60 sites have been identified for the beneficiaries of VRS 2, eight for the beneficiaries of ERS, and six under the Blue Print, for those affected by factory closures.³³

³¹ Cash compensation for employees amounted to nearly €90 million. Infrastructure and other costs for these employees would amount to some €5 million resulting in a total cost of some €140 million. Adding to this amount, the cost of closing Mon Loisir, Deep River, Beau Champ and Union St Aubin, was estimated at some €3 million. As of mid-April 2008, €45 million had been raised and used.

³² A list was drawn up of employees eligible for the VRS 2, who had expressed interest in re-training. A questionnaire was issued by the RTC to ascertain the preferences of these employees. A matching exercise with the capability of institutions to provide training was undertaken. The Industrial Vocational Training Board, the Agricultural and Research Extension Unit (AREU) and JR School (specialised in food production matters) were contacted and they agreed to provide courses with the RTC playing a supervisory role. The sugar companies, FUEL and Mon Loisir, made arrangements with AREU for training purposes. Some 240 employees have been enrolled.

³³ To ensure that employees get their land in time, the SIE Act 2001 provides a maximum time to undertake and complete infrastructural works. Otherwise, the sugar companies are subject to fines. The SIE Act 2001 also allows the sugar companies to recoup part of the costs incurred under the schemes through the conversion, development, and sale of land. The extent of land to recoup cost is determined by dividing the amount of eligible expenditure, defined under the SIE Act 2001, by the net proceeds per unit area (net realisable value) obtained through the sale of this land. Taking into account refunds from Accompanying

5.3.6 Electricity production

Under the MAAS, one objective of the co-generation plants is to increase the contribution of the sugar cane cluster to national electricity production through increasing the productive capacity of the sugar industry. The MAAS also aims to increase the contribution of bagasse to national energy generation, and reduce levels of imported fuels in an attempt to offset to some extent the negative impact on foreign exchange brought about as a result of the erosion of preferences for sugar sales to the EU market. Further goals include reducing the need to expand existing fuel-oil plants to mitigate the impact of emissions from such plants on the environment, and to attract carbon emission reduction credits under the Kyoto Protocol, arising from burning bagasse as a renewable energy resource.

Power plant projects have been identified in the MAAS, associated with Savannah, Flacq United Estates Limited (FUEL) and Médine.³⁴ The two 42 MW power plants at Savannah were commissioned on schedule in August 2007. The other projects will only be considered once a study funded jointly by the Government of Mauritius and the Mauritius Sugar Producers Association has been completed. The study will be conducted by an independent expert and is expected to assess the various independent power producers against agreed benchmarks and provide a perspective on the Power Purchase Agreements that govern them.³⁵

5.3.7 Ethanol production

Ethanol can be produced from any sugar-containing product. Two potential inputs derived from sugar cane are molasses and cane juice. Given the current market, it is not feasible to produce ethanol from cane juice. However, it is economically viable to produce ethanol from molasses, when oil prices are around US\$60 per barrel. From the 120 000 tonnes of locally produced molasses around 30 million litres of ethanol can be obtained. This is sufficient for a 20/80 blend with gasoline, taking into account gasoline consumption of some 120 million litres.

Under the MAAS, two factories (Savannah and FUEL) have been identified as having the potential to economically convert all their molasses into ethanol. Both factories have the capacity to produce around 15 million litres. However, three major constraints have been identified with respect to investments in ethanol distilleries for large-scale production. The first relates to the disposal of the highly polluting liquid effluents (vinasse). The issue of vinasse disposal is being resolved through its transformation into a concentrated molasses

Measures, interest payable, the current market situation and based on the net realisable value method, some 1 700 ha of land would have to be sold to recoup social costs incurred.

³⁴ Savannah: 2 x 42MW (82 bar) bagasse/coal power plant operational as from 2007. Subject to closure of the Union St Aubin sugar factory and cane redirection to Savannah, an additional 42 MW unit is to be operational in 2008. The capacity of this additional unit and its start of operation have yet to be decided. FUEL: 2 x 42 MW (82 bar) bagasse/coal power plant with one unit to be operational between 2008 and 2009 after the completion of centralization. No formal agreement has yet been reached for this plant and there will be a delay in implementation of this project. Médine: 1 x 42 MW (82 bar) bagasse/coal power plant to be operational in 2012. The decision about whether or not to invest in this plant has not yet been made.

³⁵ CTSav 1 and 2 were able to export 125 kWh of electricity for every tonne of cane that was milled at Savannah in 2007 and also in 2008. This performance compares favourably with the power plants of Belle Vue or on nearby Reunion Island.

stillage enriched with urea (as a nitrogen source) and used as fertilizer. The second constraint relates to the absence of a policy rendering a blend with gasoline mandatory for use in the vehicle fleet (which is still under consideration). The third is the absence of a pricing policy for the sale of ethanol. Every country that has pursued an ethanol and gasoline blend has adopted mandatory blending.

In 2004, a distillery was commissioned at Rose Belle, in the South of the island. It encountered numerous problems and has so far not been able in any single year to adequately use its installed capacity. This distillery uses molasses as feedstock and meets its energy requirement through imported oil, diesel in particular. All the ethanol produced by this distillery is exported to the EU. In contrast to the sugar milling companies, the distillery has no equity participation from employees and small- and medium-sized growers. The MAAS also notes that the break-even point between gasoline and ethanol from cane juice is an oil price of US\$83 per barrel. A comparison between distilleries operating within a sub-cluster and distilleries operating outside a sub-cluster is presented in Table 10.

Table 10: Comparison of a sub-cluster distillery with one operating outside a sub-cluster

Item	In a sub-cluster	Outside a sub-cluster
Transport of molasses from sugar factory to distillery	No	Yes
Use of fossil fuels in transport	No	Yes
Use of fossil fuels in operation of distillery	No in cane crop season, yes in cane intercrop season	Throughout the year
Emission of sulphur oxides	No	Yes as diesel containing sulphur is used
Complementarities with white sugar production	Yes	No
Cost of producing ethanol	Lowered significantly	No cost lowering elements
Lowering cost of production of white sugar	Yes	No
Maximum energy saving and export to grid	Yes	No
Full justification of case for carbon credits	Yes	No
Maximum earnings for producers, including small planters and country	Yes	No
Flexibility to adjust sugar and ethanol production to reckon with market circumstances	Yes	No
Cost to consumer	Cheaper option	More expensive option; higher costs of energy and transport
Disturbance to local populations	No	Yes if located in inhabited areas, no if located in uninhabited areas.
Compatibility with MAAS	Yes	No

Source: Agreco Consortium (2007).

5.3.8 Production in marginal areas

Prior to the sugar reform, the preferential price of sugar encouraged many planters to extend sugar cultivation to some 5 000 hectares in marginal (“difficult”) areas along mountain slopes. Sugar cane is a perennial crop and has the advantage that it helps control erosion in environmentally sensitive areas. Over 4 000 small growers and *metayers* derived significant incomes from cane despite the fact that yields were relatively low in these areas. In the early 1990s, owing to the extra quota of 85 000 tonnes of sugar in the US market and the non-profitability of growing tea, some 2 482 hectares of land previously used for growing tea in the super-humid zone (not suitable for cane cultivation) was converted to sugar cane production, involving some 2 520 small tea holders.

According to the Mauritius Sugar Industry Research Institute (MSIRI) the marginal areas for sugar cane production refer to land that cannot be mechanized (MSIRI 2006). Some 12 341 hectares of such lands has been identified, where abandonment of sugar cane cultivation will give rise to environmental, economic and social problems.³⁶

These marginal lands pose several challenges to production. For example, de-rocking is uneconomical due to topography, even partial mechanization is difficult, yields are low and costs of production are high, the land is exposed to the adverse impacts of drought and cyclones, the land is generally leased from large estates by small growers and *metayers*, and conversion into residential units and commercial sale is very difficult. With the drastic drop in sugar prices, production in these marginal areas will no longer be sustainable and will result in a change in land use. Although there is a case for these marginal lands to be supported and kept under sugar cane production for environmental and social reasons, it is expected that they will become uneconomical and will either be abandoned or converted to other uses.

The Government aims to prevent or mitigate any adverse environmental and social impacts from the loss of cane production in these areas and places an emphasis in the MAAS on poverty alleviation and the environment. Moreover, with Government initiatives to shift to local renewable sources of energy, the possibility of establishing wind farms combined with cane cultivation in some of these areas is being explored.³⁷

A Strategic Environment Assessment (SEA) of the policies included in the MAAS was undertaken in 2007. It found that managing 5 000 hectares of marginal land under sugar cane production through support measures to maintain sugar cultivation, and converting the remaining areas to forests, presented significant environmental opportunities. Any conversion of these lands to other uses, however, must be properly managed through site-specific planning. Growers intending to diversify from sugar cane should be provided with

³⁶ These lands have been categorized into three categories based on their specific characteristics. Category A: Land moderately to marginally suitable for sugar cane and located on the seaward slopes of three mountain ranges: the Moka–Long Mountain range, the Grand Port range, and the Black River—Savanne range (4642 hectares) (3433 small-scale growers \leq 42 ha). Category B: Inlands slopes of the same mountain ranges as Categories A and one on the flanks of an isolated mountain along the Eastern to Southern edges of the Central Plateau. Category C: Flat to moderately sloping land (6 334 hectares including some 2 085 hectares occupied by small holders of land previously used for growing tea).

³⁷ The Bel Ombre, St Félix, St Antoine, Gris Gris and Grand Bassin regions have been found to be suitable sites in this regard. The first two regions are considered marginal areas.

support under the MAAS, only if they choose appropriate crops for the local climatic and soil conditions, to ensure that conversion to other crops is properly managed.³⁸

6 The relationship between the sugar sector and ecosystem services

Historically, the sugar industry has been as service provider to rural communities (housing, healthcare, recreational facilities, education, training and technical). Its multifunctional role in the economic, social and environment domains has played a key role in the economic and social development of Mauritius. The environmental life-cycle benefits of sugar cane are significant as all its by-products can be utilized in some way.³⁹ It provides global environmental benefits through the sequestration of atmospheric CO₂. And sugar cane cultivation has aesthetic benefits in terms of “greening” the island to support tourism.

In addition to the benefits associated with the sugar sector, there are also areas of concern. One key concern is with regards to the negative impacts on air quality arising from burning cane. Other concerns are associated with the disposal of by-products (such as bagasse) and the negative impacts of sugar factory effluents on water quality and aquatic biodiversity. Table 11 summaries the major economic, social, environmental and biodiversity related impacts of the sugar industry.

Table 11: Economic, social, environmental, and biodiversity related impacts of the sugar industry

Economic	
+	The sugar industry contributes 4% to 5% of GDP.
+	The sugar industry contributes around 25% to the national export earnings (MUR6.5 billion) in terms of sugar and molasses exports and savings on coal imports.
+	Cogeneration of energy from bagasse contributes around 20% of the country’s energy requirement and offsets the import of around 255 000 tonnes of coal.
+	Reduces the country’s exposure to fluctuation in world energy prices.
+	Export earnings are vital for the country’s food imports.
+	Reduces the country’s exposure to fluctuations in world energy prices.
+	The sugar industry directly employs around 4% of the national labour force and is the source of livelihood for some 28 000 small sugar cane growers.
+	The milling and growing companies contribute to government revenues in the form of tax.
Social	
+	In 2004, some 40 000 people depended directly or indirectly on the sugar industry for their livelihoods,
+	The sugar industry has contributed to a wide range of logistical and service supports for the development of rural areas, such as health care, education, training, housing and recreation.
+	Several schemes to assist growers. The Sugar Industry Labour Welfare Fund promotes welfare of workers and their children. The FSC provides technical advice to sugar cane growers. The Sugar Insurance Fund Board covers growers against losses due to cyclones and fires. The MSIRI conducts research and training.
+	The Sugar Investment Trust ensures that the benefits are distributed among workers.

³⁸ They should also employ recommended practices. For example, codes of practice for environmentally sound farming such as that for vegetables elaborated by APEXHOM.

³⁹ For example, bagasse and cane thrash can be used for power generation, filter cake and combustion ash can be used as soil conditioner, molasses can be used for the production of bio-fuel, vinasse as a source of fertilizer, and composted or incinerated vinasse can be used as an organic fertilizer.

Environmental	
+	The root structure of sugar cane and the minimal disturbance of the soil with the adoption of an eight-year cycle and the large volume of mulch and organic matter generated contribute to erosion control even on sloping land.
+	The materials generated by de-rocking are used in the construction industry, reducing pressure on coral sand, which led to destruction of marine habitat.
+	Limited amount of pesticides used in sugar cane cultivation means an absence of pesticides in potable and ground water.
+	Fertilizer application is rationalized and based on soil analysis for sugar estates. No surface and ground water pollution is associated with sugar cane cultivation. Absence of eutrophication in streams and reservoirs.
-	Effluents from sugar factories add a high organic load, which significantly increase turbidity and biological and chemical oxygen demand in receiving watercourses. The high temperature of the effluents affects aquatic biodiversity in water.
-	Effluents from co-generation plants have negative impacts on water quality due to presence of heavy metals and other contaminants.
-	Disposal of coal ash presents environmental concerns due to leaching of contaminants.
-	The disposal of vinasse produced by the distillation process in the production of rum is potentially highly polluting. Controlled field applications as a source of fertilizer is being investigated. The volume of vinasse to be produced will increase and its disposal is a challenge.
-	The demand for water for irrigation of cane is around 14 000m ³ . With the increasing demand for water from other sectors, there is a risk of depletion of aquifers and saline intrusion by overexploitation of ground water sources.
Biodiversity	
+	Monocropping has had little influence on the biodiversity associated with sugar cane, which covers 45% of the cultivated area.
+	The gas emissions from bagasse combustion are a potential source of pollutants but factories have invested in equipment to reduce pollution effects. CO ₂ emissions are being monitored.
+	The adoption of a code of practice with regard to burning cane is recommended to reduce impacts on air quality. With mechanization, green cane harvesting is increasingly being practiced.
+	Safe storage, handling, and application of pesticides are recommended to field workers to minimize potential hazards. Health and safety legislation is in place to protect workers in Mauritius, but is not enforced.
+	The generation of energy from bagasse and coal is increasing to reduce import of fossil fuel. These projects can benefit from Clean Mechanism Development financing for CO ₂ emissions reduction.
+	Sugar cane efficiently sequesters CO ₂ and its extensive cultivation can provide net global environmental benefits.
-	There is no evidence of pollution affecting aquatic biodiversity but intensification of cane production has led to the increased use of agrochemicals, presenting a risk of nutrients leaching and environmental pollution.
-	The discharge of effluents from sugar mills and co-generation plants significantly pollutes watercourses and lagoons during the milling season.
-	Piles of bagasse, filter cake, and fly ash are exposed to wind and lead to air pollution in the vicinity of factories and co-generation plants.

The sugar sector also provides a range of ecosystem services. Indicators for these services were identified during a brainstorming workshop with stakeholders and are presented in Table 12.

Table 12: Ecosystem services and indicators for the sugar sector

	Ecosystem service	Indicator
Provisioning	Sugar production	Source of income
	Bagasse production	Electricity generated through bagasse
	Molasses production	Source of income
	Ethanol production	Reduction in import of fossil fuel
	Vinasse	Volume used as an organic source of fertilizer
	Scum (filter cake)	Volume used as soil conditioner and organic fertilizer
	Green tops	Volume used as source of fodder
	Availability of land for interline cropping	Increase in food crop production
	Employment	Number of people directly or indirectly employed by the sector
Regulating	Water demand	Water demand for sugar sector
	Control of soil erosion runoff and sedimentation	Assessment of sedimentation and soil erosion in environmentally sensitive areas
	Population of natural predators	Volume of pesticides used
	Hydrological services	Assessment of infiltration rate and run off downstream
	Pollination	Pollination by bees and insects
Cultural	Historical and cultural heritage	Number of visitors to “L’Aventure du Sucre”
	Habitat of wild animal and plant species	Population of <i>tendrac</i> , quail, hare and <i>mangoose</i>

Baseline data was not available for most of the indicators identified. This made the assessment of impacts, before and after the policy change, difficult to determine. Monitoring these indicators would be useful to assess existing and future policies. In the absence of information on some of these indicators, anecdotal evidence of changes in the status of some indicators was gathered at the focus group meetings.

7 The integrated assessment

7.1 The methodology and conceptual framework

The methodology employed during this IA followed UNEP’s approach to IA as described in the UNEP policy assessment on Trade, Agriculture and Biodiversity⁴⁰ and the ‘General Guidelines on Assessment of Biodiversity’ developed by members of the core advisory team. The study was undertaken using a consensus-based multistakeholder approach with the final results validated at a national stakeholders’ workshop. Major partners, stakeholders, the core project team and the many meetings that were held are discussed in detail in the technical report, which is attached to this report as Annex 3. Annex 3 also contains a description of the methodology that was employed during the IA.

⁴⁰ The project used the approach described in the draft manual (June 2007) with the working title: Incorporating biodiversity into integrated assessments of trade policy in the agricultural sector.

The study took into account the current evolution of the sugar sector and focused on the small sugar cane growers and the corporate sector simultaneously to provide an accurate picture of the impact of the EU sugar reform at the national level. Relevant documents related to trade, biodiversity, and policy measures related to the EU sugar reform were compiled. Stakeholders and experts were consulted, and a survey was conducted with smallholders of sugar cane lands to compare various parameters between production under regrouped small cane growers and non-regrouped growers. Two focus group meetings were organized with different groups of small-scale farmers regrouped under the FORIP to gather information about small growers and their practices and to validate the findings of the survey and other sources.⁴¹

Due to time constraints, several impacts could not be observed over the course of the study. Therefore, the IA employed scenarios, identified by stakeholders, of the likely outcomes of the policies. The two main scenarios considered for analysis were:

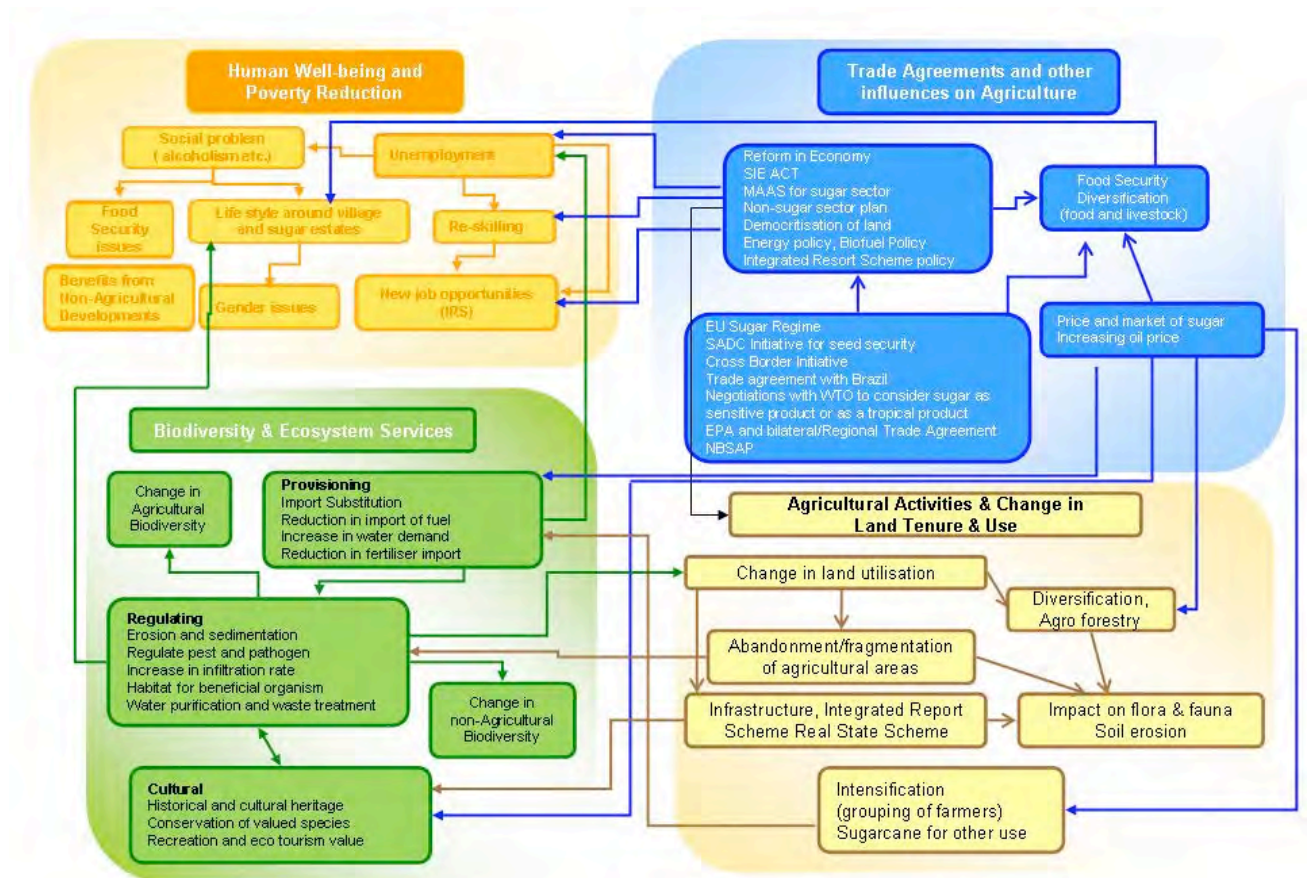
- sustaining sugar cane production under current or modified conditions consistent with MAAS interventions; and
- moving out of sugar cane, specifically in marginal areas where sugar cane cultivation is not profitable.

A multistakeholder working group was organized to assess three likely options of possible changes in land use in marginal areas. These options were: abandonment, conversion from sugar cane to other agricultural uses (such as food crops, livestock, or agro-forestry), and conversion to non-agricultural uses (such as IRS projects, or residential and infrastructure development). Historical data and qualitative information from technical reports and stakeholder consultations were used to forecast future trends.

A conceptual framework was developed depicting the relationships among the drivers of change (the EU sugar reform and MAAS) and their impacts on agricultural activities and land use, and ultimately on agricultural biodiversity, ecosystem services, food security and the well-being of farmers. The conceptual framework reflected a common understanding among stakeholders and guided the analytical work in the IA.

⁴¹ The methodology used for the survey, the results, and the questionnaire, are included in Annex 4.

Figure 1: Conceptual framework for the assessment of linkages between trade policies, agriculture, biodiversity and ecosystem services, and human well-being



7.2 Results of the integrated assessment

Overall, from an environmental perspective, the IA showed that the implementation of the Action Plan will help preserve the sustainability benefits already associated with the sugar industry and, through its activities, will add positive impacts. For example, regrouping of land under the field operations will provide an opportunity for improved soil and water conservation practices to be introduced more widely amongst small growers, and the closure of older polluting factories during centralization and the introduction of clean technologies and processes at the remaining factories, will help reduce the environmental impacts in the milling sector. Furthermore, environmental benefits will arise from improved stack emission controls within the power generation sector and the increased use of renewable fuels such as bagasse (assuming sufficient bagasse is burnt to offset the CO₂ emissions from the increased use of coal). Global environmental benefits may arise from the local production of ethanol as a fuel substitute. Finally, the maintenance of production in marginal areas will help control the risk of soil erosion in upland areas.

The sugar industry has traditionally contributed significantly to social development and welfare in Mauritius through its role as a service provider to rural communities. Despite the planned closure of seven sugar mills over the next ten years, implementation of the Blue Print for centralization will ensure that essential services (housing, healthcare, education and training, recreational facilities and financial assistance) are still provided for three to

five years following the closures. The relatively generous cash and in-kind compensation given to workers as part of the VRS will contribute to the financial security of rural communities. The provision of land is also valuable, providing a means to grow subsistence crops and/or to build a house, and providing an asset that can be handed down to future generations.

The closure of mills will result in a reduced workforce, but seasonal employment will continue and training is available to acquire skills in other fields. The sugar industry has also put in place mechanisms to ensure that the benefits in the sector are distributed among workers and their dependents through the Sugar Investment Trust and through support to the institutions and organizations associated with the sector, and its labour force.

Finally, the regrouping of farmers proposed under field operations, centralization, and maintenance of production in marginal areas, has significant social benefits for small farmers, by increasing cost efficiency and lowering investment risk. It provides an opportunity for intensification of production and increased returns, while encouraging community cohesion and capacity building.

7.2.1 Sustaining sugar production under current or modified conditions

The IA indicated that measures implemented to sustain and intensify the sugar sector will contribute significantly to maintain national export earnings and the country energy requirement through co-generation of energy from bagasse thereby offsetting the import of fuel. Besides access to the VRS and the sale of sugar cane land to recoup the social costs incurred, factory closures and centralization will help the sector take advantage of economies of scale and optimize the use of bagasse for electricity production. The adoption of air pollution control systems, effluent treatment, and water cycling, will help reduce CO₂ emissions, improve water quality, and reduce the amount of water needed for processing. The closure of some factories will have a positive impact on the quality of fresh water, air, and biodiversity in the area around the factory.

The regrouping of some 28 000 small- and medium-sized sugar cane growers will help improve efficiency through the adoption of recommended sugar cane varieties, cultural practices, modern irrigation systems, and mechanization. It will also promote nutrient management and soil and water conservation through farm planning. The FORIP will promote sharing of skills and technology between the small- and medium-sized growers and the sugar company, for the management of the blocks and encourage growers to undertake other activities as they will have more free time. On the other hand, the FORIP will change the way sugar cane is grown in Mauritius from a diverse habitat to an intensive monoculture production system resulting in a reduced habitat for natural predators and a reduction in crop biodiversity.

The economic, social, environmental and biodiversity impacts of the key projects included in the MAAS Action Plan are presented below.

7.2.1.1 Production of direct consumption sugar

Economic impacts. The survival of the sugar industry rests on the shift from the export of raw sugar for destination refining to the production and export of value-added sugars. The limited market for specialty sugars (around 120 000 tonnes) justifies the large-scale

production of refined sugar and of direct-consumption Plantation White Sugar which complies with food standards. Therefore, the refinery projects are essential for the sugar industry from an economic perspective. In addition, the freight cost per tonne of white sugar, is lower than the cost per tonne of raw sugar by some €30 per tonne.⁴² Under its long-term agreement with Südzucker, the MSS can supply up to 400 000 tonnes of sugar (refined sugar) to Südzucker between 2009 and 2015 at a specified price.

The refinery project will benefit all stakeholders, including refiners, millers, large growers and the growers and employees who can become 35 per cent equity partners in the refineries and mills. Nevertheless, the production of direct-consumption sugar is part of a comprehensive project aimed at cost reduction, rightsizing of the labour force and increasing revenue so that the industry can withstand the impact of the 36 per cent price reduction, which amounts to a loss of roughly €100 million per year. During 2009-2010 refiners will have to adapt to the new reality and will face logistics and supply problems as the price drops. During this time, it is likely that the cost of refining will actually increase, if the raw material is supplied in the form of “unclean” cane (with a high percentage of green material).

However, there will be positive impacts for energy, and ultimately costs of production should be reduced. In this context, the pilot project that uses cane field residue⁴³ as boiler fuel along with bagasse will have a positive impact on levels of renewable energy and ensure that the sugar mills receive clean raw materials with lower field residues. This will lower the costs of refining over time. Moreover, it is likely that the costs associated with producing ethanol (and value-added sugars) will drop if ethanol distilleries and refining processes are linked to the factories, thereby reducing costs associated with transporting molasses, and providing energy for refining. Experience in Brazil has illustrated the synergies between sugar refining and ethanol production.

Social impacts. By producing refined sugar, Mauritius can remain competitive as a supplier to the EU and maintain its export earnings. This is positive for all stakeholders, in particular vulnerable small growers with equity stakes of up to 35 per cent in the refineries. It will maintain employment for a significant number of skilled workers in the refineries and provide opportunities to build additional capacity in the labour force. However, this scenario also implies that raw sugar will no longer be exported in bulk which will lead to the closure of the bulk sugar terminal and the loss of hundreds of jobs at the terminal.

Environmental impacts. From an environmental perspective, the processes adopted in the refining process will rely on existing technologies.⁴⁴ One new element has been added to the overall process. That involves burning sulphur to produce sulphur dioxide, which is used in the sulphitation process to eliminate colour causing compounds. The sulphur dioxide is normally produced under extremely controlled conditions and is fully converted into sulphates and leaves the processing plant as precipitates. The industry had been using a

⁴² This is because the Port Louis harbour has an effective container hub.

⁴³ Cane field residue is crop materials left in the fields after harvest and include cane tops and cane trash.

⁴⁴ For example, to recover the sugar from cane through juice extraction, clarification using lime, separation of precipitated impurities in the form of mud and subsequent mud filtration, concentration of clarified juice into syrup by evaporation in quintuple effect evaporator station, boiling of syrup mixed with concentrated intermediate sugar containing products into *massecuites*, followed by crystallization and centrifugation to separate sugar crystals from the molasses.

similar process in the production of EEC Grade II refined sugar in refineries in operation at Britannia and Mon Desert Alma and has the necessary expertise to handle such products in an environmentally responsible way, even though levels of sulphur dioxide (sulphur) will increase as a result of the significantly higher volumes of sugar projected for refining.

The fact that the refineries must comply with the most stringent food norms in the world will ensure that they operate under the most environmentally responsible conditions. Moreover, there are price premiums available in the market for environmentally friendly sugar products.

Table 13: Summary of changes and impacts of MAAS policy: production of direct-consumption sugar

Policy measures	Changes required	Economic impacts	Social impacts	Environmental and biodiversity impacts
Production of direct consumption sugar <i>White refined sugar EEC Grade II</i> <i>Specialty sugars</i>	<ul style="list-style-type: none"> • High investment (€50 million) required in two refineries. • Compliance with EU food standards. • Shift from bulk export to one tonne bags requiring conditioning and packaging. • Need logistics to ensure timely delivery. 	<ul style="list-style-type: none"> • Mauritius will remain a competitive supplier to the EU. • Refined and special sugar fetches a premium over raw sugar. • Premium shared among stakeholders (producers, millers). • Freight costs of €30 less per tonne of white sugar compared to raw sugar. • Secure market from 2009 to 2015 and increased revenues. • Optimize synergies between ethanol production and sugar refining. • Risk of higher cost of refining due to supply of unclean cane. • Increase in energy production from cane field residue along with bagasse. 	<ul style="list-style-type: none"> • Sustained flow of export earnings will benefit all stakeholders • Enable vulnerable partners like planters to become shareholders up to 35% in equity. • Continuous employment of skilled workers in sugar refineries. • Opportunity for capacity building in personnel. • Closure of the Mauritius Sugar Bulk Terminal and loss of employment of some 100 employees. Need for compensation to workers. 	<ul style="list-style-type: none"> • Production of raw sugar and special sugars require no change in processing technology. • Use of sulphur dioxide in refining for juice and melted sugar clarification under controlled conditions, although industry has experience with this process. • SO₂ leaves process as sulphate compound with inorganic colouring materials. • Energy production from bagasse will reduce imports of fossil fuel.

7.2.1.2 Centralization and factory closures

Economic impacts. The main economic benefit of the centralization has been the reduction in costs of production by reducing the number of mills and upgrading and modernizing the remaining mills. Upgrading the mills enabled two essential operations to take place: building a refinery, and integrating the sugar factory with a power plant. Moreover, the volume of molasses that can be produced in the larger factories can justify the operation of an ethanol distillery. Centralization is the underlying condition for the establishment of a sub-cluster.

However, this project has the disadvantage of longer distances for transporting cane from fields (or different loading zones) to the centralized locations. The impact of these

additional costs are mitigated to some extent by using high payload lorries (25 to 30 tonnes).

Factory closures are also associated with the payment of the Blue Print compensation, which is very generous, compared to compensation packages available for workers in other sectors.⁴⁵ The cost of this compensation is borne by the sugar milling companies and is viable due to funds available under the EU's Accompanying Measures. Without these funds, no company could have undertaken VRS for factory closures in the face of the imminent drop in the price of sugar.

Social impacts. From a socio-economic perspective, job losses and lack of a regular income for the ex-workers can increase the risks of poverty and secondary effects like child labour, lowered school attendance, and criminal activity. However, the Blue Print cash and in-kind compensation payments and the possibility of accessing pensions, will mitigate these risks. Employees of sugar cane factories represent the highest number of employees compared to other sectors of the economy and there is scope for redeployment in other sectors (such as tourism, construction and agri-business) following re-training.

Environmental and biodiversity impacts. In 1994, 19 factories were in operation. By 2005 eight factories had been closed, implying that any negative impacts of their effluents on air quality, water quality, and biodiversity had been eliminated. Moreover, the remaining factories, where capacities had been upgraded, had been implementing measures to mitigate the impact of the effluents on the environment and reducing their water intake per tonne of cane processed. The centralization process continued after 2005 when five more factories ceased cane-milling activities. Therefore, problems associated with the impact of temperature, dissolved oxygen (DO) and biological oxygen demand (BOD) in water effluents from the closed factories, on biodiversity both at point of outfall into rivers or marine sites, have been eliminated.

- **Water discharge.** Sugar cane factories consume a significant amount of water for their operation and the usual source of such water is local rivers. After use, the water is discharged, normally after some form of treatment, into the receiving water bodies, such as rivers or lagoons. Alternatively, some factories send such water for use in the irrigation network for irrigating fields under sugar cane. Studies carried out in 1994 established that all sugar factory effluents input organic loads, but to varying degrees.⁴⁶ The closure of factories implies fewer points of discharge into water bodies. Discharged water from mills is characterized by high temperatures,

⁴⁵ Blue Print compensation comprises two and a half month compensation per year of service, the payment of some €1 875 in the form of business and training grants, and the provision of an average extent of 14 perches (one hectare is equal to 236.9 perches) of land with infrastructure (with a market value of €1 125 per perche). For an employee with 30 years of service and drawing €225 per month (the average in the case of factory closures), he secures in cash and in kind an amount of nearly €35 000. In addition, he is entitled to the early receipt of an actuarially reduced contributory pension. A comparable employee of any other sector of the economy would be entitled to a cash compensation of at most 15 days per year of service and on the basis of a much lower salary, around €125 per month. The compensation comes to €1 875 which is nearly 19 times less than the employee benefiting from the Blue Print.

⁴⁶ The highest loading was recorded in Rose Belle S.E., followed by Constance S.E. and FUEL with DO being lower, around 6 mg/L (the lowest proposed standard for receiving waters, under the EPA (Mauritius) 1991, Proposed Regulations 1993). The other factories are also close to six (7.1 to 7.8), hence nearer to the lower limit. The results obtained for Biological Oxygen Demand (BOD-5) reflect exactly the trend (inversely) for DO, reaching 51 and 60 in the case of Rose Belle and Constance. This confirmed the organic loading from sugar factory effluents.

BOD, chemical oxygen demand, total soluble solids, and low levels of pH and DO. These discharges into rivers and lagoons lead to eutrophication of plants and animals, with a subsequent negative impact on biodiversity.⁴⁷ The closure of sugar factories and the elimination of these discharges will remove this negative environmental impact. Moreover, the factories that are being upgraded to receive additional cane are being modernized. These centralized factories will require more inputs, but modern technology will result in minimal water consumption and maximum water recirculation and appropriate treatment to comply with effluent standards established in the Environment Protection Act (2002).

- **Air quality.** The integration of cogeneration with the centralized mills will improve air quality. The new power plants are equipped with state-of-the-art air pollution control systems.⁴⁸ These power plants have also adopted closed circuit system for cooling purposes.⁴⁹ The means of transport from fields to factories has normally been by lorry, with payloads varying between 4 and 30 tonnes (the smaller payloads are common in the small-grower sector). With centralization, the payload of cane lorries in the medium-sized and large, corporate mill grower sectors has increased which reduces the litres of fuel used per tonne of cane transported. However, transport distances have increased due to the longer distances required to transport cane from loading zone at closed mills and from fields in areas around closed factories, to the newly centralized mills. Nevertheless, given that the payloads have increased significantly, the relative increase in fuel consumed as a result of longer distances is mitigated.
- **Biodiversity.** Biodiversity is particularly impacted by the discharge of water from factories. Studies show that water effluents from sugar cane factories have a higher temperature at the outfall than upstream (control station). Tropical organisms already live very close to their upper tolerance temperature limit. Any temperature increases are stressful, especially in summer.⁵⁰ Studies also show that with respect to the effects of the effluents on freshwater plant and animal organisms, there is a marked depression in total biodiversity at outfall points as compared to upstream, and in some cases even the total disappearance of biodiversity. Recovery of the water quality to upstream (control) standards is dependent on the effluent pollutant load, river turbulence, and the dilution factor downstream; hence the great

⁴⁷ Studies carried out in 1994 has revealed that such organisms include Viriparid (*Bellamya bengalensis zonata* – gastropod snail), *Lymnea* (Rad) *mauritianus* (Gastropod snail), *Hydrobia spp.* (Gastropod snail), Anisoptera (dragon fly), Dytiscidae (Coleoptera – the water beetle), *Lumbricus sp.* (Earthworm), *Caridina sp.* (Shrimp), *Gambusia affinis holbrooki* (Cyprinodontid fish), *Poecilia (leb) reticulata*, *Tilapia sp.* (fish), Fish (Unidentified combine, Blennid fish, *Bufo regularis* (tadpoles), Trichopterous larvae (red), Nepidae (*Nepa spp.*–Hemiptera, water scorpion), *Neretina gigates* (Gastropod snail), Pleurocera *sp.*, *Raghovelia spp.*, *Gyraulus mauritianus* (Gastropod Snail), Insect (Unidentified), *Ferrissia modesta* (Limpet-like), *Colocasia antiquorum* (Brede songe), *Eichhornea crassipes* (water hyacinth), *Salvinia spp.*, Spirogyra, and Sewage fungus.

⁴⁸ The technology employed is electrostatic precipitators. Particulate matter discharge from the stack is well below the 100mg/Nm³ norm established in the Environmental Protection Act. In addition, with proper air/fuel ratio adopted to optimise combustion efficiency, greenhouse gases emissions like carbon monoxide are minimized.

⁴⁹ Only make-up water (make-up water is used to compensate for losses in the closed circuit system) is used both as boiler feed water and for condenser cooling purposes. Power plants have adopted costly demineralization plants.

⁵⁰ However, according to Canadian Guidelines, an increase of 5°C or more is detrimental to living organisms in aquatic ecosystems. This was the case for several rivers, where in some cases temperature rises of more than 10°C had been recorded.

variability of the distances towards recovery.⁵¹ The occurrence of sewage fungus, a pollution bio-indicator for acute organic enrichment, is also a concern. Sewage fungus has been found in the river and lagoon ecosystems, especially at or around points of outfall. Another potential bio-indicator is the local shrimp *Caridina sp.* (*chevrette*) which was not found during the study and which should be confirmed by more detailed field and laboratory investigation. It is encouraging that none of the rivers or lagoons studied showed any sign of eutrophication. Levels of inorganic nutrients (nitrates and phosphates) were relatively low. The study made several recommendations with respect to water quality.⁵²

Table 14: Summary of changes and impacts of MAAS policy: centralization and factory closures

Policy measures	Changes required	Economic impacts	Social impacts	Environmental and biodiversity impacts
Centralization and factory closure	<ul style="list-style-type: none"> • By 2010, number of factories will drop from 10 to 4 with increased crushing capacity. • Upgrade and modernize sugar mills and integrate with power plants. • Use continuous power plant to optimize capacity of factory. • Establish sugar cane clusters. 	<ul style="list-style-type: none"> • Increase in volume of cane crushed will optimize use of bagasse for electricity generation and economies of scale will justify investment in a modern refinery and demineralization plants. • Reduce costs of production. • Reduce coal consumption. • Increase amount of molasses produced and justify the operation of an ethanol distillery. • Invest in improved technology enabling automation. 	<ul style="list-style-type: none"> • Compensation of employees in cash and in kind, re-training programme and business grants, mitigate the risk of poverty due to early retirement. • Job losses and lack of regular income could give rise to socio-economic problems such as poverty, criminal activity and lower school attendance, but programmes exist to mitigate potential negative impacts. 	<ul style="list-style-type: none"> • Positive impact of closure of factories on water and air quality and aquatic biodiversity by eliminating discharges of effluents, emissions of smoke and CO₂, and reducing water demand. • Long distance transport of cane to centralized mills could increase traffic and air pollution. • Centralized mills adopt water recycling, efficient use, decrease water use, and improve water quality. • Centralized, modern mills equipped with air pollution control system and effluent treatments comply with standards in Environmental Protection Act (2002). • Use proper air to fuel ratio to optimize combustion efficiency and reduce greenhouse gas emissions.

⁵¹ For River Coignard, recovery was observed at 1200m. In other cases (Rivière Terre Rouge) and Rivière Dragon), recovery was observed at 2000m downstream, but for Rivière La Chaux and Rivière Citron, recovery occurred at 3500m downstream. In the remaining rivers, recovery took place between 2400m and 3000m.

⁵² Specifically, it noted that the best environmental option would be not to allow DO levels to go below 4 to 6 mg/L; to maintain a BOD-5 level between 4-10 mg/L or less; never to discharge factory effluent which would cause a sudden temperature increase exceeding 5°C over the ambient water temperature. It also noted that a high BOD (exceeding 10 mg/L) in running water indicates organic enrichment into the ecosystem; this creates oxygen demand, thus leading to a DO depression and eventual depletion. This, along with heated effluent, seriously impacts on the living organisms (temperature and physiological shock or stress), to the extent of species elimination at, and downstream to, sites of outfall. Under these circumstances, the best environmental option is “zero discharge” in the aquatic ecosystem. However, this may not always be economically practicable. The best practicable environmental option would seem to be to resort to effluent treatment in order to adhere to the environmental norms. The study noted that implementing these recommendations necessitates investment both for the installation of treatment facilities and the regular monitoring of the following key parameters: temperature, DO, BOD, nutrients, PH, and biodiversity.

7.2.1.3 Labour “rightsizing”

Socio-economic impacts. Job losses and the lack of a regular income for workers who voluntarily terminate their employment bring risks of poverty and indirect impacts, such as child labour, lower school attendance, and crime. However, these risks have been mitigated through the compensation programmes that have been established. Moreover, many of the workers are being re-employed, on a seasonal basis, in the sugar industry (although these jobs could disappear over the long term as a result of more intense mechanization of field operations, and automation and centralization in cane mills) and a significant number have moved into other economic sectors as a result of re-training programmes. Labour costs in both the cane-growing and cane-milling sectors constitute a high percentage of total operating costs. The implementation of the VRS 2, the ERS and Blue Print is also expected to significantly reduce costs of production.

Environmental impacts. The compensation package available to workers includes land, and the corporate sector is recouping the costs of implementing the compensation packages through the sale of land. This implies changes in land use. Potential indirect impacts include uncontrolled development of land. However, environmental impacts are being mitigated because the development proposals must comply with conditions, including requirements for green space and limited building coverage (60 per cent of land area).⁵³

Table 15: Summary of changes and impacts of MAAS policy: Labour “rightsizing”

Policy measures	Changes required	Economic impacts	Social impacts	Environmental and biodiversity impacts
Labour rightsizing	<ul style="list-style-type: none"> • VRS includes compensation in cash and in-kind (plot of land with infrastructure), re-training, and business grants. • Re-deployment of workers to other sectors of the economy. 	<ul style="list-style-type: none"> • As of October 2008, 7 254 employees had opted for the VRS, and cash compensation stood at MUR3.6 billion. • 4 277 out of 7 254 ex-employees expressed interest in training schemes and 1 865 enrolled for training courses in 2008. • Infrastructure costs of MUR2 billion. • Sugar companies would have to sell some 1 700 hectares of land to recoup social costs incurred. • Adoption of mechanized harvesting and cultural practices and modern technology in milling (automation). 	<ul style="list-style-type: none"> • 812 out of 7 254 VRS employees re-deployed to other economic sectors. • Job losses and lack of regular income for VRS workers. • Risk of poverty leading to secondary effects, such as child labour, lower school attendance and crime. 	<ul style="list-style-type: none"> • Land use changes as a result of sale of land to recoup costs. • Potential indirect impacts as a result of uncontrolled development of land. • Environmental impacts being mitigated given that development proposals should comply either with a compulsory Environmental impact assessment (EIA) license from the Ministry of Environment for business development or a municipal clearance for residential purposes.

7.2.1.4 FORIPs

Economic and social impacts. In order to assess the economic impacts of the policy changes associated with the FORIP, this study employed the Queen Victoria site as a case study. At that site, the 49 planters opted for mechanization, which led to an increase in

⁵³ These conditions were established by the Ministry of Environment and the *Morcellement* Board, which is a board regulating the parcelling of land fulfilling specified conditions.

sugar cane yield, an increase in sugar yield, and an increase in total cultivated area. The combined effects of regrouping productivity are presented in Table 16. There has also been a decrease in harvesting and transportation costs, through the adoption of mechanical harvesting practices. Costs have also been reduced for the planters through a 50 per cent reduction in weed control (as mechanical harvesters leave a blanket of residue) and in the avoidance of waste management (both before and after harvest), which resulted in a roughly 100 per cent cost saving for that operation.

Table 16: Impact of regrouping in cane and sugar yields based on the project at Queen Victoria

	Before project*	After project	Change (%)
Extent cultivated (ha)	90	92.7	3% increase
Number of plots	78	8	
Cane yield (t/ha)	80	100	12.5% increase
Sugar recovered (% cane)	10.0	10.80	10.8% increase
Total sugar yield (t/ha)	8.0	10.8	13.5% increase
Sugar accrued to planters (t/ha)	6.24	8.42	13.5% increase
Total sugar accrued to planters (t)	562	781	39% increase
Total sugar accrued to miller (t)	158	221	39% increase
Harvest and transport cost (MUR/t)	250	185	26% decrease

Notes: *averaged over an 8-year crop cycle. MAIFPS (2006).

The implementation of the project has established a synergy and trust between the two key stakeholders in the sugar industry – the small- and medium-sized growers and the sugar companies. It has also demonstrated that there is a future for the small-grower sector and has countered the perception that planters are conservative and averse to change. As a result, the growers have accepted the project, contribute to it, and feel a sense of ownership of it (which reflects a changing mindset from being assisted to being self reliant). The planters regrouped into a cooperative unit and can now benefit from economies of scale in operations and in the acquisition of major inputs (fertilizers and herbicides) and can take advantage of mechanization.⁵⁴

Increased cane production is beneficial both to the miller and to the grower. The miller will receive more cane in a reliable, sustainable and planned manner. The grower can use the additional cane to lower costs and maintain sustainable production levels.

The coarse and fine de-rocking and the type of land preparation undertaken, means that recourse to heavy agricultural machinery, such as crawler tractors or excavators, will be minimal or eliminated for the ensuing crop cycles. Thus land preparation for subsequent plantations can be undertaken using tractors at a lower cost.

The Sugar Planters Mechanical Pool Corporation has derived significant benefits namely, better machine efficiency, reduced downtime, and more importantly, capacity building for tractor operators. These operators did not have the opportunity to work on large plots and

⁵⁴ Regrouping small fields to form one large contiguous plot means that field boundaries, such as roads, so called “*Muraille Creole*”, or aligned rock boundaries between fields or hedges, have been eliminated, resulting in an increase in cultivable area.

have learnt from the corporate sector how to bulldoze and break huge boulders and carry furrowing over a relatively longer distance in a straight line. Sharing skills and technology in land preparation and cane planting between the corporate sector and the various operators has been possible. Opportunities have been provided to empower small- and medium-sized enterprises (SMEs) coming from the neighbouring villages in activities related to the project. Planters also benefit from advice from the MSIRI and the application of its research.

In the context of establishing the cane cluster around four sub-clusters, the MAAS Action introduced voluntary, negotiated, cane cultivation agreements between growers and millers, whereby the millers would, in consultation with the growers, organize the cultivation and harvesting of the cane. The goal was to move to a situation where the miller would buy standing cane from the growers. It could also encourage the establishment of several small- and medium-sized entities providing specialized services, with the resulting creation of sustainable employment. In addition, it would have a positive impact on the sucrose content of the cane, which would be harvested at the peak of its maturity.

Environmental and biodiversity impacts. From an environmental perspective, the changes in growing practices undertaken on the larger plots under the regrouping will encourage the adoption of Good Agricultural Practices or Good Management Practices (GMP) with regards to land management, fertilization, burning cane and timing of the harvest. The SEA has suggested that the mechanization of field operations and the regrouping of small growers is expected to improve soil management practices and is unlikely have any significant adverse impacts on soil. In order to ensure that the current trend towards green cane harvesting continues, the regrouped planters are discouraged from burning sugar cane in the context of mechanized harvesting. To ensure that all opportunities for establishing bio-corridors and for minimizing surface run-off are utilized, these projects ensure that sugar cane farming ceases in riparian zones (wetlands) along water courses and that adequate buffer zones are established along amelioration channels in the sugar cane fields. Such an approach has already been adopted in the first regrouping projects and should become standard practice.

Intensification. Regrouping of small-scale growers is changing the way that sugar cane is grown in Mauritius – moving it from a diverse habitat to a monoculture system of cultivation. Monoculture represents an extreme form of simplification of nature's biodiversity. The original flora and fauna is being replaced in vast areas by a simple ecosystem consisting of only sugar cane. Patches of natural vegetation (if present) often occur in areas unsuitable for sustaining the ecosystem associated with sugar cane, make a limited contribution to ecological stability, and are unsuitable for sustaining natural enemies. Larger areas under monoculture can directly affect the abundance and diversity of natural enemies (Altieri and Nicholls 2002). Studies show that specialized species usually exhibit higher abundance in monoculture than in diversified crop systems (Andow 1991). Recent reviews indicate that higher pest losses should be expected in more vulnerable ecosystems, usually mechanized, large-scale monocultures (Altieri and Nicholls 2002). Such systems represent highly disturbed systems exhibiting ecological conditions that may be more susceptible to colonization by invasive species. Herbivores with a narrower host range are more likely to colonize crops grown in pure stands and thus attain pest states in simplified agro-ecosystems (Smith and McSorely 2000). Detailed ecological studies carried out in Great Britain have shown the devastating effect of the intensification of agriculture on biodiversity (Krebs *et al.* 1999). Land use changes from complex natural ecosystems to

simplified managed ecosystems and intensification of resource use, have caused a drastic decline in biodiversity worldwide (Tschamntke *et al.* 2005).

The sugar cane environment under the MAAS will cause a decrease in landscape diversity. Having larger blocks and aggregation of fields, will increase the uniformity in terms of crop age and physical quality (Nicholls and Altieri 2007). There will also be a decrease in inter- and intra-specific diversity within the fields. Variations in crop age, cane variety and nutrient status among adjacent fields usually maintains a population of several pest species and natural enemies. Although competition among different pest species in sugar cane fields has not been studied, it is clear that stability is maintained when several species co-exist. Therefore, planting a homogenous crop over large areas will increase the chances of pest outbreaks.

De-rocking and mechanization. Associated interventions such as de-rocking and removal of rock piles in fields to facilitate mechanization of field operations, are designed to facilitate the implementation of the MAAS. Rock piles serve as habitat for several species of plants and act as source of food for many insects which, in turn, are preyed upon by several natural enemies. Removing the rock piles leads to a depletion of the food source for natural enemies, which might lead to an increase in pests of other crops. Rock piles also serve as niches for rodents and mongooses in sugar cane fields. With their removal, the rodent population could migrate to built-up areas causing public health problems. Also the population of the mongoose, which was introduced to control rats, would decrease.

The need to have large blocks to ease mechanization will lead to the destruction of wild vegetation along field borders. In the past, it was common to come across trees and shrubs among cane fields. Trees and shrubs serve as nesting sites for predatory birds (such as the Indian Mynah). In the absence of adequate nesting sites, these birds could migrate to urban areas and become a nuisance. Many species of *parasitoids* (such as *scoliid* wasps) need the nectar of the flowers of the shrubs to complete their development. Lack of suitable plants would impede their development and, over the long term, lead to pest infestations. These shrubs are also visited by honey bees, hover flies, and other pollinators. It is expected that the natural biological control agent-host plant-pest equilibrium would be negatively affected over the long term.

An example of the effect of the mechanical harvesting of sugar cane has been the re-appearance, since 1992, of army worms in young re-growth sugar cane.⁵⁵ Studies have shown up to a 16 per cent reduction in cane growth caused by this pest. Although *parasitoids* are present, their reaction time is too slow, and by the time they get into fields the damage has already been done. Insecticides are employed to control the army worm and

⁵⁵ Mechanized cane harvesting was attempted for the first time in 1976 and 1977 (MSIRI 1977; 1978). However, at that time army-worm outbreaks did not occur, probably because trash blanketing was not adopted and the machine-harvested area was small. In 1993, 11 per cent of the machine-harvested fields (representing 25 per cent of the area) showed moderate to severe damage while the presence of the pest was observed in all such fields (MSIRI 1994). Similar levels of infestation were observed in 1998 (MSIRI 1999). In other years, damage ranged between 4 per cent and 15 per cent of the area that had been machine-harvested (MSIRI 1995; 1997; 2000; 2002). The infestations occur in the young ratoons of fields that had been green harvested, as well as in those that had been burnt at previous harvest. Among the insects present six species have been identified, namely *M. loreyi*, *M. pseudoloreyi*, *M. insulicola*, *M. phaea*, *M. pyrausta* and *M. tinctoria* (Ganeshan and Rajabalee 1996; Ganeshan 2007). Damage occurs usually about four to five weeks after harvest and lasts for about three weeks (one generation only).

every year around 500 hectares are treated. With increasing areas under mechanized harvesting and the practice of trash blanketing, army worm damage will probably increase and insecticide use is expected to increase as well. Excessive use of insecticides will have negative effects on non-target organisms, such as trash feeding caterpillars, biological control agents, and some bird species.⁵⁶

Vetiver grass is a grass species commonly grown along field borders to prevent erosion. Apart from its role in soil conservation, vetiver grass has been found to attract stem borers and several other insect species away from sugar cane fields.⁵⁷ During the mechanization and de-rocking process, the cultivation of this grass is being phased out.

Sugar cane debris in fields has been found to be the primary breeding source for the stable fly *Stomoxys nigra* (Kunz and Monty 1976), encouraged by moisture and warm temperatures. Green-cane harvest accompanied by trash blanketing is the usual practice at present in machine-harvested fields. With increased areas under trash blanketing and irrigation, an increase in the population of stable flies is expected during summer.⁵⁸

Irrigation. Incidence of pests is influenced by water conditions. Crops are more susceptible to pests under water stress conditions. The increased and improved irrigation systems proposed in the MAAS will help reduce the occurrence of pests (such as borers and white scale). Recent studies have shown that the incidence of borers is closely related to humidity; regions with lower rainfall are more prone to damage. Irrigation can significantly reduce damage by this pest (Soma and Ganeshan 1999). However, irrigation systems such as the centre-pivot, can actually spread pests, such as soft scale, from infested areas to non-infested areas. This requires the careful management of the cultivation and the use of appropriate techniques to manage the pest in synergy with the irrigation technique.

Box 1 presents the results of the impacts of the regrouping of small sugar cane growers. A complete report of the survey is attached to this report as Annex 4.

⁵⁶ Such as the Village Weaver (*Ploceus cucullatus*) and the Indian Mynah (*Acridoteres tristis*).

⁵⁷ The potential of vetiver grass both as a trap crop to attract the stem borer *Chilo partellus* out of maize fields and as a refuge for natural enemies has been demonstrated in South Africa (Van den Berg *et al.* 2001).

⁵⁸ Kunz and Monty (1976) found that the adults could fly up to 3 kilometres, and so attempts to control stable flies at their breeding sites is of limited value.

Box 1: Result of the survey undertaken with growers under the regrouping schemes

The findings of the field survey carried out among small- and medium-sized sugar cane growers under the regrouping schemes showed that:

- Most farmers were willing to regroup themselves with the incentives provided by the Government (de-rocking, carting away rocks, land planning, planting cane, fertilization, weed control, building of farm roads, and drains).
- Faced with an acute shortage of hired labour and the absence of family labour, sugar cane growers preferred management by the cooperative.
- The main advantage to formally regrouping was the benefit from economies of scale and opportunities to mechanize on a larger piece of land. The costs of production (per tonne of cane) were reduced dramatically and amounted to roughly MUR5 000 per hectare (equivalent to an overall reduction in operating costs of 20 per cent). These cost savings are summarized below.

Operation	Cost per hectare in adjacent fields not under regrouping project	Cost per hectare in fields under regrouping projects
Weed control	MUR3 500	MUR2 500
Trash lining	MUR1 400	0
Harvest and loading	MUR7 000	MUR5 200
Transport	MUR3 100	MUR2 600

- Planters were able to recover uncultivated areas (such as those occupied by rock piles). The value of their land increased, despite decreasing trends in the value of agricultural land.
- The impact on biodiversity appeared to be negative since only one variety of sugar cane was being planted over large areas.
- The rational use of agrochemicals and improved drainage systems was positive.
- The cane yield of the newly introduced cane variety (M 1400/86) was 18.38 t/ha compared to 15.6 t/ha for the previously grown cane variety (R 570).
- Increasing numbers of growers will join the regrouping scheme. The younger generation are mainly part-time farmers with limited knowledge of sugar cane cultivation. For them, regrouping is a viable option.
- Herbicide use reduced the wide range of weeds and some fauna and flora providing habitat and food disappeared due to removal of rocks and the non-cultivated borders.
- Planters were detached from their land and family labour became redundant. The labour force living in the vicinity of the farm were made redundant and had to seek jobs with contractors. They may thus have had to travel further distances to work.
- It is not yet known what the full extent of the impacts will be after the initial seven-year period of the project.

Table 17: Summary of changes and impacts of MAAS policy: FORIP

Policy measures	Changes required	Economic impacts	Social impacts	Environmental and biodiversity impacts
FORIP <i>funded by EU accompanying measures, global cess and contribution from planters, sale of rocks to stone crusher and with management support and supervision from corporate sector</i>	<ul style="list-style-type: none"> • Covers some 28 000 growers on around 15 000 hectares. • Canvassing of planters in very difficult areas. • Adoption of recommended crop varieties, cultural practices, fertilizers, herbicides and mechanization. • SPMPC involved in de-rocking, land preparation, and furrowing. • Removal of boundaries around individual fields. • Land is fully or partially mechanized. • Introduction of modern and efficient irrigation systems. 	<ul style="list-style-type: none"> • Regrouping to 100 hectare blocks for economies of scale in harvesting, transport, bulk purchase and application of inputs, abandonment or increase in sugar cane yield. • Improve cane and sugar yield per unit area (a 17% increase in the total sugar accrued to millers). • A 26% decrease in harvest and transport cost (MUR/t). • A 20% reduction in costs of production. • Improved road infrastructure and transport facilities. • Adoption of modern irrigation system on 130 hectares. • Better machine efficiency. • Elimination of rock boundaries leads to an increase in cultivable area. • Sale of rocks to stone crushers. • Lower initial capital cost. • Contribution from growers to irrigation and payment for metered water. 	<ul style="list-style-type: none"> • 28 000 small- and medium-sized growers to benefit from the regrouping scheme • A change in mindset from being assisted to self dependent. • Some 830 growers have already regrouped into a cooperative unit have more free time and are trained to run the system. • Development of SMEs for land preparation, cultural practices and mechanization. • Perception of growers as conservative has changed. • Synergy and trust between small- and medium-sized growers and sugar companies, sharing skills and technology. • Encourage community cohesion. • Casual labour in the vicinity will become redundant. 	<ul style="list-style-type: none"> • Improved soil management through farm planning, upgrading drains, and minimal runoff. • No significant adverse impacts of mechanization on soil quality. • Removal of rock piles leads to the depletion of food sources for natural enemies, which might lead to an increase in pests and public health problems. • Destruction of wild vegetation, trees and shrubs along field borders and corners, which serve as nesting sites for predatory birds that could migrate to developed areas and become a nuisance. • Vetiver grass common along field borders has been found to attract stem borers and is being phased out. • Green cane harvesting. • Change from a diverse habitat to intensive monoculture affects abundance and diversity of natural enemies. • Original flora and fauna is replaced in large areas by a simple ecosystem consisting of only sugar cane. • Sugar cane environment with the MAAS will cause a decrease in landscape diversity. • Larger blocks and aggregation of fields will increase uniformity of crop age and physical quality. • With increased areas under trash blanketing and irrigation, an increase in the population of stable flies is expected during summer. • Increased and improved irrigation systems will help reduce pests like borers and white scale. • Centre-pivot irrigation can spread pests such as soft scale from infested areas to non-infested areas.

7.2.1.5 Sustaining sugar cane production in marginal areas

Under the MAAS, policy measures directed at marginal areas will address two types of land, marginal land remaining under sugar cane production and land removed from cane production. With respect to land remaining under cane production, the Government of Mauritius will sustain sugar cane cultivation for social and environmental reasons. This will be achieved through incentives for regrouping small- and medium-sized sugar cane

growers, and providing financial support for social and environmental reasons (as is made available in the EU) to those operating in mountainous and difficult regions. *Metayers* and small growers would benefit from such measures. The MAAS has proposed a grant of MUR20 000 per hectare for 2 000 hectares, beginning in 2008 (a year when prices drop by 17 per cent) and running until 2015. However, providing financial support may not be a viable solution in the long term and there is a high probability that these lands will ultimately move out of sugar cane and either be abandoned or used for other purposes.

Economic impacts. Providing financial support to sustain sugar cane production in marginal areas would require direct support of MUR40 million annually, between 2008 and 2015, amounting to MRU320 million. In the short term, however, this support does not ensure the long-term sustainability of the project. Sustaining sugar cane in these areas will also contribute €10.6 million in the form of sugar, electricity production, and ethanol.

Social impacts. Maintaining sugar cane will ensure the livelihood of small farmers and *metayers* and sustain the jobs of those living in the vicinity of the environmentally sensitive areas. This primarily concerns women and family labour involved in lining cane trash and applying fertilizers. Some 2 500 artisanal fishermen who depend on the resources in lagoons will also be spared, as damage to lagoons from erosion and sedimentation would no longer be a threat if sugar cane cultivation ceased.

Environmental impacts. The root structure of the sugar cane, the minimal disturbance of the soil under the common seven to ten year ratoon crop cycle, and the large volume of mulch and organic matter left after harvest, contribute significantly to erosion control on sloping lands. In addition, the limited volume of pesticides required by sugar cane gives it an advantage over other horticultural crops. Maintaining sugar cane will prevent invasions by alien species.

7.2.1.6 Electricity production

Economic impacts. From an economic perspective, the new power plants have increased the contribution of bagasse to the Mauritian national energy stock. Electricity produced from bagasse has increased from 300 GWh to 425 GWh. Incremental electricity from bagasse amounts to some 85 million GWh and avoids the use of roughly 50 000 tonnes of coal. Moreover, the power plants produce cheaper energy than power plants using diesel. This additional energy production also reduces the need to import fossil fuels, or expand existing fossil fuel facilities, reduces the impact of volatile global energy prices on the Mauritian economy, and has the potential to attract Carbon Emission Reduction credits under the Kyoto Protocol.

Social impacts. The new plants, which have adopted state-of-the-art technology and must adhere to strict operational guidelines, have created employment for a new generation of highly skilled power plant operators and engineers. Employees and growers, as partners in the power plants, are entitled to revenue distributed by the power companies.

Environmental impacts. With the implementation of the CTSav power plant, three other plants have been closed down.⁵⁹ The negative impacts on air quality (through emissions of particulate matter) and on water quality (through effluents) from these plants, has been

⁵⁹ Riche en Eau, Mon Tresor, Mon Desert, and Savannah.

eliminated. CTSav has adopted electrostatic precipitators which efficiently reduce particulate matter emissions to levels that are well below the maximum permissible levels specified in Mauritian and European standards. Moreover, avoiding the use of coal has lowered emission of CO₂ by roughly 150 000 tonnes per year.

Nevertheless, the CTSav plant burns some coal as a complementary fuel and generates a significant amount of coal ash. This ash contains metals which, if not properly handled, could enter the process waters. However, the higher capacity plant uses less water and has treatment plants that can reduce the levels of pollution in the effluent water.

The European Commission has addressed the issues linked to the environment in the SEA of the MAAS. This report noted that the installation of new coal and bagasse power plants in the remaining mills (FUEL and Medine) and the extension of the capacity of the CTSav plant (through an additional unit of 25 MW) would improve the efficient use bagasses as an energy source and reduce Mauritius's reliance on imports of heavy oil. Any relative energy losses during the combustion of the coal at the modernized co-generation units would be offset and, on balance, benefits would accrue from burning bagasse. Modernizing current combustion and flue gas treatment technologies at FUEL and Medine could also significantly reduce emissions of pollutants (especially particulate matters). The modernization is not expected to reduce emissions of SO₂ and NO₂, which are expected to remain well below international standards. Indeed, they may decrease further if existing commercially viable technologies are used to replace grate-firing boilers or pulverized fuel firing. Several options exist for the safe use of coal ash resulting from the use of coal during off-crop operations of these plants.

In addition, the SEA recommended that EU support to the MAAS should promote the upgrading of co-generation plants and should encourage the use of modern combustion technologies.⁶⁰ It recommended that the environmental impact assessment study for future power generation facilities should satisfy the requirements of the Ministry of Environment and include a proper and comprehensive air modelling exercise. It also recommended that all power generation facilities in the sugar cane cluster gradually develop an International Organization for Standardization-certified environmental management system. The basic monitoring system for the quality of the coal used in the co-generation plants, and procedure for consulting Ministry of Environment and National Development Unit on changes of the coal quality, also need to be established.

CTSav 1 and 2 have signed a Memorandum of Understanding (MOU) for the sale of Carbon Emission Reduction credits to a specialized agency of the World Bank and procedures to secure the relevant Clean Development Mechanism approvals are under way. Credits accrued would, pursuant to the Power Purchase Agreement of CTSav 1 and 2, be passed on to the Central Electricity Board, thereby decreasing its net cost of purchase. The relevant authorities have evaluated the request and the methodology for evaluating bagasse/coal power plants has to be established and validated before the application can be proceed.

⁶⁰ Such as the use of 110 bar steam pressure boilers and turbo-generators for steam extraction and condensing, careful control of moisture contents of bagasse, and use of topping/combined cycles or fluidised bed combustion processes

Table 18: Summary of changes and impacts of MAAS policy: Electricity production

Policy measures	Changes required	Economic impacts	Social impacts	Environmental and biodiversity impacts
Electricity production	<ul style="list-style-type: none"> • Increase electricity production from bagasse. • Increase capacity of power plant. • Improve stack emission controls. 	<ul style="list-style-type: none"> • New power plant has increased contribution of bagasse -- electricity produced from bagasse increased from 300 to 425 GWh. • Power plant produces cheaper energy than the those using diesel • Reduced import of fossil fuel and need to expand existing fossil fuel plants. • Reduced impact of world energy price. • Attracts Carbon Emission Reduction credits. 	<ul style="list-style-type: none"> • Employment of a new generation of highly skilled power plant operators and engineers. • Employees and planters are partners and entitled to revenue distributed by the power companies. 	<ul style="list-style-type: none"> • Closure of three continuous power plants and investment in new technologies is likely to have positive impacts on air quality (use of ESP versus wet scrubbers). • Positive impacts on water quality (reduction in number of hot water discharge points 1 versus 3) – impact on fewer receiving water bodies. • SO₂ and NO₂ emissions avoided. • Ash from the power plant if not properly handled could end up in process waters. • Modernizing current combustion and flue gas treatment technologies can reduce emissions of pollutants especially particulate matters below permissible levels.

7.2.1.7 Ethanol production

Economic impacts. From the economic perspective, the production of ethanol and its use locally or overseas in a unit where all stakeholders of the sugar industry are shareholders will enable sugar producers, large and small, to fully capture whatever value is added. This would be welcome revenue at a time when sugar prices are falling. At present there is no policy to require the use of blended fuel in vehicle fleets. Such a policy is under consideration, but it is clear that countries that have pursued an ethanol and gasoline blend have adopted a mandatory blending route. There is also currently no pricing policy for the sale of ethanol. However, it is economically viable to produce ethanol from molasses, when oil prices are around US\$60 per barrel. Cost savings are available to vertically integrated power plant and production facilities as there is no need to transport the molasses long distances to a distillery, which saves on transportation costs and lowers production costs. Therefore, the production of ethanol has complementarities with the production of direct consumption white sugar.

Environmental and biodiversity impacts. From an environmental perspective, the production of ethanol will displace emissions of SO₂, and could qualify projects for receiving Carbon Emission Reduction credits. However, the SEA of the MAAS highlighted that producing 30 million litres of ethanol annually from molasses will generate approximately 350 000m³ of vinasse. Such volumes of vinasse can be safely managed – provided that all precautionary measures proposed in this SEA are implemented – through a combination of composting, direct application on fields located at least 100m from residential areas, or through concentration of vinasse into molasses stillage and its application on fields. It is important to ensure that adequate risk management plans are prepared for all vinasse management options, and that safety management plans are developed with respect to the transportation of ethanol from production sites, and for storage and export facilities.

Social impacts. From a social perspective impacts are expected to be positive for both producers and consumers. The policy will maximize earnings for producers while making ethanol available at a low cost to consumers.

Table 19: Summary of changes and impacts of MAAS policy: Ethanol production

Policy measures	Changes required	Economic impacts	Social impacts	Environmental and biodiversity impacts
Ethanol production	<ul style="list-style-type: none"> • Target ethanol production to 30 million litres. 	<ul style="list-style-type: none"> • Ethanol production will enable sugar producers to fully capture value added, increasing revenues when prices of sugar are dropping. • Blend of ethanol with gasoline for use in vehicles. • Pricing policy for the sale of ethanol. • No revenue from molasses. • Lower cost of producing ethanol. • Synergies with white sugar production. • No transport of molasses from sugar factory to distillery (no need for fuel). 	<ul style="list-style-type: none"> • Maximum earnings for producers. • Cheaper cost of ethanol to consumers. 	<ul style="list-style-type: none"> • Avoid emission of SO₂. • Project qualifies for Carbon Emission Reduction credits. • Disposal of the highly polluting liquid effluent vinasse, which is expected to increase to 350 000 m³ can be a threat to water bodies. • Concentration of vinasse into a concentrated molasses stillage enriched with urea to be used as fertilizer. • Use of vinasse as a source of potassium in fields may allow reduction in use of inorganic fertilizer.

7.2.2 Moving out of sugar cane production in marginal areas

Despite pressures to sustain sugar cane in marginal areas for environmental and social reasons a substantial part of these lands will likely be converted to other uses. The IA identified the following three likely options for these areas:

1. abandonment of land under sugar cane cultivation;
2. conversion to agricultural uses other than sugar cane; and
3. conversion to non-agricultural uses.

With reduction in investment due to low revenue there is risk of gradual abandonment of the marginal lands and its colonization with invasive alien species. This would result in a shortfall of €10.6 million in terms of sugar, electricity, and ethanol production, and adversely affect the livelihood of many small planters and *metayers* (and female labour) involved in labour intensive growing operations. Loss of sugar cane in these marginal areas would accelerate soil erosion leading to sedimentation and eutrophication in downstream reservoirs or lagoons. It would also cause a loss in the aesthetic green landscape, which is an asset to the Mauritian tourism industry.

Alternatively, the conversion of marginal lands on the seaward side to food crop production would likely increase soil manipulation and the use of agrochemicals. The changes in agricultural practices would increase the risk of soil erosion and the pollution of waterways and nearby lagoons, negatively affecting the livelihood of artisanal fishermen. The change in land use would require additional investment to provide amenities and irrigation facilities to ensure sustainable production. Shifting to livestock activities presents some risks with respect to solid waste and effluent management. On the other hand, conversion to agroforestry would gradually help to control soil erosion and land degradation, while providing habitats and ecosystem services. The conversion to other agricultural uses will in turn also contribute to ensure food security in the country. Effective land-use planning and the

adoption of appropriate environmental guidelines could help mitigate the environmental concerns.

Besides providing opportunities for jobs and leisure facilities for villagers in the vicinity of the marginal areas, the conversion of sugar cane land to non-agricultural uses, such as residential areas, integrated resort, golf courses, and ecotourism projects could encourage soil erosion and land degradation. If poorly designed and where they have not been subject to strict EIA requirements, these types of developments could have significant and hazardous off-site effects. The heavy use of agrochemicals on golf courses could create negative environmental effects on nearby rivers and lagoons.

The potential economic, social and environmental impacts associated with each option are considered below.

7.2.2.1 Abandonment of sugar cane cultivation

The impacts discussed below relate to the marginal areas covering 4 642 hectares, located on the seaward mountain slopes, which are considered environmentally sensitive (Category A). Three quarters of production in the marginal areas is undertaken by small growers.

Economic impacts. The withdrawal of 4 642 hectares from sugar cane production would result in the potential loss of the production of around 32 500 tonnes of sugar. This represents around 6 per cent of the production level of sugar projected for the next decade (550 000 tonnes). It is equivalent to a loss in revenue of about €8 million and a loss of 39 GWh of electricity valued at around €1.7 million (assuming future plants would generate 130 KWh from one tonne of cane). A further shortfall of €750 000 would arise from ethanol production (assuming 1 tonne of molasses yields 240 litres of ethanol). The aggregate gross shortfall from the production of sugar, electricity and ethanol would be around €10.6 million.

Social impacts

- ***Loss of employment opportunities for women.*** Sugar cane cultivation on these mountain slopes depends heavily on the work of women (78 210 man days compared to 341 250 woman days). Women are typically recruited to labour-intensive growing operations such as scum application, placement and covering of setts, weeding, and trash lining. For small-scale growers, the variation in labour requirement per unit area is due mainly to gender preference for a particular field operation and the date of planting. In the case of millers and large-scale growers where cane burning has enabled the suppression of trashing and trash lining, the mean annual demand per hectare for female labour was much lower than that for small-scale growers (20 versus 93 woman days). The mean number of man days per hectare was slightly lower than that of small-scale growers (14 versus 18). On the basis of this information, it is clear that if sugar cane cultivation on the mountain slopes were abandoned, female workers and family labour would be the major losers.
- ***Reduced incomes for villagers.*** The marginal areas are cultivated mainly by *metayers* and small-scale growers, and removing production from these areas would affect them negatively. All the labour associated with field operations, such as planting, thrashing, fertilizer application, herbicide application, trash lining, harvesting, loading, and transport would disappear, which would affect the vitality

of entire villages in the area. The deterioration of the standard of living of these labourers would have a negative impact on small businesses that service the villages, and lead to an overall drop in income levels.

- **Threats to tourism and artisanal fishing.** Scenery, such as that offered by the cane fields on mountain slopes, is an invaluable asset to the tourism industry. Moreover, sugar cane prevents soil erosion and pollution of the nearby lagoons, which enables the promotion of lagoon-based economic activities in the tourism sector and the continuation of artisanal fishing. Large-scale abandonment of sugar cane fields on the seaward mountain slopes could render the lagoon less favourable for water-based economic activities such as tourism and artisanal fishing. Deterioration of the water quality in the lagoon as a result of sedimentation and eutrophication could have a direct impact on the hotels close to the marginal areas. In 2005, the tourism and artisanal fishing sectors directly employed some 7 503 people and any job losses in these sectors would be in addition to the unemployment that results from an abandonment of production. In addition, the indirect jobs, especially those based in the village (such as transport and retail) would be adversely affected by any negative impacts on hotels. Unemployment in several sectors could lead to the partial collapse of the surrounding villages, with low-income households being the worst affected.

Environmental and biodiversity impacts. The end of production of sugar cane in marginal areas could affect both inland biodiversity (reservoirs and rivers) and disrupt the beach-lagoon-reef equilibrium. For around 5 000 hectares (mainly Category A), conversion to less stable uses could accelerate erosion and lead to sedimentation and eutrophication in downstream reservoirs or lagoons.⁶¹ This could have a negative impact on water supplies and on aquatic biodiversity. The impact of sedimentation would be particularly significant on coral reefs. The specific effects on biodiversity of abandonment will depend on the previous state of the land. In general, in the short term, gains for biodiversity would be slow but could gradually increase. However, not all biodiversity gains are necessarily beneficial. For example, several colonizing weed species attract pests that attack cultivated crops, which could increase the need for pesticides. On the other hand, other species may attract natural predators.⁶²

7.2.2.2 Conversion to other agricultural uses

The second option involves the conversion of marginal areas to other agricultural uses, such as food crop production, livestock and agro-forestry. Between 2001 and 2005, 6 000 hectares of sugar cane lands were converted to other uses. This implies that, on average, 1 200 hectares per year (approximately 1.6 per cent of land under sugar cane production)

⁶¹ Data available on soil erosion on the mountain slope in the region of Bel Ombre and St Felix regions are quite alarming. A study carried out in 2001 showed that at Bel Ombre (altitude 59m), soil loss on bare plots would on average be around 25 t/ha per year in contrast to less than five t/ha per year for plots under standing sugar cane crop (MSIRI 2005) while at St Felix (altitude 329m) the soil loss on the bare plots was several folds higher than the cropped ones. The large difference between bare and planted plots is a clear indication of the sugar cane being a perennial crop with good land cover that has low negative impacts on the environment on these slopes and the nearby lagoons.

⁶² A common coloniser is the weed *Brassica* sp. This plant is heavily infested with aphids and mites and will favour the development of aphid parasitoids and predators. Other invasive weeds which are likely to colonise abandoned areas are the *Lantana camara*, *Rubus alceifolius*, *Panicum* spp., *Paspalum* spp., etc. These plants are infested by several species of pests that could affect cultivated crops.

was lost during that period. Observations show that the trend is increasing. According to the Chamber of Agriculture, 1 700 hectares of sugar cane lands were converted to other uses in 2006.

The millers and large-scale growers have begun the process of converting parts of their land to uses that they consider to be more profitable than sugar. These include palm cultivation, raising deer, or developing tourism services. It is expected that over the medium and long terms, small farmers will also opt for alternate agricultural activities. Because the marginal areas are ecologically sensitive and prone to degradation, the choice of alternative crops is crucial and the impacts of diversification could vary depending on the specific agro-climatic characteristics of a specific category of land. The SEA stipulated that any conversion of these lands to other uses needs to be properly managed through site-specific planning approaches.

The Government of Mauritius has set a target to reach 70 per cent food self-sufficiency by 2015. This should be taken into account when considering alternate crops. However, the option to use food crops to replace sugar cane on marginal lands will depend primarily on the economic viability and adaptability of the crops under the rain-fed conditions. The use of traditional cultivation practice poses several problems due to the heavy reliance on chemicals inputs for the management of pests and to amend the soil. Unlike sugar cane, biological control of pests of food crops is not readily accepted by small-scale farmers who have a tendency to apply insecticides for pest control.

The strategic crops proposed for cultivation are maize, potato, onion, pulses, and soybean. The main pests of these crops are all controlled by the application of insecticides. Increasing areas under food crops will invariably lead to an increase in pesticide use with negative effects, such as development of resistant populations, pest resurgence, environmental effects, and health hazards. Increases in the use of pesticides will also raise costs of production.⁶³ Several species of nematodes have been identified on sugar cane lands (Lamberti *et al.* 1987). Severe infestations of nematodes in food crops could reduce yields and lead to an increase in the use of pesticides following conversion.⁶⁴

From an environment perspective, food crops and mixed cropping are short-term activities that are relatively prone to pests and diseases, have high water requirements, shallow root systems, and cannot bind the soil effectively. Being a short-cycle crop, the soil has to be worked frequently thereby disturbing its structure and encouraging erosion. It has been recommended that appropriate soil conservation techniques, such as contour farming, strip cropping, and terracing, be adopted to mitigate erosion.

From an economic perspective, the scenario is viable in light of the Government's policy to attain self sufficiency in a number of agricultural commodities. However, some of the alternatives may not provide tangible economic benefits, but will be very useful in terms of

⁶³ An integrated pest management approach has been recommended for the potato. The main component of any integrated pest management strategy is the monitoring of fields for the timely application of selective pesticides.

⁶⁴ It is not economically viable to control nematodes in sugar cane and no attempt has been made to do so. The root-knot nematode *Meloidogyne javanica* has been recorded from tomato, pepper, egg-plant, cucurbits, ginger and onion (Lambertii and Taylor 1979) and *Paralongidorus buchae* has been recorded on chilli. Severe infestation by *Meloidogyne* caused up to a 50 per cent loss in carrot production at Mon Desert Alma and Medine (expert observation).

the environment, as levels of biodiversity could be increased significantly. Several alternatives have been proposed for the marginal areas now under sugar cane cultivation, including the following:

- **Environmentally suitable perennials:** this could include the large-scale cultivation of new palm species (*pejibaye*) along with a cover crop;⁶⁵
- **Cultivation of crops and fruit trees:** such as mixed orchards, which would increase biodiversity and exploit local underutilized fruit species;⁶⁶
- **Protected flower cultivation:** the main limitation is the remoteness of the area and the absence of electricity and water supply for greenhouse production;⁶⁷
- **Cultivation of fibre crops:** for use in the artisanal industry (*vacoas* and jute), these crops can provide a source of livelihood for women and villagers who make handicrafts for the tourist sector;
- **Livestock and/or fodder production:** livestock activities viable in the marginal areas include raising goats and sheep for meat, dairy farming, deer ranching, poultry farming (confined system) and fodder production;⁶⁸ and
- **Cultivation of energy crops:** crops such as *Jatropha spp.* and *Pongamia spp.* could produce alternative sources of energy.⁶⁹

Agro-forestry. Some of the very marginal lands on the steep mountains slopes could best be converted back to productive or conservation forestry, especially those found in the

⁶⁵ Palm production for fresh consumption or as pickle and other transformed products are alternatives. Palm heart is a high value exotic product still restricted to the tourist industry and has the potential for large scale exploitation. To achieve economies of scale around 1 hectare of land will be required for a plantation. Currently the variety *Pejibaye* as well as Royal Palm has been found promising and is recommended for these areas. Large sugar cane growers have started shifting to palm plantation in marginal lands mainly on sloping areas. However, due consideration has to be given to attend to soil conservation measures including the use of cover crops. For palm production to be successful, the projects must be implemented in a coherent and integrated manner that would make them economic viable as well as socially acceptable. In the development of any project the fact that small sugar cane planters do not generally have full expertise in farming other crops should be taken into consideration. Further, an appropriate cover crop should be identified that will enrich the soil and at the same time increase biodiversity.

⁶⁶ Suitable crops for mix cropping include creepers (such as cucumber, pumpkin, and calabash), crucifers (such as cabbage, cauliflower, and broccoli), carrot, bean, squash, and chilli. Spices like coriander, thyme, spring onion, parsley and mint, shallots and cardamom cultivation are good alternatives. Seed and seedling production activities have also been found to have good potential. Banana is the most suitable fruit that can be exploited in these areas. Citrus (especially mandarins), passion fruit, and guavas are also viable alternatives. Strawberries can be produced under protected cultivation using low tunnels. Cultivation of pineapple under plastic mulch on the high ground is also appropriate.

⁶⁷ Anthurium, gladiolus, liliun, rose, alphinia, heliconia, bird of paradise and *Gerbera* can be produced. The production of orchids and foliage plants (ferns and other decorative plants) under protected culture is also possible in these areas. The use of greenhouses (mainly plastic tunnels) for the production of selected crops offers a good opportunity, as it overcomes some of the limitations of the adverse climate.

⁶⁸ Livestock activities can cater to the local meat and milk demand and help small farmers earn a livelihood while sustaining the economic viability of the nearby villages. The provision of amenities such water and electricity supply is required to undertake some of these activities. The intensification of deer ranching is a viable alternative that will help make venison available year-round and reduce the need to import meat. Plantations of fodder species (elephant grass, setaria grass, rhodes grass, *herbe d'argent* and *herbe bourrique*) offer a new opportunity for marginal lands in the ex-tea areas. Fodder yield is estimated at around 100 t/ha under good management practices.

⁶⁹ In the context of the increasing demand for energy, the rising price of oil and the Government's policy to promote the concept of *Maurice Île Durable* (a policy targeting the use of renewable energy and sustainable technologies).

immediate vicinity of reservoirs, water bodies, and alongside rivers. Forestry would provide invaluable ecological services for reservoirs and catchment areas.⁷⁰

The New Forest Policy (2006) proposed the establishment of forests with multi-purpose tree species in combination with agricultural and horticultural crops for agro-forestry, deer ranching and ecotourism on some 7 000 hectares. Serious attention should be given to the establishment of protected forests, nature parks, or other agro-forestry projects using native species in marginal sugar cane areas. Both small and large areas of protective forests or agro-forestry lands may also become viable for generating revenue, if economies of scale are achieved in this emerging sector. The practical implementation of these projects may, however, be constrained by the rental and ownership rights of the current land users. Such projects would also require a package of adequate support measures necessary to smooth the transition from sugar cane cultivation.

In the implementation of the forestry and agro-forestry scenario for the marginal areas, biodiversity should be managed to ensure conservation of habitats and ecosystems, protection of native fauna and flora, and enhanced crop and animal production to meet the food, health, and other socio-economic needs of the villages in the area. Viable populations of naturally occurring species should be maintained to ensure that biodiversity continues to evolve.

Although managed agro-forestry often supports diversity, the choice of tree species is important to reduce risks of the spread of invasive species. Birds, honey bees, and other pollinators will benefit from agro-forestry. Fruit bats, which are becoming pests of cultivated fruits, could be attracted to agro-forestry areas rather fruit trees. On the other hand, the population of bats may also increase and a study of the bat population should be undertaken. Overall, managed agro-forestry would encourage faunal diversity.

Economic impacts. To avoid adverse economic, social and environmental impacts, it is important that any alternative agricultural activities on the mountain slopes have the same multifunctional role as sugar cane. Therefore, the identification and selection of alternate agricultural activities should satisfy the following criteria:

- environmental sustainability;
- agronomic sustainability (long-term yield stability);
- economic viability (projects do not rely on support measures);
- capacity to absorb part of the displaced agricultural labour force; and
- potential contribution to development (for example, small business).

Agronomic sustainability and economic viability will help prevent the socio-economic degradation of the villages concerned. Ultimately, the decision of sugar cane planters (large and small) to opt for other crops, pasture lands, or agro-forestry, in lieu of sugar cane, will be governed by economic considerations. However, consideration should be given to ensuring that the use of these lands assists the country to meet its demand for food, reduce imports, maintain food security, and achieve some degree of self sufficiency.

⁷⁰ Productive forest may include trees such as pine and or eucalyptus trees combined with fodder species like *herbe bourrique*, elephant grass, setaria grass and *herbe d'argent*. Pine trees have been successfully grown and some species like bois noir, giant acacia, and *sesbania* sp. can also be exploited.

Social impacts. Soil erosion due to changes in land use will lead to the leaching of chemicals (fertilizers and pesticides), and sedimentation and eutrophication in downstream reservoirs or lagoons, and have a negative impact on water supplies and on aquatic biodiversity. The lagoon-coral reef equilibrium would be disturbed, having a direct and negative impact on the tourist industry and on the 2 500 fishermen engaged in the coastal fishery. This would have severe social consequences, similar to the impacts of abandonment presented under the first option. On the other hand, increased food-crop production would contribute to the Government's goal of achieving food security.

Environmental and biodiversity impacts. Soil erosion from the use of less stable land may cause sedimentation and eutrophication in downstream reservoirs or lagoons, which would have a negative impact on water supplies and on aquatic biodiversity. The effect could be particularly significant on the coral reef, where sedimentation would have a severe impact. The future of some 2 500 fishermen engaged in coastal fishing could also be seriously affected. The maintenance of sugar cane cultivation will help prevent soil erosion in the steeply sloped marginal areas (such as those in the south of the island).

Growing food crops, which generally have a short crop cycle, demands more soil manipulation, agrochemicals and water compared to sugar cane. The heavy use of fertilizers and pesticides will have adverse impact on ground water quality, especially if combined with improper management practices. The absence of proper livestock management systems may result in negative environmental impacts such as poor solid waste and effluent management or disposal, and overgrazing (cattle, goat and sheep) that may expose the land to soil erosion.

Intensification of dairy farming and deer ranching is likely to increase the population of stable flies (*Stomoxys* spp.) and ticks (*Boophilus* spp.). In these cases biological control alone may not be effective and chemical controls may be required. The increase in the population of stable flies may also become a nuisance for the public as humans are also affected by this pest.

The development of agro-forestry will provide environmental benefits by increasing the diversity of fauna and flora and at the same time protect the land from soil erosion. The implementation of agro-forestry should be properly managed to avoid risks of spread of invasive species. For example, two new species of pest – *Glycaspis brimblecombei* and *Oophelimus maskelii* – were recorded recently, from *Eucalyptus* spp.

Shifting from sugar cane to food crop production will encourage the production of a wider variety of crop biodiversity, mainly horticultural crops.

7.2.2.3 Conversion to non-agricultural uses

The third option for the marginal areas involves its conversion to non-agricultural uses, such as IRS, real estate development, ecotourism or residential development. The Government recognizes that there is great potential for more growth in the tourism industry and associated IRS projects. However, if the tourism industry is to be sustained, it is of crucial importance that the natural resources that nurture this industry be safeguarded. Mauritius must have a competitive edge on other countries offering similar tourism services and IRS projects, coupled with environmental quality, can provide a further competitive

edge. IRS projects aimed at low density development (where only 15 per cent of the plot size will be used for development), in harmony with nature, will result in a win-win situation for the protection of natural habitats.

The conversion to IRSs of sugar cane lands in marginal areas and of productive land represents a very serious long-term environmental risk. Therefore, any conversion of sugar cane lands to IRS, residential zones, and golf courses in the coastal areas are allowed to proceed only after the completion of an environmental assessment, undertaken for the entire plan. This involves in-depth site specific investigations of the quality of the receiving water bodies and analysis of the cumulative impacts of the proposed land-use options. It is also important to ensure that all new urban development zones provide a sewer network available to all homes and include basic wastewater treatment facilities for both sewage and grey water. Since 2005, the conversion of some 657 hectares of land under sugar cane production has been approved for the development seven IRS projects.

Ecotourism is an activity that is becoming more popular as an alternative source of revenue. There has been a shift in the mentality of traditional tourists as increasing numbers of people are visiting forests for leisure activities such as hunting, hiking, camping, picnicking, collecting wild fruits, and observing wildlife and birds. The annual revenue from ecotourism is estimated at US\$5 million and it is a viable alternative economic use for the marginal areas.

In the context of the project, *Maurice Île Durable*, the establishment of wind farms combined with cane in some areas that are moving away from sugar cane production is a possibility for future use. The Bel Ombre, St Félix, St Antoine, Gris Gris and Grand Bassin regions are potential sites for such activities. Bel Ombre and St Félix are considered marginal areas.

Socio-economic impacts. The IRS projects have multiple benefits on society through their large contribution to leisure, employment, and income generation. They also play an important role in promoting art and culture, by providing local residents with a venue where they can sell their goods, display artisanal work, and share their culture. Opportunities are provided to local artists and musicians to participate in open air displays and shows.

Environmental and biodiversity impacts. With respect to biodiversity, IRS projects rely heavily on the preservation of habitat preservation and the natural assets in a particular site, and on the prospect of introducing appropriate plants for specific types of environment. The long-term economic sustainability of the projects is linked to ecosystem and habitat. However, there are no defined policies to integrate biodiversity issues into the planning and development of IRS projects. Specific impact that could arise, include the following:

- **Golf courses.** Golf courses associated with IRS project are located mainly on areas with sandy soil, near the coast. Heavy applications of insecticides and fertilizers could leach into the lagoons and affect aquatic diversity. The main pest problems on golf courses are webworms and nematodes, which are controlled through the application of large amounts of pesticides. The environmental concerns surrounding IRS project are addressed in EIA studies, and an IRS development permit is issued only after the developer has satisfied all the requirement of the Environmental Protection Act (2002).
- **Ornamental plants.** The IRS demands high quality, blemish-free ornamental plants. Maintaining these plants free from pests and diseases requires large applications of

pesticides, and the effects of these pesticides on flora and fauna should be studied, including the possibility that the plants could spread pests.⁷¹

- **Public health (pests).** The IRS requires an environment free of public health risks and household pests (such as, mosquitoes, cockroaches, spiders and geckos). To achieve this, pesticides are applied on a regular basis. The excessive application of pesticides might lead to a depletion of beneficial organisms such as biological control agents, honey bees, predatory insects and endemic species.⁷²

Table 20: Summary of changes and impacts of MAAS policy: Production in marginal areas

Policy measures	Expected changes	Economic impacts	Social impacts	Environmental and biodiversity impacts
<i>Moving out of sugar cane</i>	Abandonment of sugar cane production.	<ul style="list-style-type: none"> • A shortfall of €10.6 million in terms of sugar, electricity and ethanol. • Water-based economic activities may be adversely affected. 	<ul style="list-style-type: none"> • Female labour would be most affected. • Livelihood of small planters and <i>metayers</i> will be adversely affected. • Deterioration of standard of living of labourers will negatively affect small businesses in the area. 	<ul style="list-style-type: none"> • Abandonment will affect inland biodiversity and disrupt the beach-lagoon-reef equilibrium. • Accelerated soil erosion leading to sedimentation and eutrophication in downstream reservoirs or lagoons. • Loss of aesthetic green landscape on the mountain slopes as an asset for the tourism industry. • Slow gain in biodiversity with a gradual increase in plant and animal diversity. • Risk of invasive alien species.
	Conversion to other agricultural uses (food crops, livestock and agro-forestry).	<ul style="list-style-type: none"> • Increased use of pesticides due to presence of root knot nematodes from sugar cane lands. • Higher demand for irrigation competing with other sectors. • Additional investment required for shifting to alternate agricultural activities. • Shifting to agro-forestry may not be economically viable on small scale. • Need for amenities such as water and electricity supply particularly for 	<ul style="list-style-type: none"> • Re-training labour will be required. • Production of food-crop and livestock will help meet vegetable, meat and milk demand in the local market. • Livelihood of some 2 500 artisanal fisherman affected as well as the tourism sector. • Deterioration in standard of living of labourers resulting in a negative effect on small business in the area. • Direct and indirect job loss in tourism and hotels 	<ul style="list-style-type: none"> • Increase in soil manipulation would increase run-off and soil erosion affecting nearby lagoons and marine ecosystems. • Heavy reliance on chemical inputs for the management of pests and for soil amendment may lead to contamination of water bodies. • Livestock waste management can raise environmental concerns. • Conversion of habitats and ecosystem and protection of native fauna and flora by adopting agro-forestry. • Uncontrolled deer ranching is likely to increase the population of stable flies and ticks.

⁷¹ A very common plant in many IRS is the *Lantana camara*. This plant was in the past considered to be an invasive weed and several species of biological agents were introduced, with some success, to limit its spread. Today, this plant is considered to be of ornamental value and pesticides are applied against the same insects that had been introduced as biological control agents. Another ornamental plant, the adult coconut, is being transplanted from various areas into the IRS. This will lead to the spread of several pests (such as the rhinoceros beetles) throughout the island.

⁷² For example, the wasp (*Ampulex compressa*) preys upon cockroaches, and the use of pesticides might impact negatively on their population. Excessive pesticide applications will also affect the population of endemic geckos (*Phelsuma* spp.) and birds.

		livestock activities.	close to marginal areas.	
	Conversion to non-agricultural uses (IRS, ecotourism, residential)	<ul style="list-style-type: none"> • Conversion from poorly profitable sugar cane production to other activities with higher economic return. • Heavy investment required in infrastructure, such as electricity and roads. 	<ul style="list-style-type: none"> • IRS projects have multiple benefits in term of leisure, employment and income generation. • Foreign investors are attracted to these projects. • Opportunities for local artists to earn a living and for villages to develop agribusiness around IRS. 	<ul style="list-style-type: none"> • Well-planned IRS projects meeting EIA requirements will help enhance biodiversity and prevent soil erosion.

8 Policy recommendations

Faced with the current changes in trade policies and the subsequent development of the MAAS, several impacts on the environment and biodiversity have been identified. The following priority recommendations are proposed to contribute to the sustainability of the sugar industry and enhance the conservation, and sustainable use, of biodiversity in the agricultural sector.

Shift from the export of raw sugar to refined direct-consumption sugar (EEC Grade II). Making the shift from the export of raw sugar to refined direct-consumption sugar requires the implementation of quality standards related to the production and processing of sugar cane so that it meets standards established in the EU. Therefore, all institutions associated with the sugar industry (such as the MSIRI, the FSC, and the Cane Planters and Millers Arbitration and Control Board) should be encouraged to develop, implement, and enforce quality standards for direct-consumption sugar. Awareness-raising and capacity building among growers and millers is necessary to comply with these standards. Upgrading existing laboratories (with respect to both expertise and equipment) will be required to provide accredited testing services.

Accelerate the adoption of good management practices (GMP). The adoption of GMPs is necessary to ensure the long-term sustainability of the sugar industry, improve market access, and diversify market opportunities. The GMPs developed by the MSIRI at the farm level, address issues such as water use and pollution, which are related to the environment and biodiversity. They also take into account economic considerations such as crop yield and the long-term maintenance of soil health. Adopting GMPs will help address issues of food safety and traceability.

Expand research on good management practices. Local research institutes should identify and test GMPs that are suitable and economically viable, and develop manuals for their implementation.

Increase capacity building with respect to extension services and the dissemination of knowledge about good management practices. There is a need for capacity building among extension workers to distribute knowledge about the benefits of GMPs. Capacity building for farmers with respect to GMPs should also be undertaken, to ensure a steady supply of quality sugar cane. The GMPs include:

- planting disease- and pest-tolerant varieties and varieties adapted to different soil types and climatic conditions;
- adopting minimum tillage techniques to prevent soil erosion;

- creating contours or using barrier crops to prevent soil erosion in environmentally sensitive areas;
- conserving and maintaining natural buffers, such as ecological corridors and wetlands, to conserve water and prevent soil loss and to act as a bio-filters, trapping and removing nutrients that may flow into rivers or into the sea; and
- using by-products from the sugar milling operations to make organic fertilizer to replace chemical fertilizers, such as filter cake, scum or press mud for phosphorous, vinasse for potassium, and boiler ash as a soil conditioner.

Develop incentives to encourage environmentally sustainable food crop and fruit production systems. With the likely conversion of sugar cane land to other uses in the marginal areas, incentives are needed to encourage conversion to environmentally sustainable food crop and fruit production systems to help give farmers a competitive edge and improve market access (for export and for the tourist industry). The value of sustainably produced products can be enhanced through certification and eco-labelling. Efforts should be directed towards developing alternatives to the expansion of agricultural land and should support environmentally sound farming systems that reduce the risk of groundwater pollution and off-site effects, such as eutrophication. The incentives could be provided through both financial and non-financial instruments. Financial support might be provided in the form of a one-time grant to farmers and research institutions, to support research in organic farming techniques.

Other incentives include providing extension services oriented to supporting a transition from conventional agriculture to organic production. Such incentives could include hiring private consultants to provide advice and training to farmers on organic methods. Institutional support for the development and implementation of legislation and regulations on organic production to encourage the development of organic agriculture could also be considered. The Government should encourage private sector organizations to provide technical support to farmers and develop certification and labelling regimes (consistent with international certifications) for goods produced using environmentally friendly methods. A legal framework should be developed and enforced to apply to certification and eco-labelling. Mechanisms and procedures should be established to ensure that any additional revenue generated by certified sustainable products is channelled back to producers to help ensure their sustainable livelihoods. In order to develop the market for environmentally sustainable products, a network to provide information on sustainable producers should be established.

Support small farmers in marginal areas in the case of abandonment of sugar cane production to prevent land degradation. Due to low profitability of cane cultivation on marginal land there is high probability that sugar cane production will be abandoned in environmentally sensitive areas, such as on the mountains slopes facing the coast. Small sugar cane growers most likely to be affected should receive support from the Government to help prevent the degradation of their lands. Financial instruments, such as incentive schemes to maintain sugar cane, or conversion to agro-forestry, should be evaluated to ensure minimum damage to the environment and to conserve biodiversity. Alternatively, agro-environmental schemes could be developed to encourage farmers to adopt environmentally sound agricultural practices in these sensitive areas.

Reward efforts to promote sustainability. Efforts to promote sustainability to help access the export and tourist markets should be rewarded through the internalization of environmental costs or the prohibition of production systems with high environmental

costs. Mechanisms such as ‘green’ or ‘organic’ labels should be employed to help consumers understand the impacts on the environment and biodiversity of their purchasing decisions.

Regulate the movement of goods that are harmful to local biodiversity. The Government of Mauritius should regulate the movement of goods that are harmful to local biodiversity. These goods might include, for example, GMOs, alien invasive species, dangerous chemicals, and hazardous waste. Legitimate trade controls, based on the precautionary principle and sanitary and phytosanitary rules, relating to invasive alien species or GMOs should be enforced and personnel should be trained to effectively apply these rules. Capacity building should be undertaken to develop and apply methodologies to evaluate risks from biological agents, bio-control agents, GMOs, and exotic species. Awareness raising activities are required to prevent and control the movement of goods that are harmful to biodiversity. Methods for equitably sharing the costs of such controls should be explored.

Establish incentives to further encourage small farmers to regroup under FORIP. As a result of the interest identified in the FORIP survey, incentives should be provided to encourage the further regrouping of small farmers under the programme. This would enhance access to the credit necessary for investing in GMPs, and reduce costs through the bulk purchasing of inputs, and sharing costs associated with machinery, harvesting, and transportation to mills. The regrouping into larger blocks of land occupied by small- and medium-sized sugar cane growers will facilitate the creation, rehabilitation, and maintenance of ecological corridors and conservation areas.

Develop public awareness-raising activities. Awareness-raising campaigns should be launched to expose the public to the value of conserving biodiversity. And the importance of the conservation of biodiversity should be included in the educational curriculum so school children learn to value, manage, and conserve the components of biodiversity.

Integrate strategies for the sustainable use and conservation of biodiversity into relevant sectoral or cross-sectoral plans, programmes and policies. Over the course of the IA, it has been observed that there are low levels of participation by different stakeholders in policy making, a divergence of interests between environmental and land-use policies, and very little integration between strategies for conserving biodiversity and pursuing economic development activities. Strategies for the sustainable use and conservation of biodiversity should be integrated into relevant sectoral or cross-sectoral plans, programmes and policies and all sectoral activities should incorporate both environmental and biodiversity related concerns. Concerns related to biodiversity should also be integrated into environmental legislation. Farmers should not simply be regarded as producers of food, but as stewards of nature. Agricultural subsidies should be refocused to promote sustainable agricultural practices and compliance with environmental legislation.

Promote partnerships among stakeholders to build capacity to manage agricultural biodiversity. The lack of interaction identified among stakeholders points to the need to enhance capabilities to promote partnerships among researchers, extension workers, and farmers in research and development programmes for the conservation and sustainable use of biodiversity in agriculture. This could occur through training and education programmes, and establishing a network for exchanging information and expertise, including traditional knowledge.

Undertake capacity building in biodiversity valuation techniques. No valuation study could be undertaken during this IA due to lack of expertise in economic analysis of the

value of biodiversity and ecosystem services. Therefore, there is an urgent need for capacity building in techniques for biodiversity valuation.

Undertake an inventory of existing agricultural biodiversity. Due to the absence of baseline data on agricultural biodiversity and, specifically, on biodiversity associated with the sugar cane industry in Mauritius, there is an urgent need to conduct an inventory of existing agricultural biodiversity as a baseline for future assessment and evaluation. The last study to assess the impact on biodiversity of effluent discharges into streams and rivers from sugar factories was conducted in 1994. Capacity building is required as there is a dearth of insect taxonomists on the island. An effective data system for the scientific community should be developed to improve access to information on various elements of biodiversity. The biodiversity indicators identified in this IA can be included with the biodiversity indicators for EIS projects under the Ministry of Environment, for regular monitoring.

Compensate farmers for conserving local species. Given the gradual erosion of indigenous agro-biodiversity by higher performing crop varieties, mechanism should be established to compensate farmers using and conserving local biodiversity (traditional plant varieties and local breeds) subsequently used in breeding. A regulatory framework should be established and enforced, to ensure access and benefit-sharing measures, and the protection of intellectual property rights.

Respect conditions for investment related to environmental protection and biodiversity conservation. In the context of liberalization of foreign direct investment in the development of IRS, the Government of Mauritius should ensure that the conditions for investment related to sustainability and biodiversity conservation are fully respected and that there are no obstacles blocking relevant authorities from taking action to conserve biodiversity. Implications of the development of a liberalized investment regime on local biodiversity and ecosystem services should be monitored and assessed in the future.

9 Conclusions

In the past, agricultural policies have been designed to provide incentives and market mechanisms to meet the challenge of attaining self sufficiency through the optimal use of resources, mechanization, and chemical inputs. However, these policies, geared towards promoting trade and economic growth, did not take ample consideration of the environment and biodiversity and have caused environmental degradation over the long term, including the loss of biodiversity, contamination of ground water, reduced soil fertility and increased erosion.

Policy development is an ongoing process that must take into consideration dynamic changes, such as a global food crisis, economic crisis, falling fuel prices, and evolving markets. This IA, which has approached the critical issue of sugar cane and integrated economic, social, environmental, and biodiversity considerations, has identified areas of concern and raised awareness of potential impacts of trade policies on Mauritius's fragile environment and rich biodiversity. It has contributed to the capacity to generate sound policies related to agriculture and trade in the future that take into consideration the longer term impacts of those policies on sustainability. This initial pilot study has generated a large amount of information and a series of recommendations to help decision makers approach policy making that supports the sustainable use and conservation of local biodiversity. Such

an approach could be extended to the tourism, energy, transportation and other sectors and would ultimately contribute to protecting the valuable ecosystem services provided by land, species, and water, which are the basis of Mauritius's economy (notably through the tourism industry).

This IA has also provided an opportunity to bring together stakeholders from relevant government ministries, the private sector, research institutions, representatives of growers, non-governmental organizations, local specialists, and consultants from partners, such as UNEP, to encourage policy coherence and ensure that a broad expertise was included in the process. The implementation of the recommendations in this IA will require the collective effort of all the stakeholders. Finally, this IA has provided a basis from which to integrate sustainable environmental and natural resource management, conservation of biodiversity, and protection of ecosystem services, as core components of a comprehensive EPA.

References

- Agreco Consortium. 2007. Strategic Environmental Assessment (SEA) of the Multi-annual Adaptation Strategy (MAAS) for the Mauritian Sugar Cane Cluster (2006-2015) Final Report. Contract No. 2006/130754.
- Altieri, M. A., and C. I. Nicholls. 2002. Invasive arthropods and pest outbreaks in the context of the ecology of mechanized agricultural systems. In *Invasive arthropods in agriculture*, Hallman, G. J. and C. P. Schwalbe eds. Science publishers. Plymouth, UK.
- Andow, D. A. 1991. Vegetational diversity and arthropod population response. *Annual Review of Entomology* 36: 561-586.
- Centre for Applied Social Research (CASR). 2002. Attitudes of the Unemployed Towards Accepting Employment In The Textile Factories Of The EPA In Mauritius. Government of Mauritius.
- CASR. 2005. The Integration of the Elderly in the Family. National Economic and Social Council (NESC). Mauritius.
- CASR, UNDP, ILO. 2005. Discrimination Practices in the Mauritian Labour Market. Ministry of Labour & Industrial Relations. Government of Mauritius.
- CASR, United Nations Development Programme (UNDP), International Labour Organization (ILO). 2007. Coping with Retrenchment – Globalization, Employment and Livelihoods: Socio-Economic Impact of the end of the Multi Fibre Arrangement on Retrenched Workers in Mauritius. Ministry of Labour and Industrial Relations, Government of Mauritius.
- Chinappen, M., S. I. Seewooruthun, and S. Ganeshan. 2004. Preventive measures against the entry of the sugar cane white grub *Hoplochelus marginalis* (Coleoptera: Melolonthidae) into Mauritius. In *Proceedings of the sixth Meeting of Agricultural Scientists, Reduit, Mauritius, 8 –9 May 2003*, J. A. Lalouette, D. Y. Bachraz and K. J. Bheenick eds. Food and Agricultural Research Council.
- Decentralized Cooperation Programme (DCP). 2008. Poverty Observatory Qualitative Methodology First Run Report. DCP, Mauritius.
<http://www.gov.mu/portal/sites/ncb/dcp/reports/reports.html>.
- DeCharmoy, D. D'E. 1912. Report on *Phytalus smithi* (Arrow) and other beetles injurious to the sugar cane in Mauritius. Port Louis: Govt. Printing Office.
- DeCharmoy, D. D'E. 1917. Moth borers affecting sugar cane in Mauritius. Bulletin of Department of Agriculture, Mauritius. *Scientific Series* 5: 27.
- Ganeshan, S. 2001. A guide to insect pests of sugar cane in Mauritius. Mauritius Sugar Industry Research Institute (MSIRI). Republic of Mauritius.

- Ganeshan, S. 2007. Six armyworm species (Lepidoptera: Noctuidae) occur in sugar cane fields in Mauritius. *Proceedings International Society Sugar Cane Technologists* 26: 830-834.
- Ganeshan, S. and Rajabalee, A. 1996. The *Mythimna* spp. (Lepidoptera: Noctuidae) complex on sugar cane in Mauritius. *Proceedings of South African Sugar Technologists Association* 70: 15-17.
- Ganeshan, S. and Williams, J. R. 2000. Entomological parasitoid-host records from Mauritius 2nd revised ed. Occasional Paper. Mauritius Sugar Industry Research Institute.
- Greathead, D. J. 1971. A review of biological control in the Ethiopian Region. Technical communication. *Commonwealth Institute of Natural Control* No. 5. : 162.
- ILO/Ministry of Labour and Industrial Relations. 2002. Work and the Family. Centre of Applied Social Research, University of Mauritius.
- Julien M. H. R., G. Pillay, J. Tonta. 1995. La contribution des petits exploitants à la production sucrière mauricienne- problèmes et perspectives. Paper presented at « les Méthodes participatives de recherche de développement dans l'océan indien », 6-10 November, Réunion Island.
- Krebs, J. R., J. D. Wilson, R. B. Bradbury and G. M. Siriwardena. 1999. The second silent spring? *Nature* 400: 611-612.
- Kunz, S. E. and J. Monty. 1976. Biology and ecology of *Stomoxys nigra* Macquart and *Stomoxys calcitrans* (L.) (Diptera: Muscidae) in Mauritius. *Bulletin Entomological Research* 66: 745-755.
- Lamberti, F. and C. E. Taylor. 1979. Root knot nematodes (Meloidogyne species): systematics, biology and control. London: Academic press.
- Lamberti, F., M. Chinappen, F. Roca, N. Vovlas, M. Di Vito, and J. Bucha. 1987. Plant parasitic nematodes found in sugar cane fields. *FAO Plant Protection Bulletin* 35: 83 – 91.
- Landell Mills Ltd. 1991. Small Planters' Efficiency Study. Ministry of Agriculture, Fisheries and Natural Resources. Vols 1-6. Mauritius.
- Moutia, L. A. 1934. Report Department of Agriculture. Mauritius 1933: 25 -29.
- Moutia, L. A. and R. Mamet. 1946. A review of twenty-five years of economic entomology in the island of Mauritius. *Bulletin Entomological Research* 4: 439 - 472.
- Moutia, L. A. and R. Mamet. 1947. *Clemora smithi* (Arrow) – Un ennemi de la canne à sucre à l'île Maurice. Scientific Series Bulletin No. 28. Department of Agriculture, Mauritius.

Mauritius Chamber of Agriculture. 1993-1999. Mauritius Chamber of Agriculture Annual Reports. Government of Mauritius.

Mauritius Deer Farming Cooperative Society Limited. 2005. Quatre Bornes, Mauritius.

Mauritius Sugar Authority. 1994. Characterization of Cane Sugar Factory Wastes and Pollution Control. Funded by the World Bank. Government of Mauritius.

Mauritius Sugar Industry Research Institute (MSIRI). 1977. Annual Report Mauritius Sugar Industry Research Institute. 1976: 37 – 43.

MSIRI. 1978. Annual Report Mauritius Sugar Industry Research Institute. 1977.

MSIRI. 1981. Annual Report Mauritius Sugar Industry Research Institute. 1980.

MSIRI. 1990a. Annual Report Mauritius Sugar Industry Research Institute. 1998.

MSIRI. 1990b. Occasional Report No 4, 1990: Land Index Project for Small Planters.

MSIRI. 1992. Annual Report Mauritius Sugar Industry Research Institute. 1991.

MSIRI. 1994a. Annual Report Mauritius Sugar Industry Research Institute. 1993.

MSIRI. 1994b. Occasional Report No 7, 1994: A Socio-Economic Study of Small Sugar Cane Planters in Mauritius.

MSIRI. 1995. Annual Report Mauritius Sugar Industry Research Institute. 1994.

MSIRI. 1996. Occasional Report No 10, 1996: Rehabilitation of Abandoned Cane Lands.

MSIRI. 1997. Annual Report Mauritius Sugar Industry Research Institute. 1996.

MSIRI. 1999. Annual Report Mauritius Sugar Industry Research Institute. 1998.

MSIRI. 2000. Annual Report Mauritius Sugar Industry Research Institute. 1999.

MSIRI. 2002. Annual Report Mauritius Sugar Industry Research Institute. 2001.

MSIRI. 2003. Annual Report Mauritius Sugar Industry Research Institute. 2002.

MSIRI. 2005. Annual Report Mauritius Sugar Industry Research Institute. 2004.

MSIRI. 2006. Occasional Report No 32, 2006: Agro-Economic Study On Difficult Areas Under Sugar Cane.

MSIRI. 2007a. Annual Report Mauritius Sugar Industry Research Institute. 2006.

MSIRI. 2007b. Good Management Practices to improve the productivity, competitiveness and sustainability of the Mauritius Sugar Cane Industry, January 2007.

- Ministry of Agro Industry, Food Production and Security (MAIFPS). 2005. Ministry of Fisheries Annual Report 2003. MAIFPS Fisheries Department. Government of Mauritius.
- MAIFPS. 2006. Multi-Annual Adaptation Strategy (MAAS) Action Plan 2006-2015: Safeguarding the Future through Consensus. Mauritius Sugar Authority. Government of Mauritius.
- MAIFPS. 2007a. Annual Report of the Sugar Insurance Fund Board July 2006 to December 2007. Government of Mauritius.
- MAIFPS. 2007b. Strategic Options for Crop Diversification and Livestock 2007-2015. Government of Mauritius.
- MAIFPS. 2008. Annual Report of the Tea Board for the year 2007. Government of Mauritius.
- Ministry of Finance & Economic Empowerment (MoFEE). 1988-2003. Digest of Agricultural Statistics. Central Statistics Office. Government of Mauritius.
- MOFEE. 2005. Annual Digest of Statistics 2005. Central Statistics Office. Government of Mauritius.
- MoFEE. 2006. Annual Digest of Statistics 2006. Central Statistics Office. Government of Mauritius.
- MoFEE. 2007. Digest of Energy and Water Statistics 2007. Central Statistics Office. Government of Mauritius.
- MoFEE. 2008. Digest of Agricultural Statistics 2007. Central Statistics Office. Government of Mauritius.
- Nicholls, C. I. and M. A. Altieri. 2007. Agroecology: contributions towards a renewed ecological foundation for pest management. In *Perspectives in ecological theory and integrated pest management*, Hogan, M. and P. Jepson eds. Cambridge: Cambridge University Press.
- Rajabalee, M. A. and N. Banyamadhuh. 1995. Notes on the grass mealy bug *Pseudaspido proctus fulleri* (Cockerell) a new record of a sugar cane pest. *Proceedings International Society Sugar Cane Technologists* 21: 633-637.
- Rajabalee, M. A. and M. Govendasamy. 1988. Host specificity and efficacy of *Apanteles flavipes* (Cam.) and *A. sesamiae* (Cam.) (Hymenoptera: Braconidae) parasites of sugar cane moth borers in Mauritius. *Revue Agricole et Sucrière de l'île Maurice* 62: 78 -80.
- Rajabalee, A., M. Govendasamy, and S. Ganeshan. 1995. Biology and ecology of sugar cane white grubs in Mauritius. *Proceedings International Society Sugar Cane Technologists* 21: 609-619.

- Ricaud, C. 1990. MSIRI's Contributions to Improve the Efficiency of Small-Planters. *PROSI Bulletin* 266: 34-36.
- Richards, N. 2006. Interviews with small planters. Desk Study for a KABP study on Small Scale Planters in Mauritius, unpublished research study. CASR. Mauritius.
- Smith, H. A., and R. McSorley. 2000. Intercropping and pest management: a review of major concepts. *American Entomologist* 46: 154-161.
- Soma, A. and S. Ganeshan. 1999. Status of the sugar cane spotted borer, *Chilo sacchariphagus* Bojer, in Mauritius. In *Proceedings of the 3rd Annual Meeting of Agricultural Scientists, Mauritius, 17-18 November 1998*. Lalouette, J. A., D. Y. Bachraz, N. Sakurdeep eds. Food and Agricultural Research Council.
- Tscharntke, T., A. M. Klein, A. Kruess, I. Steffan-Dewenter, and C. Thies. 2005. Landscape perspectives on agricultural intensification and biodiversity – ecosystem service management. *Ecology Letters* 8: 857 – 874.
- United Nations Environment Programme (UNEP). 2007. Incorporating biodiversity into integrated assessments of trade policy in the agricultural sector, Volume 1: A practical step-by-step guide (working document). Geneva.
- UNEP. 2007. Incorporating biodiversity into integrated assessments of trade policy in the agricultural sector, Volume II: A reference manual (working document). Geneva.
- Van den Berg, J., C. Midega, L. J. Wadhams, and Z. R. Khan. 2003. Can vetiver grass be used to manage crop pests? In *Vetiver grass – a world technology and its impact on water*. Proceedings of the Third International Conference on Vetiver and Exhibition, Guangzhou, China, October 2003. Agricultural Press, Beijing.
- Van den Berg J., M. Rebe, A. J. M. de Bruyn. 2001. Developing habitat management systems for graminaceous stem borers in South Africa. *Insect Science and Its Application* 21: 381-388.
- Vinson, J. 1941. Rectification d'une erreur courante relative à l'espèce de *Diatraea* (borer ponctué) s'attaquant à la canne à sucre à Maurice. *Revue Agricole Sucrière de l'île Maurice* 20: 148 -153.
- Williams, J. R. 1956. Varietal susceptibility in sugar cane to the thrips *Fulmekiola serrata* (Kobus). *Proceedings International Society Sugar Cane Technologists* 9: 789-799.
- Williams, J. R. 1978. Report on the "Pou à Poche Blanche", *Pulvinaria iceryi* (Sign.). MSIRI. Republic of Mauritius.
- Williams, J. R. 1980. The biology of the scale insect, *Pulvinaria iceryi* (Sign.). *Proceedings International Society Sugar Cane Technologists* 17: 1843-1854.
- Williams, J. R. 1983. The sugar cane stem borer (*Chilo sacchariphagus*) in Mauritius. *Revue Agricole Sucrière de l'île Maurice* 62: 5-23.

Williams, J. R. 1989. Observations on Mauritian Scoliidae/Tiphiidae. MSIRI. Republic of Mauritius.

Williams, J. R. and D. J. Greathead. 1973. The sugar cane scale insect *Aulacaspis tegalensis* (Zhnt.) and its biological control in Mauritius and East Africa. *Pest Abstracts & News Summaries* 3: 353-367.

Annex 1: International treaties

The international treaties include the following:

- Convention of Biological Diversity (1992)
- Vienna Convention for the Protection of Ozone Layer and the Montreal Protocol on Substances that Deplete the Ozone Layer
- Kyoto Protocol
- The International Convention for the Regulation of Whaling (1946)
- The African Convention on the Conservation of Nature and Natural Resources (1968)
- The Convention on Fishing and Conservation of Living Resources of the High Seas (1958)
- The Convention on Wetlands of International Importance (RAMSAR) (1971)
- The Convention for the Protection of the World Cultural and Natural Heritage (1972)
- The Convention on International Trade in Endangered Species of Wild Fauna and Flora (1973)
- The UN Convention on the Law of the Sea (1982)
- The UN Convention on the Control of Trans-boundary Movements of Hazardous Wastes and their Disposal (MARPOL) (1989)
- The UN Framework Convention on Climate Change (UNFCCC) (1992)
- The UN Convention to Combat Desertification (UNCCD) (1995)
- The Convention on Migratory Species (1994)
- The African Eurasian Water Bird Agreement (1999)
- The Indian Ocean – South-East Asia Marine Turtle MOU 2003
- The Cartagena Protocol on Biosafety (2000)

Annex 2: Features of relevant strategies and policies

Relevant policy	Main features
National Development Strategy (2003)	The National Development Policy provides policy framework to guide public and private sector in the implementation and management of infrastructural and development projects within a sustainable environment while protecting agricultural land and environmentally sensitive areas
National Biodiversity Strategy and Action Plan 2006 -2015 (NBSAP)	<p>NBSAP addresses the forest and terrestrial biodiversity, freshwater, coastal and marine biodiversity; and agricultural biodiversity, biotechnology and biosafety. Its aim is to promote a healthy environment and an enhanced quality of life through:</p> <ol style="list-style-type: none"> 1. Establishment of a representative and viable Protected Area Network by 2015; 2. Manage and conserve native flowering plants and ferns and endemic birds, reptiles, insects, local agro-biodiversity and invasive alien species; 3. Promote sustainable use of biodiversity through ecotourism development and setting of appropriate legal framework; 4. Maintain and manage ecosystem services such as forest management, monitoring of water quality and Integrated coastal zone management; 5. Manage sound application of biotechnology for breeding of sugar cane and horticultural crops; 6. Update legal framework (The genetically modified organisms act); and 7. Set up of the national biosafety framework.
National Invasive Alien Species Control Strategy (NIASS) 2008- 2017	<p>The NIASS serves as a guide to the nation to avoid, eliminate or minimize the negative impacts of invasive alien species through</p> <ol style="list-style-type: none"> 1. Prevention - to minimize the number of unintended and intended invasive alien species introductions to the Republic of Mauritius; 2. Early Detection and Rapid Response - to minimize the consequences once they are introduced to the Republic of Mauritius; 3. Eradication - an agreed framework for eradication priorities in place, eradications undertaken as necessary and results disseminated; 4. Control and Management - to contain the distribution and abundance of invasive alien species in the Republic of Mauritius to an acceptable level over the long term; 5. Restoration - to undertake ecosystem restoration where necessary in the Republic of Mauritius to achieve long-term ecosystem goals <p>The NIASS also involves crosscutting elements such as: establishment of legal, policy and institutional frameworks, capacity building and education in invasive alien species management; research and public awareness and engagement.</p>
National Environment Policy and Action Plan (NEAP)	<p>The NEAP is to preserve and enhance the quality of natural environments (air, water, soil, flora and fauna, forest, marine life, and all variety of living organisms), protect against pollution arising out of human activities, facilitate conservation and replenishment of the environment, maintain the health and welfare of all, and promote and encourage public use of national natural and cultural heritage.</p> <p>It focuses on: (i) institutional strengthening to develop the necessary framework of environmental policy and legislation; (ii) land management and tourism control to ensure the protection of natural resources and historic architecture; (iii) industrial, sewerage and solid waste pollution to address the effects of such land-based pollution; (iv) marine conservation to preserve and monitor marine resources; (v) agricultural residues to control the effects of pesticides and fertilizers; and (vi) terrestrial conservation to protect and/or</p>

Relevant policy	Main features
	<p>restore natural habitats.</p> <p>One of the thematic areas of the updated NEAP (2007) is the conservation and sustainable use of biodiversity and the objectives are to:</p> <ol style="list-style-type: none"> 1. Conserve and protect nature areas; identify and document environmentally sensitive areas for land-use plans; continue to rehabilitate, enhance and manage native (indigenous & endemic) species. 2. Promote public awareness and involve the public in nature conservation; document and update our biodiversity through regular biodiversity surveys; ensure that databases on biodiversity are readily accessible to users. 3. Establish a Protected Area Network to manage ecosystems. 4. Establish networking with local and international research institutions to exchange expertise and knowledge. 5. Review the legal, economic and administrative policy instruments with a view to improving and coordinating the management of threatened, environmentally sensitive areas and private forests. 6. Promote public/private partnership in biodiversity management. 7. Implement the obligations of biodiversity-related conventions, such as the RAMSAR Convention, the UNCCD and the UNFCCC through domestication of provisions into the local legislations to enable enforcement and compliance.
National Forestry Action Plan	<p>This policy action plan designated for the development of the forest sector aims at protecting and enhancing the country's natural environment, biodiversity and national heritage, while at the same time promoting recreation and tourism through:</p> <ol style="list-style-type: none"> 1. Conservation and protection of watersheds and other environmentally sensitive areas in Mauritius and Rodrigues. 2. Increasing tree cover to enhance the environment and the carbon sink capacity of the forests. 3. Degradation of native forests by invasive alien species. 4. Deer ranching. 5. Development of inland recreation and ecotourism business. 6. Forest destruction by recurrent cyclones, fire, insect pests and diseases. 7. Conversion to forest of abandoned sugar-cane land in environmentally sensitive areas. 8. Land degradation in Rodrigues. 9. Development of small forest-based businesses for income generation in Rodrigues and Mauritius. 10. Improvement of the forestry service in Mauritius and Rodrigues.
National Biosafety Framework (1999)	<p>This framework sets out guidelines for the 'Safe development and introduction of Genetically Modified Organisms (GMOs) in Mauritius'. It recommends practices and procedures for the safe use of biotechnology to protect the environment and human and animal health from the potential adverse effects of GMOs.</p>
Multi Annual Adaptation Strategy (MAAS) 2006 – 2015	<p>The MAAS was developed to reform the sugar sector following the drastic cut in sugar price. It aims at ensuring the long term viability and sustainability of the sugar industry through improving productivity and competitiveness and at tapping the energy potential of this industry through the generation of electricity from bagasse and coal (a complementary fuel to bagasse) and the production of ethanol.</p> <p>Considering the market environment, the overall objectives of the MAAS are:</p>

Relevant policy	Main features
	<ol style="list-style-type: none"> 1. Transformation of the sugar industry into sugar cane clusters and to move the industry moves from an essentially raw sugar producer to a state where it produces several types of sugar i.e. raw, special, industrial and white; electricity from bagasse/coal using state of the art technology and ethanol using molasses. 2. Establishment of a competitive, viable and sustainable sector. 3. Fulfilment of the trade commitments of the country. 4. Reduction of the dependency on the import of fossil fuels 5. Continuation of the multifunctional role of sugar and in particular the support to national environment and social objectives.
Strategic Options for Crop Diversification and Livestock Sector (SOCDL) (2007 – 2015)	<p>In the context of world food crisis, agro-fuel and energy supply; global climate change; and the eroding protective measures, the SOCDL is developed to restructure and consolidate the non-sugar sector with a view towards exploiting new profitable opportunities, and venturing into the exploration of new technological avenues to engender economic growth and reduce poverty. Its priorities are as follows:</p> <ol style="list-style-type: none"> 1. Empower entrepreneurs in improving their productivity, quality and output; 2. Assist agro-producers in innovating and marketing their products; 3. Assist stakeholders in the agro-industry in an export-oriented agro-production, including conservation techniques, value-addition, packaging techniques and market research and access; and 4. Access to land for the farming community and agro-entrepreneurs. <p>It is envisaged that land under sugar cane will be released at a greater pace consequent to the drastic reduction in sugar price. It is expected that by 2015, some 7 000 hectares, now under sugar cane, would be available for agricultural and other uses. These include some 5 000 ha that are classified as difficult areas as they are found in highly rocky and sloppy regions or mountain slopes. These lands are cultivated by small planters and <i>metayers</i>.</p>
Food Security Policy (2009-2011)	<p>Owing to the rising global food prices and the vulnerability of Mauritius, a net importing country, this policy was to reform the food sector. Massive investment in agriculture is envisaged in order to foster local production of foodstuff so as to mitigate the dependency of the country on imported food commodities. Some 515 additional ha of land will be developed for food production, of which 382 ha will be allocated for food crops and 133 ha for meat and milk production.</p>
Energy Policy (2007 – 2025)	<p>Due to the increase in demand for electricity associated with economic growth and the improvement in the standard of living and the volatility of oil prices, the government of Mauritius launched this Energy Policy 2007–2025 which aims at broadening the energy base of the country so as to reduce dependence on imported fuels and shifting from diesel to coal and increasing the use of bagasse and reducing emission of green house gases arising from energy consumption. The target for Mauritius over the next 50 years is to achieve about 70 per cent self-sufficiency in terms of energy supply through a progressive increase in the use of renewable energies. It is estimated that over the next 25 years Mauritius will need to invest about MUR80 billion on new electricity generation plants.</p>
Integrated Resort Scheme	<p>This scheme aims at attracting foreign capital as part of the country's economic development strategy. Numerous advantages, including tax incentives are already offered to foreign investors. as a means to further encourage investors to seize business and investment opportunities in Mauritius</p> <p>The government of Mauritius has introduced a Permanent Residence Scheme</p>

Relevant policy	Main features
	for eligible foreign businessmen. This scheme is meant to attract foreign investors as part of the country's economic development strategy.
Cross Border Initiatives	In the context world food crisis, the government of Mauritius has set up a regional food security company to take advantage of the region as an agricultural production base and to utilize the production capabilities in neighbouring countries including Madagascar and Mozambique which have abundant unexploited land resources and offer very cheap labour. It aims at promoting investment of local and foreign entrepreneurs in the region so as to develop a competitive agro-industrial sector and exploit new export avenues. The possibility of producing a number of primary products, such as potato, maize, onion and garlic with guaranteed access to the local market and regional markets is being considered.

Annex 3: Technical report of the integrated assessment study for Mauritius

The Mauritius country project on the “Integrated Assessment of Trade Related Policies on Biological Diversity in the Agricultural Sector” was undertaken by the Ministry of Agro-Industry, Food Production and Security (MAIFPS) and was implemented by the Agricultural Research and Extension Unit (AREU). The IA focused on the economic, social and environmental impacts of changes in the sugar cane industry due to the loss of trade preferences following the reform of the ACP-EU Sugar Protocol.

Three officers from Mauritius (two from MAIFPS and one from AREU) attended the Capacity Building Workshop that was held in Geneva in October 2006. A MOU and a Letter of Agreement were signed by AREU and MAIFPS in February and March 2007. The Government of Mauritius designated AREU to implement the project on behalf of the Government and under the coordination of the Ministry of Agro-Industry. An extension MOU was signed by AREU in December 2008 to give sufficient time for the completion of the IA and the submission of the final report by 31 January 2009.

A3.1 Main partners in the IA

The main partners involved in the study are institutions directly or indirectly concerned with sugar production in the agriculture, environment, and trade sectors.

The **MAIFPS** was the lead ministry responsible for policy decisions, planning in the agricultural sector and more precisely for the development of the sugar sector. MAIFPS coordinated and implemented the study.

The **AREU** was responsible for research and extension in the non-sugar sector. Its activities focus on adaptation and introduction of new technology to the farming community and to train farmers in the adoption of released technologies. AREU is implementing the project.

The Forestry Services within the MAIFPS is responsible for the management of forest resources to ensure a healthy forest environment that will satisfy the needs and aspirations of present and future generations of Mauritians for goods and services from forests in a sustainable manner.

The **Fisheries Division** within the MAIFPS works towards the sustainability of aquatic resources and social development for the benefit of all stakeholders. The Division is also providing an enabling environment for the promotion of sustainable development of the fisheries sector and to ensure continued economic growth and social development within the framework of good governance.

The **National Parks and Conservation Services within the MAIFPS** ensures the sustainable management and restoration of the natural resources of the Park with special regard to the highly endangered native plants and animals and the promotion of public awareness through education and ecotourism activities.

The **Agricultural Planning and Analysis Unit within the MAIFPS** is responsible for addressing issues related to international agreements and for analysing the potential impact of these agreements on agriculture. It is also responsible for planning the strategies of the Ministry and for the analysis of policy decisions of the Ministry.

The **Ministry of Environment** has as its mission, enabling Mauritius to attain the highest level of environmental quality as a means to enhance the quality of life of the people, preserve the natural environment and advance its competitiveness. The Ministry approves and monitors projects in relation to their environmental impacts.

The **Ministry of Foreign Affairs and International Trade** has as its objective to promote the national interests of the country at bilateral, regional and international levels; to pursue a pro-active, adaptable and pragmatic economic and political diplomacy with a view to achieving sustainable economic growth and development and to participate actively in the rapidly globalizing world economy and to strengthen the process of regional cooperation and integration.

The **Ministry of Finance and Economic Empowerment (MOFEE)** is responsible for the financial soundness of the Government's economic policy and for the proper control of revenue and expenditure. This Ministry monitors projects at the national level and allocates financial resources where and when they are needed.

The **Mauritius Sugar Authority (MSA)** promotes the development of the sugar industry on an efficient basis taking into account the national interest. The MSA formulates plans and policies for the sugar industry in a systematic basis on all aspects which ensure the short, medium and long term viability of the industry. It is also responsible for the development of the industry by regularly reviewing the financial, the economic, the technical and the social aspects of the industry.

The **Farmer's Service Corporation (FSC)** has as its objective, devising and implementing schemes and programmes to enhance the productivity and efficiency of small scale sugar cane growers. In addition, the FSC provides essential services to sugar cane planters; promotes agricultural land consolidation for management purposes; promotes the establishment of cane nurseries and supply seed cane to planters; assist in the preparation, de-rocking and mechanization of farmers land; provides technical advice and support to farmers on cane cultivation.

The **Mauritius Sugar Industry Research Institute (MSIRI)** has as its mission, carrying out high quality research and development on sugar cane and other crops that meet the agricultural, commercial, and societal needs of Mauritius. The Institute seeks to enhance its role as a centre of excellence.

Mauritius Chamber of Agriculture provides a high-level forum for an exchange of ideas and views and for the formulation of general policies and strategies on all major issues pertaining to the development of agriculture and agro-industries. It also gives alert on the economic situation to agricultural producers. The Chamber fully supports the initiatives of its members concerning the development of specific projects, including diversification in agriculture. It further provides a link between the sugar industry and overseas institutions with a view to widening its scope of activities and better promoting Mauritius at the international and regional levels.

The **University of Mauritius** provides an efficient and effective service to the community through quality teaching, research, consultancy and extension services, consistent with national goals and policies, supportive of regional thrusts and orientations, and in conformance with international norms and standards.

The **Mauritius Wildlife Foundation** is a non-governmental organization (NGO) in Mauritius to be exclusively concerned with the conservation of endemic species. The Foundation works in close co-operation with the Government under a Memorandum of Agreement signed in 1994.

Other stakeholders that were involved in the Technical Committee included representatives from the following institutions: Water Resources Unit, *Mouvement Autosuffisance Alimentaire*, Mauritius Council of Social Services (responsible for all NGOs) and the Sugar Cane Growers Association.

A3.2 The process of the country study

The Core Team

The Core Team responsible for implementing the project included the following roles:

- Project coordinator (MAIFPS);
- Project leader (AREU);
- Assistant project leader (AREU).

The Core Team was a multidisciplinary team responsible for project implementation, including undertaking research, identifying alternative policy measures, organizing national workshops/stakeholder meetings, preparation of progress reports (draft assessment reports, technical reports, workshops reports) and monitoring of project funds.

The National Steering Committee (NSC)

A National Steering Committee (NSC), chaired by the Permanent Secretary of the MAIFPS, was established and included a total of twelve representatives from the following organizations:

- Agricultural Services (MAIFPS)
- Farmer's Service Corporation (FSC)
- AREU
- Mauritius Chamber of Agriculture
- Ministry of Environment
- Fisheries Division (MAIFPS)
- Agricultural Planning and Analysis Unit (MAIFPS)
- Ministry of Environment
- Ministry of Foreign Affairs and International Trade
- Ministry of Finance and Economic Development
- Forestry Services
- National Parks and Conservation Services (NPCS)

The NSC was responsible for developing and monitoring the implementation of the country project by providing guidance on how the outcome of the project was expected to be

reflected in a policy reform package, commenting on project effectiveness and critically reviewing progress. It also facilitated the consultative process with relevant stakeholders to provide a forum for discussing interests and increasing transparency in the decision-making process.

The NSC was scheduled to meet on a quarterly basis. However, to initiate the project, follow and review the progress of the project, the NSC met on ten occasions, with the last meeting held on 28 January 2009.

Technical Committee

A Technical Committee was established to manage operations and field activities associated with the project. The Technical Committee included representatives from the following groups and institutions:

- Core Team;
- FSC;
- Ministry of Environment;
- Other institutions and ministries as necessary, including: NPCCS, *Mouvement Autosuffisance Alimentaire*, MSA, Ministry of Trade and Foreign Affairs, Forestry Department, Fisheries Services, and MSIRI.

The terms of reference established by Technical Committee and approved by the National Steering Committee were as follows:

- to review the timeline and activities of the project;
- to monitor operation of activities of the project;
- to assign task and responsibility for execution of activities;
- to organize meetings, workshops with stakeholders and partners as required;
- to report to the NSC, through its representative, on progress and achievements;
- to seek approval on expenditures from the NSC;
- to seek approval of the NSC on any proposed modification of activities and difficulties encountered in the process of implementation;
- to draft terms of reference for required outsourcing of capacity;
- to develop information generated by the project activities for dissemination; and,
- to report to the UNEP Project Coordinator in Geneva on achievements.

The Technical Committee was scheduled to meet on a monthly basis and by the end of the project, ten meetings had been held. Work in the Technical Committee was directed mainly towards discussing and clarifying conceptual and methodological issues encountered by the project team, including these related to: (i) trade and land use linkages; (ii) methods, tools and techniques for assessing biodiversity and the impact of changes in land use on biodiversity; (iii) developing well-defined quantitative and verifiable indicators and, (iv) developing scenarios to compare the implications of different policy options.

A3.3 Meetings and consultations

Several meetings and workshops were held in conjunction with the IA and the study relied heavily on data generated during these stakeholder workshops, specialist consultation meetings, focus group meetings, auditing of relevant national reports and statistics, review of documentation on the CBD, the EPA, the European Community Trade Desk, UNEP, and

other local publications from the MSIRI, MAIFPS, and the Ministry of Finance Planning and Economic Development.

Launching workshop (23 April 2007). The project was launched by the Honourable Minister of Agro-Industry and Fisheries on 23 April 2007. The objectives of the workshop were to:

- make the country project known to a broader audience and inform them of the benefits to be derived from the project activities;
- provide an opportunity to refine project objective, output, timeframe, results and ensure active participation of relevant stakeholders; and
- provide a forum for discussion and expression of interest and increase transparency in decision making process.

The launch received press coverage through national television broadcast and was also reported on a daily newspaper. Brochures and related materials were distributed to participants during the workshop.

Capacity Building Workshop 24-25 April 2007. The Capacity Building workshop was organized to present the objectives and planned activities of the country project. Two resource persons from UNEP were present. Some 36 participants from 20 different organizations (including government, the private sector and NGOs) attended the workshop. The main objectives of the workshop were to:

- discuss the rationale of doing an IA of a trade-related policy in the agricultural sector;
- communicate to participants the country project, objectives, activities, expected outcomes and set timeline;
- develop a better understanding of the linkages between trade policies, agriculture, environment and biodiversity;
- introduce the participants to the IA process – the main stages, the tools and techniques (such as the conceptual framework, criteria, indicators, scenario building and evaluation);
- discuss project implementation and identify the relevant project partners and stakeholders and their level of involvement; and
- distribute background materials on the country project, UNEP brochures on Trade, Agriculture and Biodiversity in Africa, the Caribbean and the Pacific, the conceptual framework, Biodiversity in Impact Assessment (International Association for Impact Assessment, Special publication series No.3), and UNEP's working document (2007) Incorporating biodiversity into integrated assessments of trade policy in the agricultural sector, Volume 1: A practical step-by-step guide.

Issues related to trade policies were discussed and eleven presentations including details of the IA methodology and related activities were made during the workshop. Participants attending the workshop: improved their understanding of the project and of the IA methodology; contributed in identifying related ongoing work that could be helpful for the project; identified related areas of studies relevant to biodiversity and sustainability issues; and, assisted with improving the project objectives, deliverables and timeframe.

Brainstorming session (15 June 2007). A brainstorming session was held with representatives from various key organizations and NGOs. The objectives of brainstorming session were to:

- determine the focus of the study;
- identify key policy measures in MAAS for impact assessment;
- identify relevant documents on trade, biodiversity and policy measures; and,
- review the conceptual framework to identify linkages between key policy measures of MAAS and the expected changes.

The following key points were identified with respect to small farmers: regrouping, sustaining marginal areas and moving out of sugar cane (diversification or abandonment). At the corporate and larger farm level centralization, “rightsizing” the labour force and ethanol production were identified as priority issues.

First International Review Meeting (Geneva, 26-28 November 2007). The Project Coordinator and Project Leader participated in the meeting. This meeting was valuable as it provided the Mauritius delegates with the opportunity to exchange views, information and experiences with the other country teams participating in the initiative. It was interesting to note similarities and differences between the country projects, as well as to identify areas for cooperation and the establishment of linkages at the national and international levels on research and analysis.

Country teams also had the opportunity to discuss some of the main challenges encountered during implementation notably with respect to (i) day-to-day project management and coordination; (ii) methods, tools, and techniques for assessing biodiversity impacts in an agricultural trade context; (iii) influence on the policy and decision-making processes, including concrete suggestions and possible ways forward for addressing these challenges and difficulties.

National Review Workshop (4 June 2008). The National Review Workshop was organized to review progress of the country study and to provide a platform for stakeholders to discuss the major challenges and methodologies for the IA of the impact of policies options of the MAAS (2006-2015). The objectives of the one-day workshop were to apprise the relevant stakeholders of the status of the country project and to validate the IA methodologies and relevant indicators developed. Stakeholders present were from the different ministries, semi-governmental institutions, the private sector, and international NGOs.

The conceptual framework developed for the country project was provided to the stakeholders and they were given the opportunity to analyse it and provide feedback. Following the discussion, the framework was amended and adopted. The workshop also reviewed the relevant ecosystem services and confirmed the various indicators and methodologies that would be employed in the IA with respect to those ecosystem services. It was recommended that the ratio of qualitative indicators to quantitative indicators needed to be balanced to produce quantifiable data for analysis.

Some concerns were raised with respect to the following issues:

- the translation of indicators to assess real impact;
- the valuation of indicators and comparison with baseline data to draw valid conclusions with reference to environment, social and economic considerations;

- the difficulty of evaluating social and biodiversity indicators compared to economic indicators; and
- the identification of expertise in valuation techniques for assessment of impacts.

The workshop was helpful for prioritizing possible scenarios for diversification. It recommended that emphasis be placed on the production of potatoes and onions, consistent with the government's strategy for food security. It was also recommended that indicators that cut across different scenarios be used to enable comparisons.

Second International Review Meeting (1-3 July 2008). During this meeting, the six country teams discussed their progress. The meeting provided an opportunity to exchange experiences and receive guidance from the Core Advisory Group before finalizing the studies and developing the national action plans. The objectives of the Second International Review Meeting were to:

- review progress in the country projects;
- exchange experiences among country project teams and with international experts in the Core Advisory Group;
- provide further guidance for completion of the IAs;
- identify specific actions needed to finalize the studies and develop national action plans;
- collect feedback on the UNEP's *Policy Assessment Manual on Agriculture, Trade and Biodiversity*;
- discuss major challenges and opportunities encountered during the IA process, including data collection and methodologies, stakeholder consultations, development of policy recommendations and influencing decision making; and
- identify specific actions needed to complete the IAs by the end of 2008.

Following the group work with subject specialists, the following suggestions were made:

- (i) The need to consider the rehabilitation and restoration of previous sugar cane areas and consider how this could create employment for workers who had been previously employed in the sugar cane industry and for the planters. Scenarios such as agro-forestry could be considered as a potential source of income for farmers.
- (ii) The need to quantify the cost of social impacts to assist the Government of Mauritius to invest effectively to mitigate potential negative impacts.
- (iii) The need to consider how the findings from the study would feed into the MAAS review mechanism, given that the study assessed directly the impact of the MAAS.
- (iv) The need to factor issues of sustainable development, and in particular food security, into the policy recommendations in the study, along with climate change, and the impacts on, and links to, biodiversity (including the production of biofuel).
- (v) The need to explore the possibility of government support for farmers to diversify into other activities.

- (vi) The importance of clarifying the role of the different institutions or organizations linked to the sugar industry in Mauritius, and the importance of other sectors, such as tourism.
- (vii) The need for a strong analysis during the IA taking into consideration both national policies and the local decision-making process. The IA should deliver a strong message with an emphasis on biodiversity impacts.
- (viii) The need to consider the possibility that the sugar industry in Mauritius is not efficient or competitive on the international market, leaving it in a position such as that of Jamaica. The two countries might share experiences.
- (ix) The need to identify clearly the assumptions made in the IA.
- (x) The opportunities for shifting into other crops, given that sugar cane is a mono cropping system. Opportunities for rehabilitating or improving levels of biodiversity through reforestation, carbon sequestration, water management and watershed restoration might be important.

Focus group meetings. Focus group meetings were held with planters involved in regrouping programmes to gather feedback on how small- and medium-sized farmers perceived the advantages and disadvantages of the regrouping exercise under the MAAS. The feedback obtained from the farmers included the following points:

- planters have benefited from improved infrastructure and this has facilitated the mechanization of field operations;
- regrouping has led to the elimination of small paths, provided access to wider roads, an increase in acreage under cane, and improved management with regards to fertilizer application and weed control;
- with mechanical harvesting there is a percentage loss due to uneven height at which the harvester cuts the cane stem and so planters suggested that the blades of the mechanical harvester be adjusted to minimize the loss of cane;
- there is no need to look for labourers in periods of high demand and farmers are free from labour associated problems as harvest is mechanized;
- under regrouping, the harvest period has been shortened from 3 or 4 months to one month where 5 000 to 6 000 tonnes per month can be harvested;
- with regrouping, more land has become available for cultivation of sugar cane as rock piles, minor roads and tracks have been removed from the fields; and
- under regrouping, the individual growers do not have to undertake any cultural practices on their own as all operations are planned and scheduled collectively and undertaken by a private contractor.

The focus group meetings confirmed the different findings and observations of the survey that had been carried out among the planters involved in the regrouping. The apprehension voiced by planters was that if the price of sugar were to go down, the value of their land would probably also decrease.

National Stakeholder Workshop (7 November 2008). The objective of the one-day National Stakeholder Workshop was to present the status and achievements of the project and to confirm the findings of the various components of the country study. The objective also included the development of a set of recommendations to better integrate sustainable management of biodiversity in the context of trade negotiations on agriculture. The validation exercise included representatives of relevant government departments, quasi-government organizations, international organizations, the private sector and NGOs. Participants also had the opportunity to prioritize recommendations for the implementation phase.

Some 29 participants attended the workshop, which included an opening session followed by several presentations by the Core Team members and consultants. The afternoon session was reserved for group work sessions and discussions.

During the workshop the three resource persons contracted under the project had the opportunity to present the findings of their work. The final list of recommendation was circulated for comments. Following amendments, the recommendations were prioritized.

Sub-working Group on Biodiversity. A Sub-working Group was established involving the Core Team, biodiversity specialists and representatives from the Forestry Service, the National Park and Conservation Service and the Mauritius Wildlife Foundation. Several meetings were held to discuss the impact of the different scenarios of moving out of sugar cane (agro-forestry, food crop production, livestock production, ecotourism and IRS projects, and abandonment of sugar cane land) on biodiversity. The findings of the Sub-working Group have been incorporated into the final IA.

A3.4 The approach to the IA

An analytical process was applied to the policy measures identified by the NSC and in various meetings. The IA adopted a process that consisted of the following four analytical steps:

- identifying the relevant economic, social and environmental issues as drivers of change to develop indicators;
- determining the baseline for the IA;
- identifying and developing policy options (scenarios); and
- conducting the analysis and discussing results.

The conceptual framework was developed and modified, potential scenarios were developed and data was collected for the assessment of scenarios. The IA employed a systematic approach for considering the full range of effects, direct and indirect, that the policies from the MAAS could possibly have on the environment, the economy, and society, with a special emphasis on biodiversity. A range of methodologies was used (and in some instances a mix of methodologies) depending on the type of policy being analysed and the impacts being measured. The availability and type of data influenced the choice of appropriate methodology.

Conceptual framework for the assessment of linkages between trade policies, agriculture, biodiversity and ecosystem services and human well-being

Human well-being and poverty reduction	Trade agreements and other influences on agriculture
<ul style="list-style-type: none"> • Food security • Lifestyle around village and sugar estates • Unemployment • Social problems (such as alcoholism) • Re-training • New job opportunities (IRS) • Gender issues 	<ul style="list-style-type: none"> • EU sugar regime • Reform in the economy • MAAS for sugar sector • Price and market of sugar • Sugar Industry Efficiency Act 2001 • Non-sugar sector plan • EPA and bilateral and/or Regional Trade Agreements • NBSAP • Democratization of land • Energy policy • IRS policy • Negotiations with WTO to consider sugar as sensitive product or as a tropical product • Trade agreement with Brazil • Food security • Increasing oil price • Diversification (food and livestock) • Cross Border Initiative • Southern African Development Community Initiative for seed security • Biofuel policy
Biodiversity and ecosystem services	Agricultural activities and changes in land tenure and use
<p>Provisioning</p> <ul style="list-style-type: none"> • Import substitution • Reduction in import of fuel • Increase in water demand • Reduction in fertilizer imports <p>Regulating</p> <ul style="list-style-type: none"> • Control of erosion and sedimentation • Regulate pests and pathogens • Increase in infiltration rate • Habitat for beneficial organisms • Water purification and waste treatment <p>Cultural</p> <ul style="list-style-type: none"> • Historical and cultural heritage • Conservation of valued species • Recreation and ecotourism value 	<ul style="list-style-type: none"> • Change in land use • Diversification, agro-forestry • Infrastructure, IRS • Abandonment and/or fragmentation of agricultural areas • Intensification (grouping of farmers) • Sugar cane for other use • Impact on flora and fauna • Soil erosion

The conceptual framework was developed to show the linkages between the EU sugar reform, ongoing trade negotiations and domestic policies related to agriculture, land use, biodiversity, ecosystem services, and the well-being of the Mauritian population. The conceptual framework was the first step prior to IA as it helped to achieve a better understanding between trade, development and biodiversity; the key issues have been identified, including the main cause-effect chains. Information was gathered from the two

main focus groups (small planters and the corporate sector). Projections were made and potential scenarios were developed.

The main ecosystem services provided by the natural resources and processes of the sugar industry were documented in the IA and indicators were identified for each of the ecosystem services were developed for use in future assessments. Some of the most important indicators are:

- the increase in use of pesticides in crops other than sugar cane;
- the loss of beneficial insects associated with host plants present on rock piles in sugar cane fields;
- the impact of diversification on number of cases of pesticide poisoning (health and livelihood of population around the fields) (quantify); and
- the contribution to cultural heritage and landscape for ecotourism (quantify).

The collection of field data (especially the survey of small planters involved in the regrouping) was done with the help of officers from the FSC. Based on data available, preliminary analysis was undertaken to assess the direct and indirect effect on the environment, the economy and society. A combination of the following methodologies was employed: field surveys; interviews; focus groups discussions; specialist consultations; brainstorming; scenario building; stakeholder consultation; trend analysis; site visits; and literature reviews.

It was difficult to include sophisticated tools for assessment, such as valuation techniques, multi-criteria analysis, or root-cause analysis due to the lack of readily available baseline data, expertise, and time constraints.

For the purpose of this IA, the following documents were consulted: several Strategic Plans (Forestry Action Plan, National Biodiversity Action Plan 2007-2015, the National Environment Action Plan 2, National Invasive Alien Species Action Plan) as well as Environmental Impact Assessment (EIA) studies for projects on Integrated Resort Schemes and *Morcellement* for residential purposes. The Strategic Environmental Assessment for the Multi-annual Adaptation Strategy for the Mauritian sugar cane cluster (2006-2015) undertaken by the European Union (EU) and relevant documents related to trade, biodiversity and policy measures related to the EU sugar reform were also consulted. Relevant documents related to trade, biodiversity and policy measures related to the EU sugar reform were also compiled and made available to stakeholders.

Three consultants were hired to conduct detailed study on: (a) the corporate sector; (b) biodiversity associated with sugar cane; and (c) livelihood of people linked directly or indirectly to the sugar cane industry.

The IA process recommended in the guidelines provided by UNEP's Core Advisory Group was considered with proposed action for biodiversity assessment and the activities undertaken were defined as follows:

- (i) the identification of the policy context and purpose of the country study;
- (ii) the identification of all relevant stakeholders (Ministry of Agro-Industry, Food Production and Security, Ministry of Environment and National Development Unit, Ministry of Trade and Foreign Affairs), specialists in the sugar industry, biodiversity, social interests, forestry and wildlife, representative of growers' associations, private sectors and NGOs with

direct or indirect interest in agriculture or trade linked to biodiversity; these stakeholders participated in the study and were major players in the provision of relevant information and data and assisted in validating findings;

- (iii) undertaking an audit of existing national environmental and biodiversity related policies and relevant international trade policies in the agricultural sector;
- (iv) establishing a NSC comprised of relevant stakeholders to monitor the development and implementation of the country project;
- (v) establishing a Technical Committee to monitor activities in the project, organize meetings and workshops, and to report progress and achievements to the NSC; a core group was also established to liaise and interact with the various stakeholders and institutions, and included the main investigator with the participation of experts in relevant fields from different institutions as required;
- (vi) disseminating awareness of the purpose of the IA through a ‘Launching Workshop’ involving all relevant stakeholders and policy makers;
- (vii) organizing a Capacity Building Workshop with the support of UNEP consultants to train relevant stakeholders on the IA methodology;
- (viii) assessing the present status of trade, and other related environmental and biodiversity related national policies, particularly the MAAS for the sugar sector (2006-2015) in the agricultural sector, for the development of a conceptual framework based on cause-effect chains;
- (ix) seeking expert opinion and organize focus group meetings to decide on policy options and priority interventions of the MAAS and identify relevant indicators of sustainability, biodiversity and ecosystem services;
- (x) holding expert consultations in the corporate sector to gather information on current issues, changes due to the impacts of MASS initiatives and other likely changes planned by the corporate sector to assure the survival of the industry;
- (xi) conducting a survey of small sugar cane holders to compare production performance, biodiversity issues and cultural practices prior to and after regrouping. Two focus group meetings were organized with different groups of small scale farmers of the FORIP to validate findings of survey and other findings from different sources. An investigation with respect to future decision making processes was also conducted;
- (xii) given that the majority of impacts cannot be observed due to the time taken for response to occur following a policy action (and all policy actions had not been fully implemented), recourse was made to **scenario building** with the involvement of stakeholders to identify the most likely responses. Two main scenarios were considered for analysis. The first was that sugar cane producers would continue with sugar production under current or modified conditions and the second scenario involved farmers moving out of sugar cane into other activities or total abandonment. In this respect multistakeholder working groups were organized to project the likely impacts of possible changes in land use under:
 - a. intensification of the sugar sector to meet the objectives of MAAS;
 - and

- b. conversion from sugar cane to other agricultural uses, non-agricultural uses or abandonment.

Historical data and qualitative information from technical reports, stakeholder consultations and collective thinking were used to forecast future trends;

- (xiii) seeking expertise of local consultants and specialists to gather information to qualify likely changes and characterized ecosystem services most likely to be either positively or negatively affected; and
- (xiv) conducting a national stakeholders' workshop to validate findings and recommendations of the country study.

A3.5 Main achievements

The main achievements of the project are as follows:

- establishing a Core Team to implement the country study;
- identifying relevant stakeholders;
- capacity building for stakeholders on the IA methodology;
- organizing the Launching Workshop (23 April 2007);
- organizing the national Capacity Building Workshop (24-25 April 2007);
- Establishing the National Steering Committee under the chairmanship of the Permanent Secretary of the Ministry of Agro Industry, Food Production and Security;
- establishing a Technical Committee with well-defined terms of reference for implementing the IA;
- determining the focus of the study;
- developing the conceptual framework;
- establishing a website (<http://www.areu.mu/biodiv>) for sharing information among stakeholders;
- extracting relevant information from existing national reports;
- undertaking a field survey for assessment of the impact of regrouping of small sugar cane planters;
- recruiting national experts to assess policy options of MAAS in the corporate sector, policy options of MAAS on biodiversity associated with sugar cane, and policy options of MAAS on livelihood of people linked directly and indirectly to the sugar cane industry;
- holding focus group meetings with planters to validate findings of the survey undertaken in the regrouped area; and
- organizing a National Stakeholders Workshop to prioritise the recommendations.

The project has helped build institutional and human capacity related to IA methodologies, project management, and inter-institutional cooperation. The IA gave the institutions involved in the project (government, quasi-government, research institutions, non-governmental organizations, and private stakeholders) the opportunity to understand the linkages between trade policy and impacts on biodiversity. Though a number of national assessments have been carried out assessing existing policies, their emphasis has been on the economic, the social and environmental impacts. The IA was new for Mauritius and all the stakeholders appreciated the new approach.

This initiative has also been very useful for policy makers as awareness of biodiversity was brought into context over and above the economic, environmental and social dimensions

that are required in the decision-making process and in the elaboration of any new future policies.

A3.6 Main challenges

Although it is not complex, the application of the proposed IA methodology was not easy for several stakeholders. The core team required practical experience and expertise in the use of the various tools for assessment suggested by the Manual and access to baseline data and field data. During the study various constraints emerged, some of which could not be addressed fully either due to lack of data or time constraints. Challenges identified included the following:

- lack of expert support in the application of the methodology at the local level in the field;
- poor access to related studies and documents;
- limited data to help to understand the linkages between environment, social issues and the economy;
- lack of expertise in valuation techniques;
- the relative recent implementation of MAAS policies and the complexity of assessing potential long-term impacts on biodiversity meant that the two-year time frame associated with the IA was not adequate;
- the participation and collaboration of some of stakeholders was insufficient.
- data, relevant analysis and findings from previous studies were difficult to access due to the unwillingness of some stakeholders to share information;
- there was a lack of baseline data on biodiversity and ecosystem services;
- the absence of effective networking among some relevant institutions;
- difficulty capturing some indicators and/or socio-economic data as farmers do not depend solely on revenue from sugar plantations;
- dynamic changes in international trade policy along with the global food crisis, the global economic crisis, the sharp drop in fuel prices, and an evolving market situation complicated the analysis and made it difficult to establish clear causal relationships; and
- the indicators developed to measure change have to be observed over time and while they were not indicative for this study, they could be useful in future assessments.

Annex 4: Field Operations Regrouping and Irrigation Projects (FORIP) survey

The objectives of the survey were to:

- assess sugar cane production under FORIP and compare benefits and constraints with the traditional method of growing sugar cane by small planters;
- observe changes in the environment of the sugar cane biodiversity; and
- observe the changes at the social and economic level of planters.

Two sites were selected, Forbach/Kalimaye and Queen Victoria, where the FORIP project was already implemented and sugar cane cultivation was already present under the regrouped management system. The two sites had different conditions as Forbach/Kalimaye is in the north and is irrigated while Queen Victoria is in the East and cane is cultivated under rain-fed condition. The sample was based on the maximum number of farmers that could be met during the data collection period of three weeks. A target of 50 per cent of planters was set for each site. The list of planters was obtained from the Farmers Service Corporation (FSC). The questionnaire was divided into two parts pertaining to the planter's profile and to the field where the cultural practices and other field observations were recorded. An additional set of planters who did not form part of the FORIP was also interviewed for comparison purposes. This set was kept small as sufficient information was available on traditional sugar cane cultivation by small planters. They were not required to answer questions related to the regrouping of fields.

Planters were interviewed, with prior appointment, by field officers of the FSC who are fully acquainted with sugar cane planters. The field officers also visited the respective fields for observations. The field officers were given a briefing on filling out the form and on observations to be collected in the field. The field officers have a good knowledge of cane biodiversity and did not require any additional training. The field officers were supervised by the manager of the FSC.

Secondary data on yield was obtained from the factory and data on cost and other inputs used for the plantation was provided by the FSC, which supervised implementation of the project.

The findings of the survey were validated in a group meeting with planter representatives where the findings were presented for discussion. Planters agreed to all responses obtained in the survey and provided valid reasons for observation made.

Results and discussion

Some 24 planters from Queen Victoria and 13 from Forbach/Kalymaye were interviewed. Another 10 planters not falling under the FORIP were also interviewed.

The planters involved in FORIP were equally male and female and all had a family. Some 70 per cent were married while the others were single or widowed. Very few households were headed by females and generally, land owned by female planters is looked after by either their husbands or their sons. Half the individuals interviewed were in the age group of 45 to 60 years while 42 per cent were 60 years or older. A small number (8 per cent)

were 30 years old or younger. All the planters had some education and 64 per cent had attended secondary schools. Some 10 per cent had tertiary levels of education and the rest had only primary levels of education. From the persons interviewed, 30 per cent were housewives with no other job while 20 per cent had another job. Some 11 per cent were operating a small business and the rest were dependent on the sugar cane plantation. All those above 60 years old were also drawing pensions. A total of 47 per cent of individuals interviewed were dependent on revenues from salaries from a fixed job and revenue from sugar cane. Some 8 per cent of individuals surveyed engaged in food-crop cultivation in addition to sugar cane.

The field sizes in the regrouped blocks varied from 0.42 to 3.86 hectares with a third of the total planters having field sizes of over 2 hectares. However, some planters own other plots outside the regrouped blocks. Before the regrouping, all operations were conducted manually except for land preparation at time of planting, which occurs once in seven to ten years or more. Other operations, such as weeding, trash lining, earthing up, and the application of herbicides and fertilizers were manually conducted on those fields. Mechanical harvesting was nonexistent in those fields and after regrouping all fields in the blocks were mechanically harvested, practicing green harvesting. Further, no burning of cane will be practiced in FORIP blocks. Following the regrouping, all these operations have been mechanized and very little labour is required. This labour is provided by the operators who have been contracted by the FORIP in the specific blocks.

Planters from both the Forbach/Kalimaye and Queen Victoria reported that under the FORIP project there has been a significant improvement in field conditions where areas unutilized due to field borders, and rock piles, had been reclaimed. An additional improvement is that the fields in the blocks have been rendered rock free as de-rocking using heavy machinery was done during the initial land preparation. On the other hand, the field demarcation has disappeared. The removal of demarcations helps create a sense of community among planters and the sense of belonging to a block while. However, for the younger generation who will inherit the land in future, they will lose track of their specific field location.

Cultural practices have been altered from what was practiced before the regrouping. The single row plantation has been replaced by dual row cane plantation to suit mechanical harvesting. The variety in cane diversity has not yet shown significant changes. However, the predominant variety R570 has been replaced by M3035 and M1400/86 has been replaced by M703/89. The variety R579 is being used to replace R570 in other blocks not included in survey. The cane yield of the newly introduced variety M 1400/86 was on average 18.38 t/hectare, compared with 15.6 t/hectare for the previously grown cane variety R570. It is believed that more cane varieties will be used as the size of the FORIP project increases.

Under the egrouping, the application of fertilizers is done with respect to soil analysis while the non-regrouped planters are still continuing with blanket application of fertilizers. Some planters complained that they are not able to intercrop or rent their land for intercropping, which has been a practice in the past.

In maintaining sugar cane plantation, planters are either involved in providing their own labour, family labour, and supervision. Activity in sugar cane fields is not a daily business and thus does not require a full-time engagement in maintaining the crop. There are fixed

periods where specific operations are necessary and there are fixed occasions when either labour or supervision is required. The survey showed that regrouped planters are no longer providing their own or family labour and their supervision time and frequency has been reduced to a large extent. Since cane cultivation uses mostly casual hired labour, only around 10 per cent of planters were providing their own labour for field activities. These farmers are now not able to provide their labour for their own cultivation as most of the operations are now mechanized.

The time for supervision of field activities has shown significant reduction with regrouping. The table below provides an indication of the percentage of farmers spending their supervision time before and after the regrouping. Planters in group meetings pointed out that the regrouping has resolved the problem of the scarcity of manual labour, which is becoming less and less available.

Percentage of planters spending days of supervision of field activities

No. of days of supervision	FORIP	
	Before	After
0	11.1	52.8
1	16.7	16.7
2	36.1	19.4
3	19.4	2.8
4>	16.7	8.3

It is clear that following the regrouping farmers have more free time, and around 41 per cent have stopped any supervision of fields and it is fully the responsibility of the group management team to look after all field operations. In the group meeting it was also highlighted that some farmers still go to the field for supervision and for social reasons. The 59 per cent of farmers who still go to the field do so as a visit to keep track of what is happening on the field rather than to supervise or give instructions. Further, some claimed that they did not want to change their lifestyle of exercising while visiting their fields in the morning.

It was observed that no new activities outside sugar cane cultivation have been undertaken by planters after the regrouping of fields. Discussion in group meetings revealed that the main reason could be that most planters are retired and pensioners. Others claimed that it is too late for them to learn and reorient their new free time to any other activities and further, that other activities are more demanding than sugar cane cultivation.

The planters perceive that there have been some disturbances to the cane ecosystem. The use of herbicides has reduced the abundance and range of weed species. A general observation has shown that an average of eight predominant species of weeds has been reduced to three species. The removal of field borders and rock piles has destroyed the natural habitat of some of the fauna such as coccenellids, mongoose, hare, and quail. They believe that they see fewer of these species when they visit the fields. In the group meetings the planters agreed that green harvesting will provide conditions conducive for microorganisms to develop in the soil, although soil compaction due to the regular use of machinery and harvesters may cause some adverse effects.

FSC, the implementing body of FORIP, has estimated the cost of production, and the table below indicates the reduction in cost of the main field operations.

Operations	Cost/hectare	
	fields not under Regrouping project	fields under Regrouping projects
Weed control	MUR3 500	MUR2 500
Trash lining	MUR1 400	MUR0
Harvest and loading	MUR7 000	MUR5 200
Transport cost	MUR3 100	MUR2 600

Planters are also convinced that the cost of production has reduced significantly as well as the management load, which had not been accounted for in monetary terms earlier.

In the group meeting, planters indicated an interest from more and more planters to join the regrouping scheme. Since the younger generation are mainly part-time farmers with limited knowledge in sugar cane cultivation, regrouping is expected to be a viable option. At the same time, some planters felt that they were detached from their land and family labour was rendered redundant. The labour force living in the vicinity of the farm was made redundant and had to seek jobs with contractors operating in distant areas.

A sugar cane plantation under optimal condition will provide good yield for a period of 7 to 10 years. Planters could not predict what may happen to plantations and the regrouping after the seventh year of the project period, which has been committed by the growers under the project.

Constraints

One main constraint recorded is that planters in Mauritius do not keep formal records and it was difficult to get accurate figures related to cost and operations. Second, it was not possible to measure and quantify the cane biodiversity and to estimate their increase or decreases due to the changes. The time factor for deeper observation and observations of trends on specific parameters was also a major constraint.

Conclusion

The survey did reveal the dynamics of changes going on in sugar cane cultivation and how FORIP was a viable option at least for the planters who have joined the project. Economic gains are evident at some cost to biodiversity, which could not be estimated or valued. The social involvement of most of the planters has changed due to the availability of extra time while, on the other hand, a sense of detachment with the field and cultivation was strongly felt. Planters still do not know how the future will be as there is no plan devised yet to cater for the regrouping after the seven years of commitment. It is agreed that economies of scale have been achieved, with costs of production being reduced drastically (per tonne of cane) amounting to some MUR5 000 per hectare which is equivalent to an overall reduction in operating costs of 20 per cent.

FORIP Survey Questionnaire

FORIP Questionnaire for Planter

Date of interview / Field Visit:/...../.....	
Name of Enumerator:	Signature:

Farmer Profile

1. Surname: 2. Name:

3. National ID No.:

--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

4. Telephone number: Mobile:

5. a Contact address: 5. b Main field address:(if different from contact)

1..... 1.....

2..... 2.....

3..... 3.....

6. Age:

<30	30 - 45	45 - 60	>60
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7. Sex

Male	Female
------	--------

8. Marital status(√):

Single	<input type="checkbox"/>
Married	<input type="checkbox"/>
Divorced	<input type="checkbox"/>
Widow	<input type="checkbox"/>
Living together	<input type="checkbox"/>

9. Position in household(√):

Household head	<input type="checkbox"/>
Spouse	<input type="checkbox"/>
Father/Mother	<input type="checkbox"/>
Daughter/Son	<input type="checkbox"/>
Brother/ Sister	<input type="checkbox"/>
Other (specify)	<input type="checkbox"/>

10. Level of education(√):

No schooling	<input type="checkbox"/>
Primary	<input type="checkbox"/>
Secondary	<input type="checkbox"/>
Tertiary	<input type="checkbox"/>
Vocational Training	<input type="checkbox"/>

10. Occupation

11. Family compositions

	Occupation
Self	
Spouse	
Father	
Mother	
Other	

Children	Sex	Occupation
1		
2		
3		
4		
5		

12. Activity involvement in agriculture

Activity type	Before regrouping		After regrouping	
	Time (hrs)	Frequency	Time (hrs)	Frequency

Labour				
Supervision				
Management				
Other				

13. Housing status

Own house	<input type="checkbox"/>
Rented	<input type="checkbox"/>
Shared	<input type="checkbox"/>
Other	<input type="checkbox"/>

14. Type of house

Luxury	<input type="checkbox"/>
Comfortable	<input type="checkbox"/>
Basic	<input type="checkbox"/>

15. Vehicle owned

	Purpose/use
Motorcycle	<input type="checkbox"/>
Car	<input type="checkbox"/>
Van / 4x 4	<input type="checkbox"/>
Other	<input type="checkbox"/>

16. Land status

Sno	Field location	Area (ha)	Status*	Crop grown	Distance from field (km)
1					
3					
4					
4					
5					
6					

* - Owned or Rented

17. Monthly total household revenue

Source of revenue

						Annual
Profession/salary	<5,000	5,000 - <10,000	10,000-<20,000	20,000-<30,000	>30,000	
Business	<5,000	5,000 - <10,000	10,000-<20,000	20,000-<30,000	>30,000	
Home industry	<5,000	5,000 - <10,000	10,000-<20,000	20,000-<30,000	>30,000	
Livestock	<5,000	5,000 - <10,000	10,000-<20,000	20,000-<30,000	>30,000	
Crop	<5,000	5,000 - <10,000	10,000-<20,000	20,000-<30,000	>30,000	
Sugar cane	<5,000	5,000 - <10,000	10,000-<20,000	20,000-<30,000	>30,000	

18. Indicate whether any revenue generating activity has been taken after regrouping

19. Remarks

FORIP Field Questionnaire

Date of interview / Field visit:/...../.....

Name of enumerator: Signature:

1. Surname of owner: 2. Name of owner:

2. Location of field:

3. Land grouping: Area (ha)

4. Soil Type

5. Rockiness of field

	Before grouping	After grouping
Very rocky with bed rock		
Very rocky		
Rocky		
Few rocks		
Not rocky		
Rock piles		

6. Soil parameters

	Value (units)		Value (units)
pH		% Organic matter	
N		% Sand	
P		% Silt	
K		% Clay	
Porosity		Compactness	
Infiltration		Level of microorganisms	

7. Mechanization (last plantation)

Activity	Type of mechanization	No. of hours

8. Labour

Activity	No of man days	Activity	No of man days

Distribution – 1: Scattered, 2: Patches, 3: Large extent, 4: Whole Field

14. Fauna

Fauna / Beneficial agents / Pest	Abundance	Inside	Border

Abundance – 1: Present, 2: Sparse, 3: Mild, 4: Infested

Distribution – 1: Scattered, 2: Patches, 3: Large extent, 4: Whole Field

15. Field demarcation Present Absent Means of field separation

16. Drainage System

- Water logging & flooding of field
- Drainage present in field
- Adequate drainage in field
- Main drainage system outside field

Before	Currently

Yes/No

17. Harvesting method

- Green harvesting
- Trashing
- Burning
- Other

18. Opinion on grouping and factors considered

Advantages	Disadvantages

19. Remarks

About the UNEP Division of Technology, Industry and Economics

The UNEP Division of Technology, Industry and Economics (DTIE) helps governments, local authorities and decision-makers in business and industry to develop and implement policies and practices focusing on sustainable development.

The Division works to promote:

- > sustainable consumption and production,
- > the efficient use of renewable energy,
- > adequate management of chemicals,
- > the integration of environmental costs in development policies.

The Office of the Director, located in Paris, coordinates activities through:

- > **The International Environmental Technology Centre** - IETC (Osaka, Shiga), which implements integrated waste, water and disaster management programmes, focusing in particular on Asia.
- > **Production and Consumption** (Paris), which promotes sustainable consumption and production patterns as a contribution to human development through global markets.
- > **Chemicals** (Geneva), which catalyzes global actions to bring about the sound management of chemicals and the improvement of chemical safety worldwide.
- > **Energy** (Paris), which fosters energy and transport policies for sustainable development and encourages investment in renewable energy and energy efficiency.
- > **OzonAction** (Paris), which supports the phase-out of ozone depleting substances in developing countries and countries with economies in transition to ensure implementation of the Montreal Protocol.
- > **Economics and Trade** (Geneva), which helps countries to integrate environmental considerations into economic and trade policies, and works with the finance sector to incorporate sustainable development policies.

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