Mauritius Sugarcane Sector Review
Competitiveness Analysis

December 20, 2020

ACRONYMS AND DEFINITIONS

ACP	African, Caribbean and Pacific
AEL	Alteo Energy Ltd
AMU	Agriculture Mechanization Unit
BTPF	Bagasse Transfer Price Fund
CAD	Control and Arbitration Department
CEB	Central Electricity Board
COMESA	Common Market for Eastern and Southern Africa
CSS	Cooperative Sugarcane Societies
ERS	Early Retirement Scheme
EU	European Union
FORIP	Field Operations Regrouping and Irrigation Project
FSA	Farmers Service Agency
GDP	Gross Domestic Product
HFO	Heavy Fuel Oil
HRDC	Human Resources Development Council
IA	Irrigation Authority
IPP	Independent Power Producers
IRSC	Industrial Recoverable Sucrose Content
IUF	International Union of Food, Agricultural, Hotel, Restaurant, Catering, Tobacco and Allied Workers' Associations
JTC	Joint Technical Committee
LEI	Landbouw Economics Institute
MAAS	Multi-Annual Adaptation Strategy
MCAF	Mauritius Cooperative Agricultural Federation Ltd
MCA	Mauritius Chamber of Agriculture
MCIA	Mauritius Cane Industry Authority
MEPU	Ministry of Energy and Public Utilities
MOAI	Ministry of Agroindustry and Food Security
MOFED	Ministry of Finance, Economic Planning and Development
MSIRI	Mauritius Sugarcane Industry Research Institute
MSS	Mauritius Sugar Syndicate
MT	Metric Ton
NPV	Net Present Value
OTEO	Omnicane Thermal Energy Operations
PC	Plant Cane
PEA	Power Exchange Agreements
PWS	Plantation white sugar
R&D	Research and Development
SACU	Southern Africa Customs Union
SADC	Southern African Development Community
SCSF	Sugarcane Sustainability Fund
SIEA	Sugar Industry Efficiency Act

SIFB	Sugar Insurance Fund Board
SIS	Sugar Industry Statistics
SSHU	Sugar Storage and Handling Unit
SSSP	Sugar Sector Strategy Plan
TCH	Ton of Cane per Hectare
VRS	Voluntary Retirement Scheme

GLOSSARY

Absolute alcohol	Common name for the chemical compound ethanol. To qualify as "absolute", the ethyl alcohol must contain no more than 1% water.
Accrued sugar	Sugar obtained from sugarcane, dependent on the sugar content of the cane and the extraction rate of the miller.
Alteo	Mauritian company focusing on sugarcane production and processing, and energy cogeneration: https://www.alteogroup.com/
Bagasse	Fibrous residue left after all sugars have been extracted from cane stalks, which can be utilized to generate electricity.
Bulk sugar	This includes all types of sugar produced from cane, including specialty, table or white sugar
Cogeneration	The concurrent production of electricity or mechanical power and useful thermal energy (heating and/or cooling) from a single source of energy.
Distiller	A manufacturer of liquor.
Grays	Mauritian distillery: https://grays.mu/export/
Green Premium	Premium paid above the normal price due to environmental services rendered.
Medine	Mauritian company focused on agriculture production among other business lines: https://medine.com/
Métayer	One that cultivates land for a share of its yield usually receiving stock, tools, and/or seed from the landlord.
Millers	Factories (or owners of factories) that processes sugarcane to produce raw or white sugar.
Molasses	Final viscous product generated when no more sucrose crystals can be formed. It is sold directly as animal feed and to distilleries to produce ethanol and alcohol.
Non-originating sugar	Raw sugar not originating (produced) in Mauritius, thus imported, mainly for refining purposes.
Omnicane	Mauritian company focusing on sugarcane production and processing, and energy cogeneration: http://www.omnicane.com/
Planter	Farmer that produces sugarcane.
Plantation white sugar	PWS is produced directly from cane processing at the mill. While PWS can be directly consumed as result of the double clarification process, it can also be refined to produce white refined sugar.
Ratoon	A shoot of the sugarcane plant. It is the method of propagation in sugarcane in which subterranean buds on the stubble give rise to a new crop stand. In this report the ratoon cycle is the replanting cycle of the sugarcane.
Raw/Brown sugar	Raw or brown sugar for consumption.
Terra	Mauritian company focusing on sugarcane production and processing, and energy cogneration: https://www.terra.co.mu/

White Refined Sugar	Type of refined sugar that comes from sugarcane or sugar beets. It is a food-grade product also called table sugar, granulated sugar or regular sugar.
Specialty sugars	Type of sugar that groups different types of sugar that have enhanced value and flavor due to the syrup used for coating the crystals at the mill.

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EXECUTIVE SUMMARY

The sugarcane sector is an important and highly interlinked sector in the Mauritius economy. It is supported by a myriad of public, private and civil society institutions, and relies on five subsectors along its value chain: planters, millers, refineries, independent power producers and distilleries.

Since the 1990s, significant efforts have been made to transform the sugarcane sector, increasing productivity and diversifying sources of revenue away from raw sugar to producing multiple types of sugar, bagasse and molasses. However, public policies and programs to improve the competitiveness of the sugarcane sector have not been fully implemented and have been countered by falling international sugar prices, the discontinuation of preferential access to the EU market, and increasing domestic costs of production. From crop years 2005 to 2019, the ex-Syndicate price of sugar declined by 30% while labor costs have increased by 62% since 2010, as the Mauritian sugarcane sector is highly dependent on exports, with over 90% of sugar production commercialized abroad.

Since 2006, an average of 2,000 hectares of land have been switched out of sugarcane production every year, an annual decline rate of 3.1%. This has contributed to a 2% annual decline in sugarcane production, which has unavoidably led to a decline in milling activity. At the current rate of decline, assuming that no measures to improve the competitiveness of the industry are taken, milling operations would cease somewhere between 2030 and 2037 in a pessimistic scenario. This highlights the extreme urgency for strategic measures to address the competitiveness of the sector.

The downturn has prompted an increase in public sector (taxpayer) support in recent years to fill the gap produced by the drop in sugar revenues. Public expenditures supporting the sugarcane sector were 1.12% of the total Government budget (Rs1.5 billion of a total public budget of Rs133 billion) in 2018, double the budget allocation in 2017. Given the large toll of such support and the continued downturn of the industry, the Ministry of Finance and Economic Development and the Ministry of Agroindustry and Food Security have requested a team of World Bank experts and advisors to undertake a competitiveness analysis to advice on the future of the industry and provide a tool to guide government actions in the transition of the sector.

The analysis (and tool) developed for this competitiveness assessment is based on two separate models built with data gathered in 2020, one focusing at the farm-level and the other at the sector-level. The analysis is intended to model different production patterns, policy and market changes to assess how these may affect the overall viability of the sector. The final objective of this work is to provide stakeholders of the Mauritian sugarcane sector with a competitiveness tool and analysis that can serve as a basis for discussing the future of the sector and the relevant public policy decisions that the Government can consider.

The farm level base model is structured around 16 farm variations covering large corporate estates and small planters. For each farm sector, there are variations by degree of mechanization, use of irrigation, and variety type. These variations were chosen to reflect common differences in on-farm management in Mauritius. Not all varieties and climatic and geographical references could be included; so 16 representative farm variations were selected based on the data gathered. Overall, this analysis shows that farming costs for small planters are 16 to 26% higher than costs from large corporate estates.

The sector-level model aggregates total costs and revenues for the entire value chain. Based on 2019 estimates, the sugarcane sector incurs losses of Rs1.35 billion annually. The sector spends approximately Rs8.87 billion every year to grow and mill sugarcane, refine sugar, and generate electricity, with 49% of costs concentrated at the farm level. On the revenue side, the sector earns around Rs7.5 billion every year from the sales of sugar and electricity, and payments for molasses and bagasse. On a subsector level, nearly all the losses are borne by planters, followed by millers. Under 2019 conditions, refining and IPPs with the generation of electricity from bagasse were the only profitable activities for the sector.

To face this negative outlook, the competitiveness model used Monte Carlo simulations[1] to simultaneously assess the impact of potential variations in market drivers or policy changes on the sugarcane sector's bottom line. The policy-related changes that can produce the largest positive impact in the sector's bottom line (short of direct support) are: (i) increasing the share of specialty sugar sold; (ii) reducing export-related costs (operations and logistics); (iii) increasing the price of electricity from bagasse; (iv) reducing labor costs, and (v) improving the efficiency (yields and/or quality) of sugarcane production. Yet, the analysis shows that no single change in market conditions through public policies or programs can make the sector profitable without direct public sector support.

Under the current production levels and structure, only the simultaneous implementation of the most impactful policy changes can increase the probability of the sector turning a profit over the next decade. Specifically, the sector could be viable if it manages to simultaneously: (i) increase the price paid for electricity from bagasse to the equivalent of HFO; (ii) reduce labor costs by 40%; (iii) increase the share of specialty sugars sold to 50%; (iv) increase the share of high-tech farms to 95%; and (v) save at least Rs200 million per year on sugar export costs. However, once simulations of variations in the international sugar prices and the exchange rate are introduced, these reforms produce an 80% probability of sector profits over the coming 10 years.

It is important to note that this competitiveness analysis does not take into account government and other types of direct payments to the sector, aiming to decouple market from public incentives around the sector. Based on 2019 national budget data, direct support to

[1] *Monte Carlo simulations* perform risk analysis by building models of possible results by substituting a range of values—a probability distribution—for any factor that has inherent uncertainty. It then calculates results over and over, each time using a different set of random values from the probability functions.

the sector stands at approximately Rs657 million[2] (mainly in the form of payments to support small sugarcane producers). If no policy reforms are introduced, a 64% increase of the current level of annual supplemental payments could bridge the gap of expected sector losses while maintaining the current sector structure (level of production). Nonetheless, this figure could increase significantly after accounting for targeting inefficiencies.

Finally, the competitiveness analysis also models six downsizing scenarios for the sector, to account for the possibility that none of the recommended changes are feasible. Although most downsizing scenarios show losses, two show a good probability of profits over the next decade. Their viability is based on the focus of the sugarcane sector on the production and export of specialty sugars. These scenarios were modeled without any additional policy changes like the ones mentioned in the previous paragraph. Yet, the fact that only a few scenarios present a positive outlook entails that there needs to be a "managed" downscaling of the sector to ensure its focus on specialty sugar production, while ensuring appropriate support levels for the transition of farmers and workers to other activities.

[2] Including budgetary measures to pay for an enhanced guaranteed price of Rs25,000/ton for the first 60 tons of sugar, the waiving of SIF premium for small planters, funds for the Cane Replantation Scheme, and grants for the purchase of fertilizer by planters with cane cultivation up to 100 ha.

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1. Mauritius Sugarcane Sector Context

1.1.1 Objective and Limitations of the Analysis

1. **The objective of this analysis is to provide the stakeholders of the sugarcane sector of Mauritius with a competitiveness tool and analysis that can serve as a basis for discussing the future of the sector and model the impact of selected potential public policy changes that the Government can consider.** This analysis does not provide an exhaustive list of potential public policy changes nor public policy recommendations, as those are expected to be a result of the discussions among sector stakeholders. However, certain options are important to consider in seeking to improve competitiveness and addressing the downward production trend.

2. **The analysis (and tool) developed is built on sector-level data gathered by the World Bank during 2020, and is not intended to show the specific situation of any individual farmer, firm or organization, but rather offer an aggregate view at the sector and subsector levels.** The analysis is also built to model different policy and market changes to assess how these changes may affect the overall viability of the sector, and thus point to potential improvements in its competitive position. The analysis is built as a tool for discussion and simulations to be carried out by different stakeholders to show different scenarios and be able to have a constructive dialogue on the needed policy changes. The model provides first order impacts of changes in markets and policies, but does not go into second order, inter-annual effects that could be produced in investments and multiplier effect-type decisions. The estimates presented are an average of sector and subsector data collected, as well as averages of the information from the last seven years[3].

3. **Other possible uses of the tool can be envisioned**. Agriculture researchers and extension officers, for example, could use the tool to analyze the economics of different sector strategies for different parts of the island. Corporate estates and individual planters could use the model to help with private investment decisions and public policymakers to analyze the impact of different public policies and investment programs.

1.2 Introduction and Sector Overview

4. **The sugarcane sector[4] has a multifunctional role in Mauritius**. From an economic standpoint, while sugar sales amount to only 1% of GDP, the sugarcane sector is a considerable earner of foreign exchange, representing around 20% of the food import bill

[3] More information on the two models underpinning the analysis will be described in the section below, and can also be found at https://mcia.mu/world-bank/

[4] Throughout this report, sugarcane sector refers to the entire value chain linked to sugarcane production, from farming, to processing (milling, refining, energy production, etc.), to storing & shipping, to marketing; including the institutions that support the sector.

(JTC Report, 2018). The sector has also served as the basis for establishing other industries and business in the country, with a relatively high economic multiplier effect[5].

5. **From a social standpoint, the non-sugar agriculture sector has a larger income multiplier effect on low income households than the sugarcane sector, but the agriculture sector as a whole is the greatest contributor to income to the lowest-income household segment in comparison to other sectors of the economy** (Sobhee and Rajpati, 2013). Nonetheless, the sector has a larger multiplier effect in the economy than the textile and financial sectors (JCT, 2015) and is an important source of foreign exchange.

6. **The sector also plays an environmental role, with many positive but also some negative impacts.** Today, cane plantations cover 80% of arable land, protecting the soil from erosion, providing a green landscape and a clean source of energy, with 16% of the country's electricity generated from bagasse, and protecting biodiversity, (JTC Report 2018; MSIRI, 2007) However, the sugarcane sector also accounts for negative environmental impacts, mainly during cane transport, processing, cultivation and harvest (Ramjeawon, 2004), and has contributed to the decline of native forests, freshwater bodies, and wetlands over time (MOIA, 2017). The sector is not expected to suffer major drawbacks from climate change, as yields have remained stable and the main risk continues to be tropical storms. However, increased volatility at a global level, as a result of global warming, could result in higher food prices domestically.[6]

7. **Since the 1990s, there have been several efforts to transform the sugarcane sector, making it more competitive by increasing productivity (through investments in R&D, irrigation and mechanization) and by diversifying its sources of revenue from raw sugar to the production of multiple types of sugar, bagasse, and molasses.** Recently (2018/19), total revenues from sugar exports continue to be the main revenue source for the sector (see Figure 13), with specialty sugars accounting for approximately 30% of sugar exports in tons, and 50% in value (MSS, 2019).

8. **The sugarcane sector is highly interlinked along the value chain and relies on five broad subsectors**: planters, millers, refineries, Independent Power Producers (IPPs), and distillers (see Annex 2 with the sugarcane sector material and financial flows along the value chain). In addition to these subsectors, there are a series of public and private institutions that support the value chain, including the Mauritius Sugar Syndicate (MSS), an independent organization governed by sugarcane sector stakeholders and responsible for the marketing and export of all the sugar produced locally (see Table 1 below with the list of public sector institutions involved in the sugarcane sector and their mandate).

Table 1. Public and private sector institutions related to the sugarcane sector

[5] The sugar sector has a multiplier effect of 2.57 compared to 2.13 and 1.66 in the textile and financial intermediation sectors, respectively.
[6] Brizmohun (2019) finds that a 35% predicted surge in the international price of rice would result in an increase of 28.8% in government spending on food security subsidy schemes in Mauritius.

Name of institution	Mandate
1. MOAI	The mission of the Ministry of Agroindustry and Food Security is to be a driver, catalyst, and facilitator for operators in agriculture and agribusiness. To spearhead the development of small- and medium-sized commercial and professional enterprises in the agribusiness sector.
1.1 MCIA	The Mauritius Cane Industry Authority's mission to promote the development of the cane sector through systematic policy measures, creating an enabling environment with innovative and efficient services, R&D, technology transfer and value addition to meet current and future challenges.
1.1.1. MSIRI	The Mauritius Sugarcane Industry Research Institute conducts Research and Development (R&D) under the aegis of MCIA. The R&D objective of the MSIRI is to increase sugar productivity, sustainability, and profitability per unit area. The activities of the MSIRI over the years have encompaased all aspects of sugarcane production and processing as well as value addition and extension. While initially an independent research institution directly financed by sugar producers, MSIRI was integrated into MCIA in 2012.
1.1.2. CAD	The Control and Arbitration Department arbitrates disputes between planters and millers, controls the milling of canes and the manufacturing of sugar, determines the quantity of sugar and coproducts accruing to planters and millers, and executes other functions under the MCIA Act.
1.1.3. FSA	The Farmers Service Agency ensures that essential services are available to planters, promotes the setting up of cane nurseries and the supply of cane setts to planters, and facilitates the adoption of agricultural practices by planters. The mandate also includes the implementation of some government support measures for small planters.
1.1.4. AMU	The Agricultural Mechanization Unit manages a fleet of agricultural machines and equipment.
1.1.5. SSHU	The Sugar Storage and Handling Unit receives, stores and delivers PWS and NOS sugar to the refineries on the island.
1.2 IA	The Irrigation Authority provides irrigation services to the planters with a view of improving their welfare.
2. MSS	Created by law in 1951, the Mauritius Sugar Syndicate is privately managed by sector actors. The Committee that oversees the MSS is composed of 22 members, 14 appointed by the corporate sector and eight appointed by the MOAI at the suggestion of the planters' associations. MSS' objective is to optimize producers' revenue through the adoption of commercial strategies to capture the highest yields from markets on a sustainable basis.
3. SIFB	The objective of the Sugar Insurance Fund Board is to insure the sugar production of planters, métayers and millers against losses due to the effect of inclement weather under its General Insurance policy. SIFB has a board with representatives of MCIA, MOIA, MOFED, and other sector institutions.
4. MEPU	The Ministry of Energy and Public Utilities ensures energy and water security, the safe disposal of wastewater and the peaceful use of nuclear technology and ionizing sources.
4.1 CEB	The Central Electricity Board is a parastatal body owned by the Government under the aegis of the MEPU to prepare and carry out development schemes with the

	general objective of promoting, coordinating and improving the generation, transmission, distribution and sale of electricity.
5. MOFED	The Ministry of Finance, Economic Planning and Development promotes economic development, good governance, and social progress through the accountable, efficient, equitable and sustainable management of public finances, marketing Mauritius as a reputable financial center, and successfully attracting higher levels of investment.

Source: Authors' compilation based on information provided by official Government documents and websites.

Table 2. Civil society organizations related to the sugarcane sector

Name of institution	Mandate
1. MCAF	The Mauritius Cooperative Agricultural Federation Ltd was created in 1950 and represents small sugarcane planters. It gathers 8,000 small sugarcane planters and 154 cooperative credit societies. It is the mouthpiece of the planting community spread out in cooperatives.
2. MCA	The Mauritius Chamber of Agriculture represents the interest of the agricultural private sector members of MCA, and some of the main functions include representation in various local institutions, mediation of differences, formulation of policies and strategies, problem solving, initiating and supporting sector projects and plans and participating in action plans and studies. MCA also provides information and analyses, and supports the promotion of new agribusiness activities initiated by its members.
3. Trade unions	Trade unions represent workers in different parts of the value chain. Several unions exist in Mauritius representing workers: Sugar Industry Labourers Union (SILU), Sugar Industry Staff Employees' Association (SISEA), Organization of Artisans' Unity (OAU), Union of Agriculture Workers (UAWCI), and Artisans General Workers' Union (AGWU).

1.2.1 Planters

9. In 2019, Mauritius produced approximately 3.3 million tons of cane in approximately 47,000 hectares (ha) of land. Maps 1 and 2 show the sugarcane-producing regions and the location of the current three mills. According to the MCIA Act, sugarcane planters are divided into different categories based on the size of their land (see Table 3): small planters cultivate plots smaller than 10 ha, medium and large planters grow on plots of less than 100 ha, and corporate planters occupy areas larger than 100 ha (MCIA Act, 2011). Small planters include métayer planters, a small percentage of planters who lease land from sugar estates for the cultivation of sugarcane for which the rent is determined in terms of sugar (i.e. 10% of their sugar accruing). They are normally categorized as the most vulnerable group of planters, relying on marginal and difficult lands. The Sugar Industry Efficiency (SIE) Act[7] regulates leasing conditions for métayers.

[7] Following a policy decision taken by government and the corporate sector in 2010, métayers can now buy the land under *métayage* based on a valuation and cross-valuation exercise.

10. Of the 47,000 hectares of land under sugarcane, MSIRI reports that approximately 14,000 ha are currently irrigated and approximately 5,000 additional hectares could be brought under irrigation. Access to water for agricultural use was in fact identified as an important constraint on the potential for irrigation given the promising results for irrigated cane measured by cost per ton. In high-rainfall areas, other types of water management systems (such as soil drainage) and/or support for soil liming are also important.

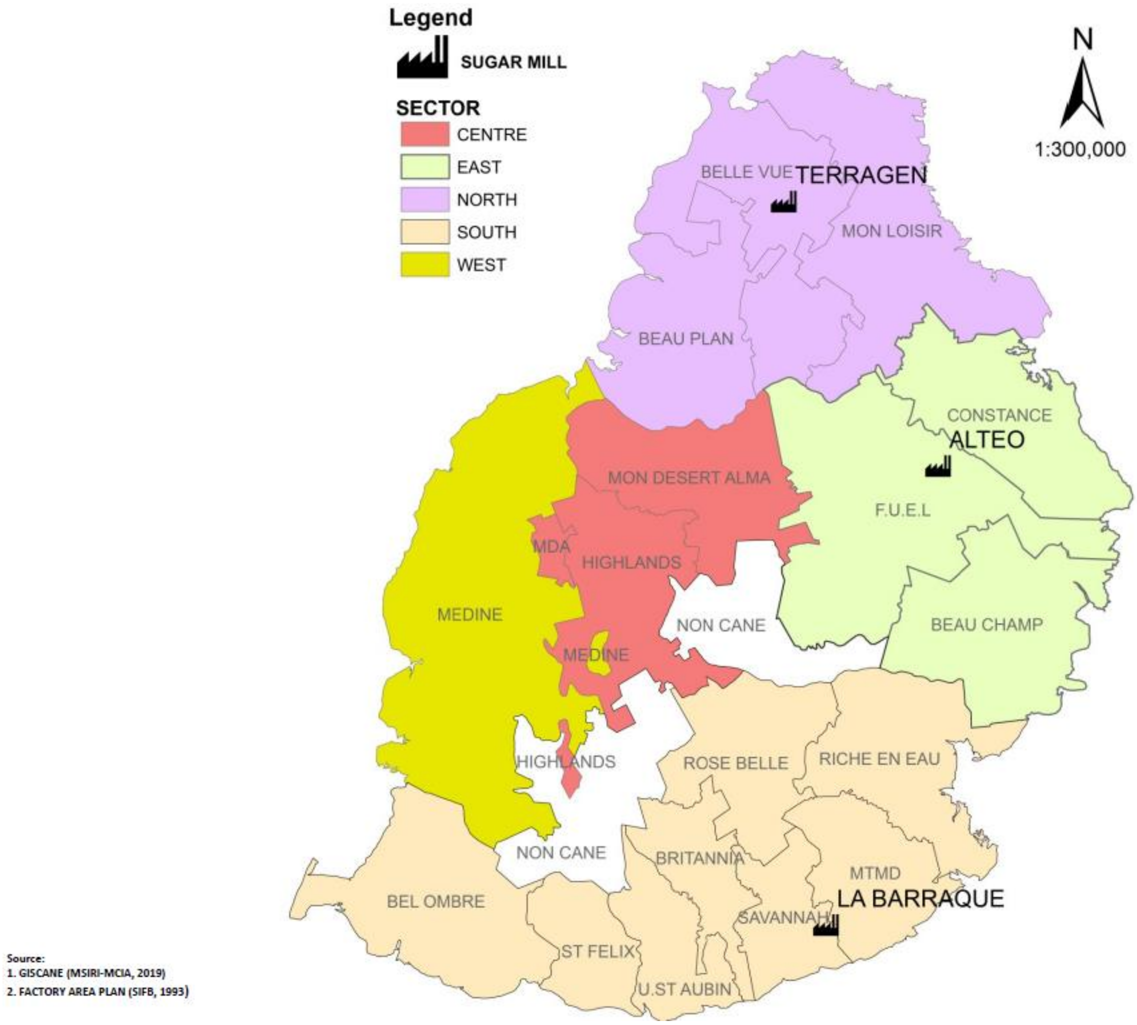
11. The Sugar Industry Statistics (SIS) defines "estates" as any planter that currently operates or previously operated a mill, while "planters" are large and small landowners who never owned a mill. As shown in Table 3, estates account for around 56% of total cane area while large and small planters account for 43% of the total area. Meanwhile, métayers account for less than 1% of the total area. According to estimates from 2017, Mauritius had 13,243 sugarcane growers, out of which 12,937 were small planters (Collaborative Africa Budget Reform Initiative, 2019). Yet, small planters produce around 19% of cane, while larger planters and estates account for about 81% of production. Overall, 77% of Mauritian farmers are male and 86% are over 40 years old. Although female farmers do make up an important share of total farmers, they tend to participate less in farmer support services and training (HRDC, 2017).

Table 3. Hectares dedicated to cane growing by categories of planters

Category	**2014**	**2015**	**2016**	**2017**	**2018**
Small planters <10 ha	11,991 ha	12,260 ha	12,057 ha	11,237 ha	10,598 ha
Medium & large planters <100 ha	2,023 ha	1,734 ha	1,813 ha	1,620 ha	1,369 ha
Corporate estates >100 ha	35,778 ha	37,700 ha	37,121 ha	36,000 ha	35,215 ha
Total	49,792 ha	51,694 ha	50,991 ha	48,857 ha	47,182 ha
Annual change		3.8%	-1.4%	-4.2%	-3.4%

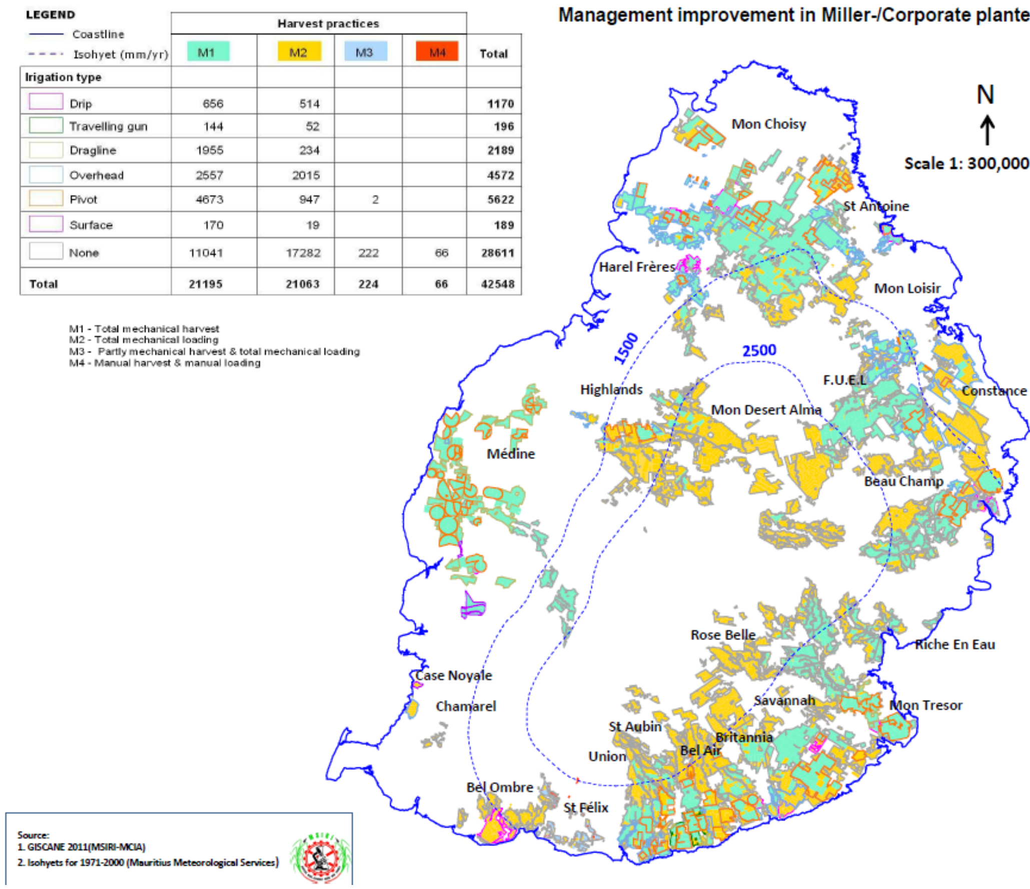
Source: Nodalis Conseil (2019)

Map 1. Sugarcane-producing regions and mills



Source: MSIRI (Note: La Barraque is the previous name for now Omnicane operations)

Map 2. Mechanization levels and irrigation equipment in corporate farms



Source: MSIRI

12. Planters and estates receive three types of market payments. First, they are entitled to 78% of the price paid by MSS (ex-Syndicate price) per ton of sugar accrued from their production. Second, they get 50% of the Bagasse Transfer Fund Price, (BTPF), which has been fixed for more than three decades. The BTPF is valued at Rs100 per ton of bagasse,[8] so while paid on the basis of accrued sugar, planters as a group effectively receive Rs50 per ton.[9] The Central Electricity Board (CEB) transfers the BTPF funds to MSS, which then pays the planters. Third, they receive full payments for the molasses retrieved from their cane at a price determined by the Mauritius Cane Industry Authority (MCIA) according to the Sugar Industry Efficiency (SIE) Act. The price of molasses is calculated annually based on the international price.

13. The revenue from sugar has historically been shared between the planters and the millers. The share for planters was 66% in 1939, then 68% in 1964 following the Balogh Report[10] (1962). The sharing ratio has kept on evolving since, and following the SIE Act, the planters' share increased further to 76% in 1988, and most recently to 78% in 2000. Table 4 below describes the planters' share of sector revenues as well as other entitlements, compared to other countries (LMC International, 2015).

Table 4. Planters' entitlements (Mauritius vs. other countries)

Source	Mauritius	Other countries
Sugar content in cane	78%	Max 74%
Mill efficiency	Cane quality (as per sugar content) is a factor in farmers' revenues	Cane quality is a factor in farmers' revenues
Molasses	100%	Millers get paid for molasses, but some countries pay for the molasses' value of the raw material
Bagasse	Rs50 per ton of bagasse used to produce electricity that gets exported to the grid[11]	Payment is rare, except in French DOMs
Distiller/bottler	Yes, fixed amount	None
Equity participation	Yes, in the Sugar Investment Trust (only small/medium planters)	None

[8] This valuation is based on 1/3 of the 1984 price of coal deducting bailing and storage.
[9] BTPF payments are calculated in accrued sugar terms with miller/planters receiving 24 percent of the planter's total share (equal to 12 percent of the total BTPF) and planters without a mill receiving 76 percent of the planter's total share (equal to 38 percent of the total BTPF).
[10] The Balogh Commission was set up in the 1960s following allegations of cheating on the weights of cane delivered by small planters to the sugar mils and the fair allocation of revenues for sugar and by-products http://www.mauritiustimes.com/mt/editorial-136/
[11] Planters are not remunerated for bagasse that is used to produce electricity that gets sent back to the mills.

Source: LMC International (2015)

14. In addition to these sources of revenue, planters benefit from: (i) income tax exemption for up to 60 MT of sugar or revenues from 10 hectares; (ii) concessionary lending and grants for specific support programs; (iii) pre-financing of sugar consigned to the MSS (up to 80%) at concessionary rates; (iv) equity participation in the Sugar Investment Trust by small/medium size planters; and (v) contribution of a fixed amount by distiller bottlers. Furthermore, since 2015, planters receive supplemental payments included in the National Budget, intended to provide relief in the face of falling international sugar prices and changing EU-demand and supply dynamics. These include payments from the Sugar Cane Sustainability Fund (SCSF), compensation from the Sugar Insurance Fund Board (SIFB), and additional financial support for planters producing less than 60 tons of cane, payments for cane replantation and the restoration of abandoned cane land, and grants for the purchase of fertilizer by planters with up to 100 hectares.

1.2.2 Millers

15. At the industrial level, cane is processed at three mills owned by the firms Alteo, Omnicane and Terra. These facilities are located at the east, south and north of the island, respectively. Mills extract mixed juice from crushed cane, which is then processed to produce different types of sugar (raw/brown, plantation white, or specialty), molasses, and bagasse.

16. Millers receive two types of proceeds for their production—both paid by MSS. First, they get 22% of the ex-Syndicate price per ton of sugar accrued, as per the revenue-sharing agreement. Second, they receive a premium for their value-addition in the production of specialty sugars, equivalent to EUR 80 per ton of sugar (MSS, 2020).

1.2.3 Refineries

17. By the end of 2020, Mauritius will have one operating refinery owned by Omnicane—following Alteo's announcement to cease its refining operations. Omnicane's facility processes PWS, raw domestic sugar and some 100 thousand tons of non-originating sugar (NOS). Raw NOS is imported to Mauritius mainly from Brazil (see Table 5 below) for refining and re-export, allowing for a better use of domestic refining capacity. The refinery also produces a small share of molasses.

Table 5: Imports of non-refined (raw/solid) cane and beet sugars to Mauritius, 2010–2019 (US$ '000)

PartnerName	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	Average (2010-2019)	Average (2017-2019)
World	**613**	**18,591**	**29,650**	**11,763**	**19,983**	**22,668**	**32,026**	**53,531**	**4,230**	**28,590**	**22,164**	**28,784**
Brazil	530	18,589	29,650	11,685	19,869	22,635	32,024	53,345		24,741	21,307	26,029
Thailand	82			78	114	32		65	3,046	1,238	466	1,450
Egypt, Arab Rep.										2,005	200	668
South Africa	0	0							882	562	144	481
India	0						1	121	117	0	24	79
Mozambique									137		14	46
Greece									48		5	16
China							1		0	43	4	14
Belgium										1	0	0
France	1		0	0					0	0	0	0
Netherlands										0	0	0
United Arab Emirates									0		0	0
Spain		1									0	-
United States						1					0	-
Italy			0								0	-

Source: UNCOMTRADE data accessed through World Integrated Trade Solutions (WITS) online portal, 22 Sept 2020.

18. **Refineries receive two types of payment: a premium for their value-added in the production of white refined sugar paid by MSS and proceeds from the sale of molasses.** In 2019, Mauritius produced 257,640 tons of white refined sugar for a premium of EUR 63 per ton of sugar. The following table summarizes cane production levels, sugar output, crop sales (in tons), and total proceeds from MSS' sales from crop years 2014 to 2019. Refineries also sell the molasses they produce to distilleries.

Table 6. Sugarcane production, crop sales, and proceeds from sugar sales from crop years 2014/15 to 2019/20

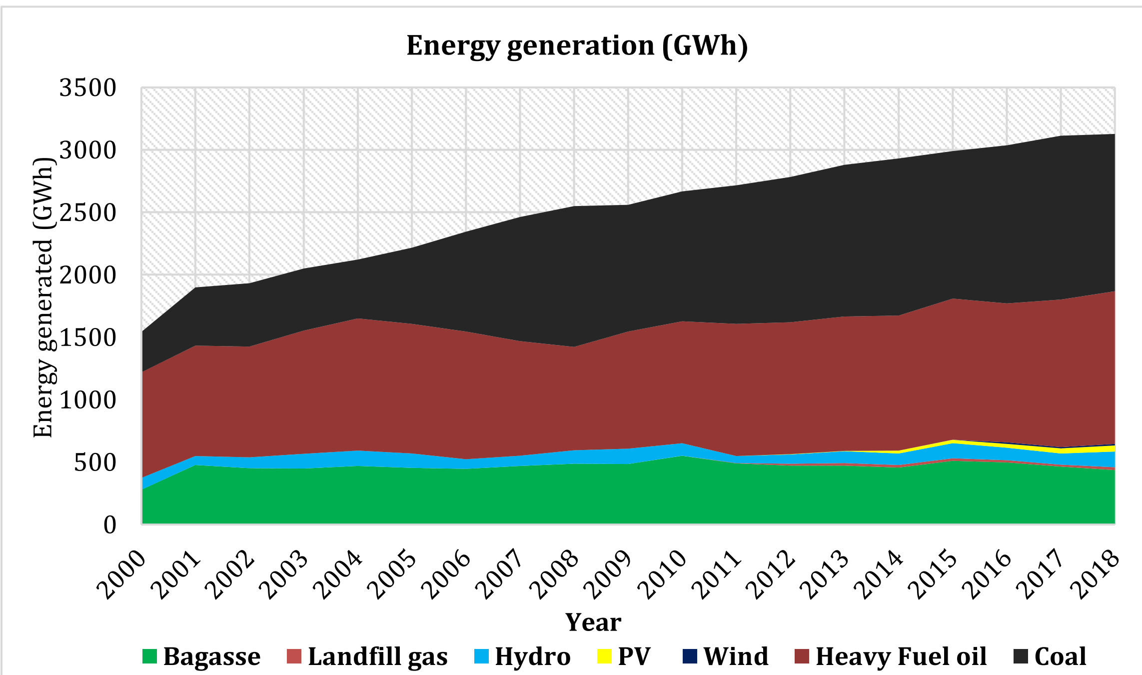
		2014/15	2015/16	2016/17	2017/18	2018/19	2019/20
Production (tons)	Sugarcane production (tons)	4,044,422	4,009,232	3,798,448	3,7133,331	3,154,516	3,300,000
	Sugar production (tons)	400,173	366,070	386,277	355,213	323,406	No info
Crop sales (tons)	Specialty sugars (tons)	96,384	30,243	96,628	115,495	100,006	No info
	Refined sugar (tons)	334,468	338,306	361,055	233,156	236,017	No info
	Raw sugar for direct consumptio n (tons)	No info	No info	5,706	14,561	47,779	No info
Proceeds from sales (Rs)	Proceeds from sugar sales ('000 Rupees)	7,474,228	8,132,135	10,661,96 3	7,178,777	6,140,505	7,422,014

Source: FAOSTAT (2020), MCIA (2020), and MSS Reports (2015; 2016; 2017; 2019; 2019; and 2020).

1.2.4 Independent Power Producers

19. **Electricity in Mauritius is produced by the Central Electricity Board (CEB) and Independent Power Producers (IPPs).** The CEB uses Heavy Fuel Oil (HFO) to produce energy in its thermal power stations. It also owns all the hydropower and is responsible for the national distribution, transmission and supply of electricity. IPPs rely on coal, landfill gas, bagasse, solar, and wind to generate power and export electricity to the CEB grid (Surroop & Raghoo, 2017). Per the terms of power exchange agreements (PEAs) with the sugar mills that supply bagasse, IPPs receive bagasse without cost from the mill and return a share of the total power generated in the form of steam and electricity to the mill. In 2018, 57% of electricity was produced by all different IPPs and 43% by CEB (Statistics Mauritius, 2019). Roughly 14% of the total electricity in the CEB grid is generated from bagasse. The electrification rate in Mauritius is at 100% (Surroop D. and Raghoo P., 2018). Figure 1 shows the electricity production from different sources.

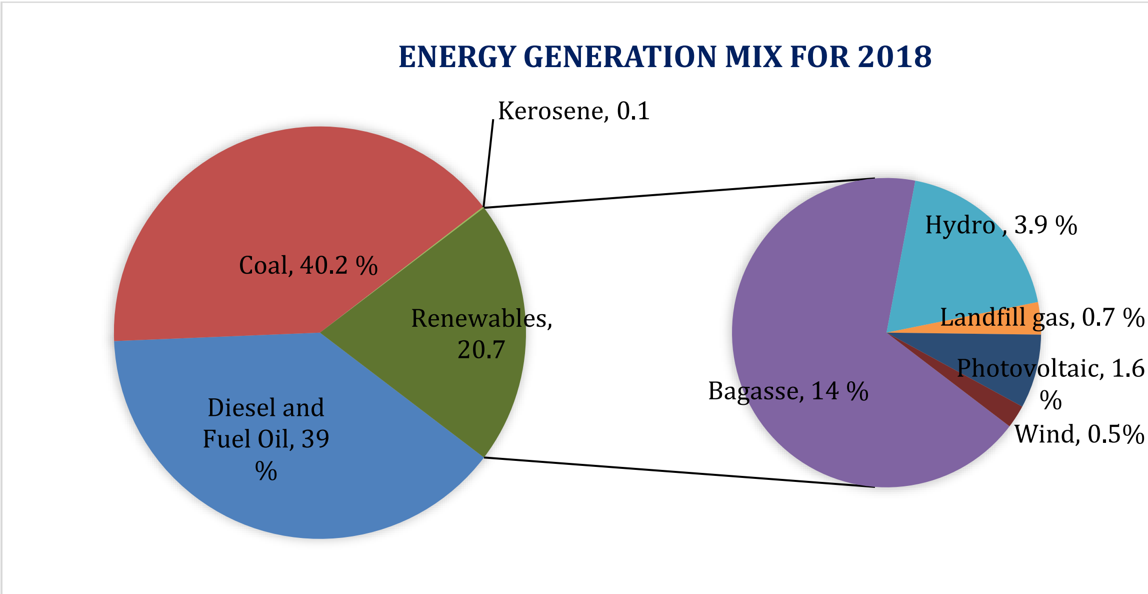
Figure 1. Energy generation for 2000–2018 (GWh)



Source: CSO Energy and Water Statistics, 2001–2018; Note: PV = Photovoltaic

20. **The share of renewable energy is around 20%, and bagasse, which is the main source of renewable energy for the island, represents 14% of the total electricity production** (2018 Energy Mix)**.** Subsidiary companies from the Omnicane, Terra, and Alteo Groups operate three IPPs (one each), using bagasse extracted from sugarcane during harvest season to generate electricity. Of the total electricity produced, approximately 45% is used to power the mill and refinery operations, while 55% is exported to the grid.

Figure 2. Energy generation mix for 2018



Source: CSO Energy statistics, 2018[12]

21. The three IPPs that are connected to the sugar industry receive two types of payment for their energy production, both from CEB. First, they receive 50% of the BTPF. In 2018, the total BTPF payment to the four IPPs that were then operating was approximately Rs27.5 million (US$764,000). Second, they receive a payment from CEB for electricity exported to the national grid. The rates paid by CEB vary for each IPP depending on contract terms. From 2017 to 2019, the price paid by CEB for bagasse electricity ranged from Rs1.96 to 4.60 per kWh. The weighted average price paid by CEB to IPPs from 2017 to 2019 was 3.06 per kWh, though it decreased significantly to Rs2.70 in the 2018 to 2020 period. These payments for electricity supply are disbursed directly by CEB. Also, IPPs receive bagasse for free in exchange for energy provided to the mills in the form of steam and electricity as per the respective product exchange agreement between the miller and the IPP.

1.2.5 Distilleries

22. In 2018, the government enacted the Ethanol and Molasses Framework, pushing for the further diversification of the sugarcane sector with the construction of distilleries to convert sugarcane molasses into potable alcohol and ethanol (Collaborative Africa Budget Reform Initiative, 2019). Under the current arrangement, MCIA determines the price of molasses sold to distillers, which is then distributed to planters in proportion to their production. In some cases, distilleries purchase mixed juice directly to produce alcohol and they pay the equivalent price of sugar the mixed juice represents. In

[12] https://statsmauritius.govmu.org/Documents/Statistics/Digests/Energy_Water/Digest_Energy_Yr18.pdf

these cases, planters are compensated for the sugar content of the mixed juice sold, instead of receiving compensation for molasses at the stipulated price. Distilleries are then responsible for commercializing their products in the market. Table 7 summarizes the production capacity of Mauritian distilleries.

Table 7. Production capacity of Mauritian distilleries in 2018

Distillery	**Production capacity in 2018**
Omnicane	• Daily production capacity of 80,000 liters • 24.4 million liters of ethanol
Grays	• 6 million liters of alcohol • Cannot operate at full capacity due to limited molasses availability
Medine	• 5.7 million liters of alcohol

Source: Omnicane (2019); Terra (2019); EUDCOS (2019)

1.1.1 Gender in the Sugarcane Sector

23. Women represent ¼ of the labor force of the sugarcane sector (Digest Labour, 2018). The industry employs 8,900 male and 3,200 female employees. However, women are not equally/fairly represented in the various entities and institutions involved in the decision-making processes (from all the sector-level institutions in the sugarcane sector, only one institution has a woman representative). Furthermore, the wage differential at the farm level is significant: women are paid approximately ¾ of what men are paid for farm labor, according to average rates reported by small planters (FSA, 2020)[13]. Tandrayen-Ragoobur (2012) finds that a high percentage of VRS beneficiaries moved to a lower income bracket as a result of industry closures, with a higher percentage of women being negatively impacted.

1.1.2 Nutrition and Public Health

24. The impact of the consumption sugars on human health is a global concern. Refined white and specialty sugars produced from sugarcane have no significant amount of key nutrients[14], and given their high caloric and Glycemic Index (GI) content, significantly increase human blood glucose levels, contributing to diseases in adults and children such as obesity, diabetes, dementia, tooth decay, and cardiovascular diseases. Although theoretically, and in cases of undernourishment, sugars can promote a positive energy balance and help maintain a healthy body weight, in reality evidence shows the negative impact of sugar consumption on human health. Today, the highest levels of per capital consumption of added sugars occur in emerging markets and among children and adolescents, as soft drinks and dairy products account for more than half of all sugars bought by the average consumer. Yet,

[13] Manual de-stoning wage is Rs400/man-day v. Rs300/woman-day. Labor for planting 1 ha is Rs35,500/man vs. Rs23,700/woman.

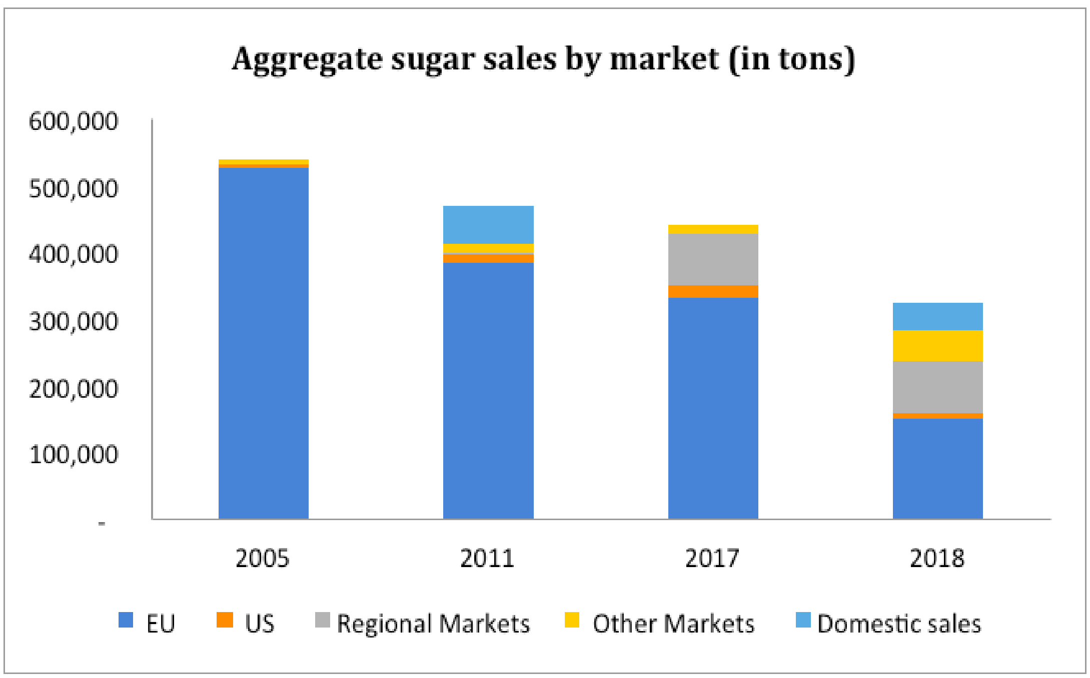
[14] Brown sugars have a slightly larger amount of calcium than white refined sugars, but still at an insignificant level to make a positive difference in human nutrition outcomes.

consumers are not always aware of the nutritional consequences of their food intake decisions (ISO, 2016). The Guidance[15] of the World Health Organization (WHO) strongly recommends a reduction in the intake of sugar at all age levels, including a halt in sugar consumption in countries with low sugar intake. Therefore, efforts to increase the amount of sugar consumed by humans should be seen as directly detrimental to human health outcomes.

1.1.3 Sugarcane Sector Markets

24. The Mauritian sugarcane sector is highly dependent on exports and vulnerable to changes in the world sugar market—with over 90% of sugar production commercialized abroad. Mauritius is extremely susceptible to changes in the European Union, which is historically its most important export market. As Figure 3 shows, EU sugar sales have decreased significantly over the 2005–2018 period, forcing Mauritius to divert exports to regional markets—mainly Kenya, South Africa, and Tanzania—and other markets—including Israel, China, and Canada.

Figure 3. Mauritius sugar sales by market



Source: ISO, 2019

25. Historically, Mauritius participated in trade negotiations with the European Union (EU) as part of the Organization of African, Caribbean, and Pacific States (OACPS, previously known as ACP), a diverse group of countries. Through the OACPS, Mauritius secured preferential access to the European sugar market for several decades

[15] See: https://apps.who.int/iris/bitstream/handle/10665/149782/9789241549028_eng.pdf

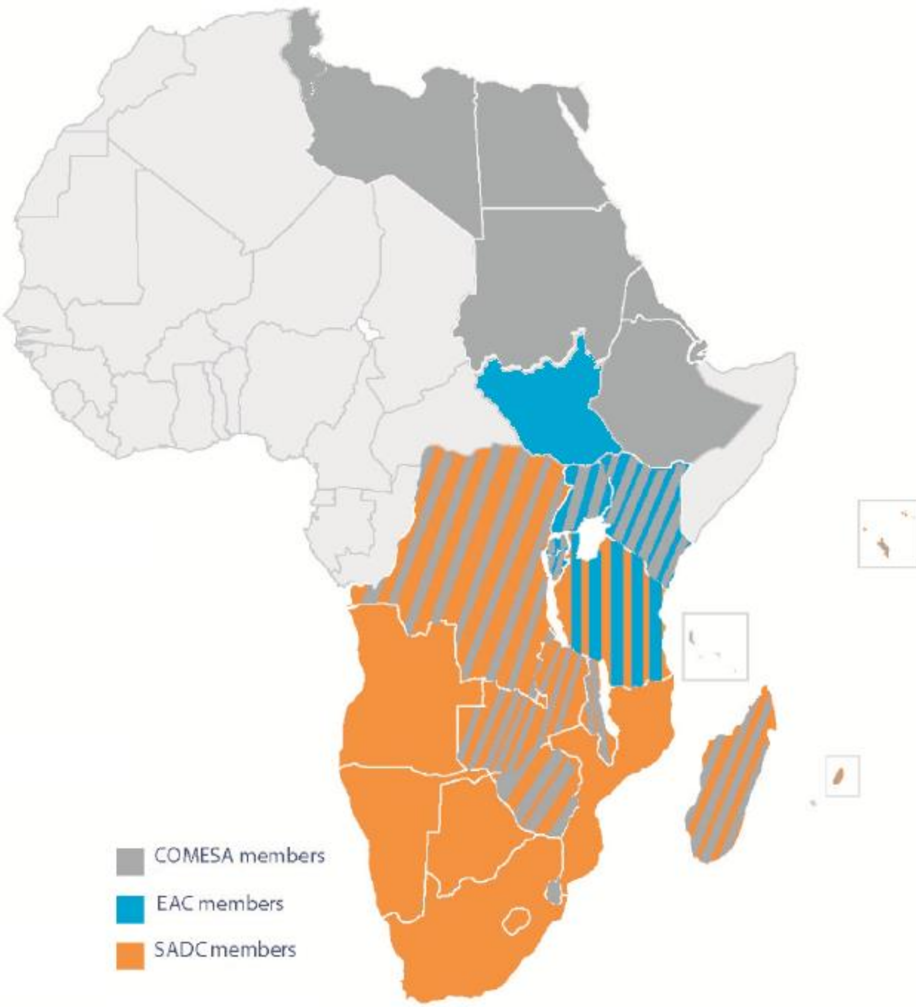
(LMC International, 2017). As part of the reform of the European Common Agriculture Policy, price guarantees for sugar imports from Africa came to an end in 2009 and EU production quotas came to an end in 2017.

26. **In addition, Mauritius is a member of both the Common Market for Eastern and Southern Africa (COMESA) and the Southern African Development Community (SADC).** Within SADC, the Southern Africa Customs Union (SACU), which includes South Africa, Botswana, Lesotho, Namibia, and Swaziland, makes up a core entity with free flow of sugar between member countries (see Map 1). The COMESA and SADC markets present both opportunities and limitations for Mauritius. Since 2001, sugar consumption in the SADC region increased annually by 4.3%, compared to a world average of 2.2%. Yet duties in the SACU market restrict the entry of non-member producers, and countries like Mauritius are subject to a small quota. Moreover, while SADC members are meant to most goods trade unrestrictedly, sugar is managed under agreed an systems of quotas, and several countries have established temporary duties or non-tariff barriers to limit sugar imports (ISO, 2018). On the other side, Mauritius has not yet implemented any policy duties/barriers to restrict the access of sugar from other SADC and COMESA member countries.[16] See Map 3 and Table 8 with the various trade blocks relevant for the Mauritius sugar trade. The domestic sugar market in Mauritius is relatively small in relation to the total sugar produced, with only 10% of the sugar produced sold locally (MSS, 2020).

27. The domestic sugar market in Mauritius is composed of sugar used for domestic consumption and imported sugar (NOS) used by refineries to complement locally produced sugars. NOS sugar, after being refined into white sugar, can be sold domestically or re-exported. While the European Union's (EU) rules of origin allow to include up to 15% of value from NOS, the Common Market for Eastern and Southern Africa (COMESA) allows for a maximum of 35%, and the Southern Africa Development Community (SADC) accepts the re-export of 100% of refined NOS that originated from within the region (IUF, 2012). Since 2011, Sugars from COMESA and SADC origins are admitted duty-free into Mauritius under the respective trade agreements. Recent arrangements have been made between Omnicane and MSS for the management and revenue sharing of the import of some 100,000 tons of NOS required annually. Yet, several fraudulent cases of imported sugar that gets locally packaged and labeled as Mauritian have been reported to the Consumer Protection Unit of the Ministry of Commerce. These practices not only displace local sugars but also taint the image of local production as what is being sold is often of inferior quality.

Map 3. Main Regional African Trading Blocks for Mauritius

[16] This option is currently being explored in conversations between the government and the private sector, as imposing trade barriers could effectively secure up to Rs200 to Rs300 million for the sugarcane sector.



Source: UNCTAD

Table 8: Top-15 market destinations of Mauritius refined and non-refined sugar's exports (US$ '000, 2010–2019, sorted by average values 2017–2019)

(a) Non-refined sugar exports

ReporterName	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	Average (2010-2019)	Average (2017-2019)
All countries All --- All	**117,586**	**102,664**	**98,662**	**98,491**	**85,221**	**80,589**	**81,928**	**84,457**	**75,259**	**77,422**	**90,228**	**79,046**
United Kingdom	30,869	31,578	30,703	28,810	22,287	19,096	18,025	14,833	11,930	14,265	22,240	13,676
United States	7,806	10,433	10,461	6,195	2,187	5,192	8,337	12,079	10,723	11,045	8,446	11,282
Germany	8,562	9,457	9,174	9,861	10,806	11,123	10,650	8,403	6,697	7,894	9,263	7,665
Italy	3,992	4,849	7,884	7,110	5,168	5,790	6,336	6,461	5,860	7,313	6,076	6,545
France	24,553	16,809	1,477	3,847	2,752	3,907	2,324	4,086	4,887	9,760	7,440	6,245
Belgium	5,569	4,243	6,329	2,998	5,131	7,960	5,903	4,097	4,898	4,931	5,206	4,642
Kenya	5,215			1,293				5,553	3,830		1,589	3,128
Poland	1,540	2,293	3,465	4,119	6,158	4,673	5,472	2,616	3,003	3,232	3,657	2,950
Switzerland	444	832	1,207	1,476	1,770	2,743	2,450	1,977	2,825	2,528	1,825	2,443
Singapore			723	1,214	1,775	1,649	2,464	1,858	2,967	2,484	1,513	2,436
Greece	1,180	1,769	2,098	2,971	3,475	2,271	1,981	2,272	1,977	1,726	2,172	1,992
Ireland	21	124	420	2,269	2,590	2,286	2,352	2,203	2,262	1,471	1,600	1,978
Russian Federation	6,275	7,271	8,418	7,550	4,304	1,987	2,129	1,816	1,402	1,289	4,244	1,502
Austria	1,686	1,846	3,167	2,290	2,158	2,124	1,142	1,967	1,011	1,440	1,883	1,473
Spain	504	1,900	1,617	476	1,534	1,095	1,205	893	1,369	510	1,110	924
Subtotal top-15	**98,217**	**93,405**	**87,143**	**82,481**	**72,095**	**71,894**	**70,769**	**71,113**	**65,642**	**69,887**	**78,265**	**68,881**
Top-15 as % world	84%	91%	88%	84%	85%	89%	86%	84%	87%	90%	87%	87%

(b) Refined sugar exports

ReporterName	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	Average (2010-2019)	Average (2017-2019)
All countries All --- All	**137,855**	**247,340**	**248,467**	**331,758**	**253,904**	**161,485**	**179,629**	**194,456**	**96,305**	**87,343**	**193,854**	**126,035**
Italy	63,704	120,084	130,535	182,040	114,205	66,443	70,796	71,943	3,796	19,627	84,317	31,789
Spain	13,449	47,684	59,914	53,246	53,787	33,348	25,121	30,853	20,293	21,242	35,894	24,129
Greece	7,856	27,432	19,048	13,989	14,061	12,839	22,591	24,562	9,309	22,068	17,376	18,646
Kenya	591			4,257				23,543	31,876		6,027	18,473
United Kingdom	13,404	28,924	28,251	42,464	33,495	28,207	19,763	14,374	4,912	7,265	22,106	8,850
France	29,811	13,574	1,524	1,992	601	864	7,520	11,597	7,700	4,308	7,949	7,868
Germany	4,532	2,831	1,067	4,046	10,984	4,714	9,077	6,545	4,010	723	4,853	3,760
Madagascar		0				4,056	4,151	2,145	1,802	2,809	1,496	2,252
South Africa	9	6	8			34	6	0	2,185	1,441	369	1,209
China	282	444	453	476	528	537	951	928	2,514		711	1,147
United Arab Emirates			803	658	819	1,069	1,502	1,983	1,000		783	994
Bulgaria		21		41	28	59	2,495	26	175	2,546	539	916
Poland	0		188	239	442	261	152	2,400	144	1	383	848
Israel	495	1,286	1,754	1,765	1,504	1,214	345	836	1,320	267	1,079	808
Rwanda						182		1,201	801		218	667
Subtotal top-15	**134,133**	**242,288**	**243,545**	**305,214**	**230,452**	**153,828**	**164,470**	**192,937**	**91,837**	**82,297**	**184,100**	**122,357**
Top-15 as % world	97%	98%	98%	92%	91%	95%	92%	99%	95%	94%	95%	97%

Source: UNCOMTRADE data accessed through World Integrated Trade Solutions (WITS) online portal, 22 Sept 2020 (mirror data).

28. **Bagasse is remunerated by CEB to IPPs, but also to farmers through the Bagasse Transfer Price Fund (BTPF).** Each year, the Central Electricity Board (CEB) pays an amount into the BTPF determined with reference to the total quantity of bagasse used by independent power producers (IPPs) to generate electricity exported to the national grid[17]. IPPs and planters share BTFP proceeds equally. Among the planters, 24% of the planter's share (i.e., 12% of the total BTPF) goes to planters with a mill and 76% of the planter's share (i.e., 38%

[17] The price paid by CEB is Rs 100/ton bagasse and has not changed since the mid-1980s when the BTPF was established. Further details of BTPF arrangements are provided in the section on alternative bagasse pricing.

of the total BTPF) goes to planters without a mill. In BTPF terminology, miller/planters are designated as belonging to "Category A" while planters without a mill are in "Category B."[18] Payments to Category A and Category B planters are calculated on a per ton accrued sugar basis while payments to IPPs are calculated in per kilowatt hour (kWh) terms. Under the terms of separate power exchange agreements (PEAs) between IPPs and mills, miller/planters also receive value from bagasse in the form of free steam and electricity that are returned by the IPP to the mill in exchange for free bagasse used as raw material.

29. The BTPF was established in the mid-1980s at which time the value of bagasse was priced with reference to coal, which is the alternative fuel used by IPPs when bagasse is not available. Bagasse has roughly one third the calorific value of coal and the price of coal delivered to Port Louis in the mid-1980s was around Rs600 per ton, giving Rs200 per ton as the equivalent value of bagasse. However, rather than use Rs200 per ton as the BTPF reference price, it was further decided to deduct Rs100 per ton to provide for bailing and storage of bagasse. On this basis the agreed reference price for determining the BTPF proceeds to be paid by CEB was set at Rs100 per ton of bagasse.

30. This price is still used to determine the CEB's contribution to the BTPF today. In reality, of course, coal prices have changed significantly since the mid-1980s, and baling and storage of bagasse was never done at scale and is still not done now. Electricity from bagasse accounts for about 14% of supply to the national grid.

31. Molasses payments are made to planters with reference to an international reference price quoted by the Landbouw Economics Institute (LEI) at Wageningen University in the Netherlands. Mauritius does not export molasses. Instead, various users of molasses pay different prices calculated with reference to the LEI price, where 40% of LEI is considered the "deemed FOB price" for Mauritius.[19] Under these arrangements, exporters of potable spirits and ethanol made from molasses pay 100% of deemed FOB; manufacturers of spirits for the domestic market pay 175% of deemed FOB (which was capped Rs3,500 per ton from 2016 to 2019), plus Rs40 per liter of absolute alcohol. The LEI price changes monthly and in 2019 ranged from EUR140 to EUR170 per ton. The most recent LEI price (July 2020) is EUR185/ton.[20] Domestic animal breeders pay a fixed price of Rs2,500/ton molasses.

32. In terms of physical consumption, exporters of ethanol capture about 56.4% of total molasses while potable spirit exporters take around 22.5%. Together, this means almost 79% of total molasses is priced with direct reference to deemed FOB. On the domestic side, spirit manufacturers for the local market get about 17.5% of total molasses while animal breeders use 3.6%.

33. In 2018, the final molasses price received by cane growers worked out to Rs3,840 per ton. The MCIA formula for determining the molasses price is complex and not

[18] The competitiveness analysis assumes planters belong to Category B. This is easy to change by adjusting a single cell in the drop-down menu portion of the Excel model.
[19] For the sake of calculation of Deemed fob, the price of molasses is taken from June to December and then January to May.
[20] See: https://www.agrofoodportal.com/AgrimatiePrijzen/Default.aspx?ID=15125&Lang=1

immediately transparent. However, unlike bagasse, molasses prices are updated periodically and bear a close resemblance to current world market conditions. Based on the data gathered, adjustments on the price of molasses greater than 10% one way or the other are difficult to foresee. Even with the introduction of ethanol-fuel blends, the price of molasses is unlikely to change significantly since the value of molasses in a blend is still determined with reference to international parity. On the one hand, fuel blends could help Mauritius save on the cost of imported fuel, but this would come at the expense of ethanol and spirit exports that are already priced with reference to parity.

1.2 Historical Trends and Future Projections of the Sugarcane Sector in Mauritius

1.2.1 History and Main Public Policies

34. The sugarcane sector has a significant historical value for Mauritius. Introduced almost four centuries ago, cane became the backbone of the Mauritian economy through the 17th, 18th, 19th and 20th centuries, reaching its peak in 1860, when the country had 259 sugar mills (Collaborative Africa Budget Reform Initiative, 2019). In 1968, Mauritius gained preferential access to the European market—first through the Commonwealth Sugar Agreement and later through the European Economic Community Sugar Protocol with ACP countries (now OACPS). This granted Mauritius an annual quota of 507,000 tons of raw sugar—the largest among ACP countries—at a guaranteed price three times the international market price. By the early 1990s, Mauritius had 17 operating mills and sugar represented 20% of total GDP (Zafar, 2011).

35. As the world market became more competitive, Mauritius passed a series of reforms to streamline its sugarcane sector. In 1997, the government approved the Blueprint on Centralization of Milling Operations, seeking to rightsize operations. Initially, this led to the closure of three sugar mills, reducing the total number to 21. According to this plan, employees of closing mills were entitled to in-cash and in-kind compensation borne by the remaining facilities. In 2001, the Sugar Industry Efficiency (SIE) Act was passed to facilitate the implementation of the Sugar Sector Strategy Plan (SSSP)—leading to the closure of three additional mills (Collaborative Africa Budget Reform Initiative, 2019). In 2005, the EU announced the end of guaranteed prices from 2009 and the liberalization of quotas from 2017 onwards. In response, Mauritius introduced the Multi-Annual Adaptation Strategy (MAAS), a ten-year plan with the following goals:

1) Reducing costs by closing seven additional mills (down to a total of 11), facilitating seasonal labor, and shrinking overhead costs at the administrative and institutional levels;
2) Increasing revenues by promoting the production of specialty sugars and introducing high sucrose cane varieties;

3) Diversifying sources of revenues by increasing the generation of electricity and fuel from bagasse and ethanol.

36. MAAS included a series of measures to mitigate the social impact of these reforms. Among these were the Early Retirement Scheme (ERS) and Voluntary Retirement Scheme (VRS), intended centralize and restructure the sugarcane sector in a socially acceptable way by providing employees of closing facilities with two options: (a) a compensation package of six weeks of pay for each year of service plus 300 m^2 of land, or (b) relocation to another facility. Overall, these retirement packages granted retiring employees some EUR94 million[21] (LMC International, 2015). MAAS also introduced the Field Operations Regrouping and Irrigation Project (FORIP), which aimed to help planters consolidate and mechanize their land to achieve economies of scale. Although this measure helped prepare the land for mechanized operations since 2009 with de-rocking efforts, it lacked follow-up measures to encourage the emergence of contractors and service providers that small planters could access. (LMC International, 2015).

37. In 2009, to add further value to Mauritian sugar, MSS launched an initiative to encourage small and medium planters to become Fairtrade certified. This process generates a minimum premium of Rs2,000 per ton of sugar sold, which is reinvested in projects to improve the quality of life of farmers and their communities through education, healthcare, infrastructure, and agricultural investments (LMC International, 2015)[22]. Currently, there are 10,880 independent planters, of which 7,000 are grouped in the 145 cooperatives, producing around 80,000 tons of sugar that could qualify for this benefit (MSS 2020)—representing around ¼ of total production. Since the initiative began, and especially in the last three years, 17 cooperatives have been decertified by the independent auditors appointed by the global certification body for Fairtrade, FLOCERT, due to a lack of compliance. In 2019, Omnicane became the first mill in Africa to become Bonsucro certified – a corporate responsibility certification that provides access to new niche markets by ensuring Omnicane's adherence to sustainable processing and harvesting practices.

1.2.2 Recent Market Trends

38. Public policies and programs to improve the competitiveness of the sugarcane sector have been countered by falling sugar prices and increasing costs of production. On a global scale, sugar-producing countries have been significantly impacted by sluggish international sugar prices and protectionist policies, but not all have had the same production trends as Mauritius (see Annex 5 for a detailed benchmarking analysis). Since the end of the

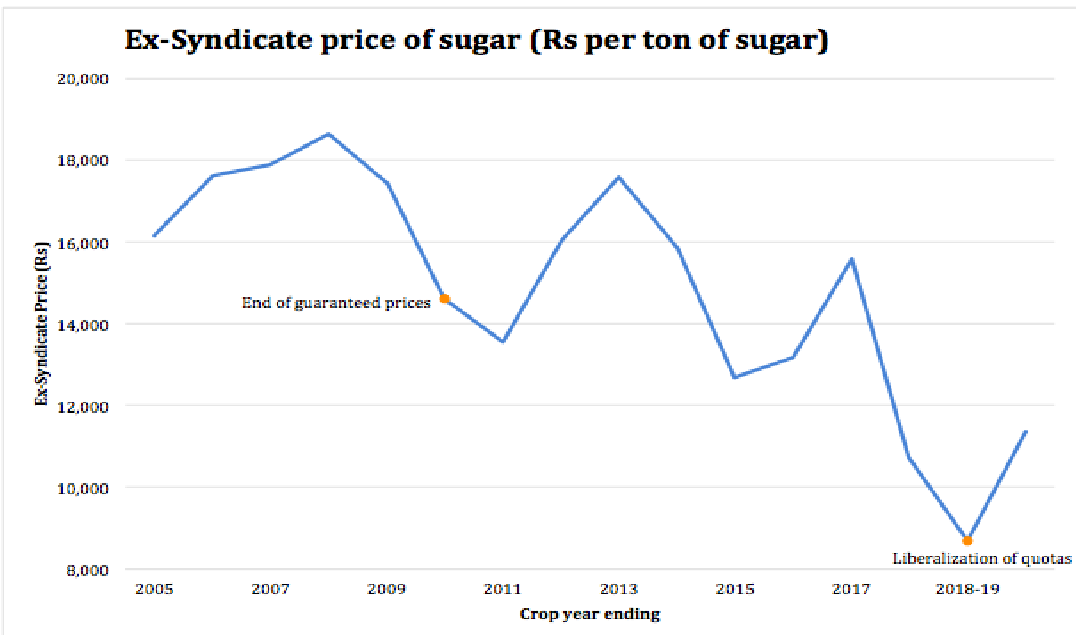
[21] As a result of several negotiations, sugarcane workers are entitled to cash compensation of at least Rs10,000 for 2 to 1.5 months per year of service, depending on age and tenure. The size of this benefit is significant relative to other sectors: in textiles and manufacturing, for example, workers receive around Rs6,000 for 0.5 months per year of service. Sugarcane workers can also choose between cash or in-kind compensation and receive education scholarships for their children (LMC International, 2015).

[22] It is worth to be noted that producers receive a Fairtrade Premium only when they have a buyer willing to pay it and, at times, there is more certified sugar than the market can absorb.

Sugar Protocol, the EU price of sugar has consistently declined and currently stands at 75% of its July 2017 level (European Commission, 2020). This mirrors the trend in other sugar markets and the international sugar price is expected to remain flat over the next 10 years.

39. In Mauritius, from crop years 2005 to 2019, the ex-Syndicate price of sugar declined by 30%, while labor costs have increased persistently (see Figure 4). Labor costs have increased by 62% since 2010—more than twice the cumulative Consumer Price Index over the same period (JTC Report, 2018). Yet, employment in the sugar sector[23] declined by almost 10% in only two years, from 7,378 to 6,659 between 2016 and 2018 (Digest of Labor Statistics, 2018), while agriculture and manufacturing jobs have decreased from over 10,000 in 1980 to less than 4,000, a drop that has been filled by the services sector, in particular tourism (see Figure 17).

Figure 4. Evolution of the ex-Syndicate price from 2005 to 2020



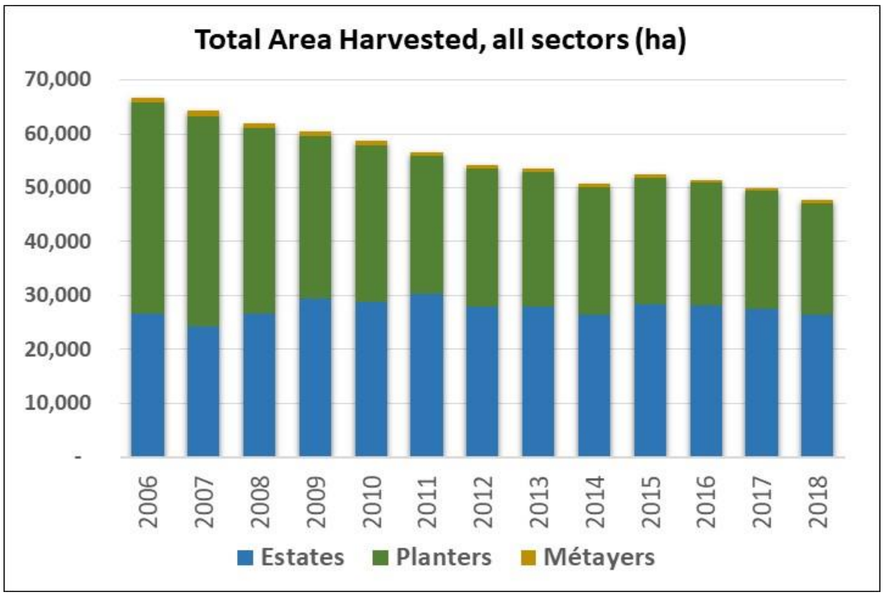
Source: MSS

40. Since 2006, around 2,000 hectares of land have been switched out of sugarcane production every year, an annual decline rate of 3.1% (see Table 3). This trend has been concentrated at the small- and medium-sized planters' level, with annual rates of 5% to 9%—compared to less than 2% for corporate estates. Moreover, the overall number of planters has suffered a steep decline, falling from 26,898 in 2005 to around 12,884 in 2018, 99% of which were small and medium planters (LMC International, 2015). Figures 5 and 6 show these trends.

[23] Including plantations of more than 10 ha and processing facilities.

41. Beyond the drop in the ex-Syndicate prices, another factor contributing to decline of hectares under cane is competing demand for the limited land in Mauritius. Despite a migration pattern from rural to urban areas and the country's focus on the service sector –putting pressure on agriculture lands to be converted to urban uses—, Mauritius's share of rural population remains high compared to that of other small island states (60%), and has one of the lowest urbanization rates globally (0.11%). Farmers have also embraced the business opportunities of producing food, substituting imports, which tend to be expensive due to the country's geographic isolation[24].Demographic changes have also led to the division of plots owned by independent sugar planters through inheritance. For many of the new generation of landowners, small plot sizes, labor unavailability, and high costs have led to little interest in cane growing, since higher income can be derived from other economic activities.

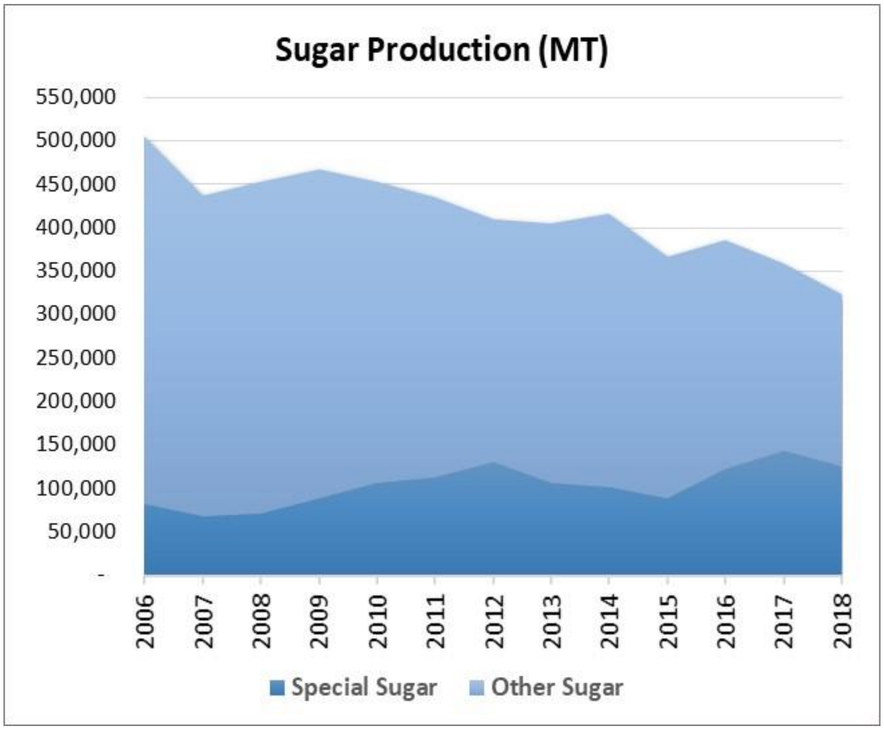
Figure 5. Total cane area harvested, 2006–2018 (hectares)



Source: Sugar Industry Statistics (MCA, 2005–2018) in which estates are defined as growers currently or formerly involved in milling.

Figure 6. Total sugar production including special sugars, 2006–2018 (metric tons)

[24] . A recent non-sugar agriculture sector study by the African Development Bank (2020) points out that the production of food in Mauritius doubled in the past three decades, from 4,000 ha planted in 1980 to about 8,000 ha today—though local vegetable and fruit production declined by 18% in 2019, according to GIEWS.

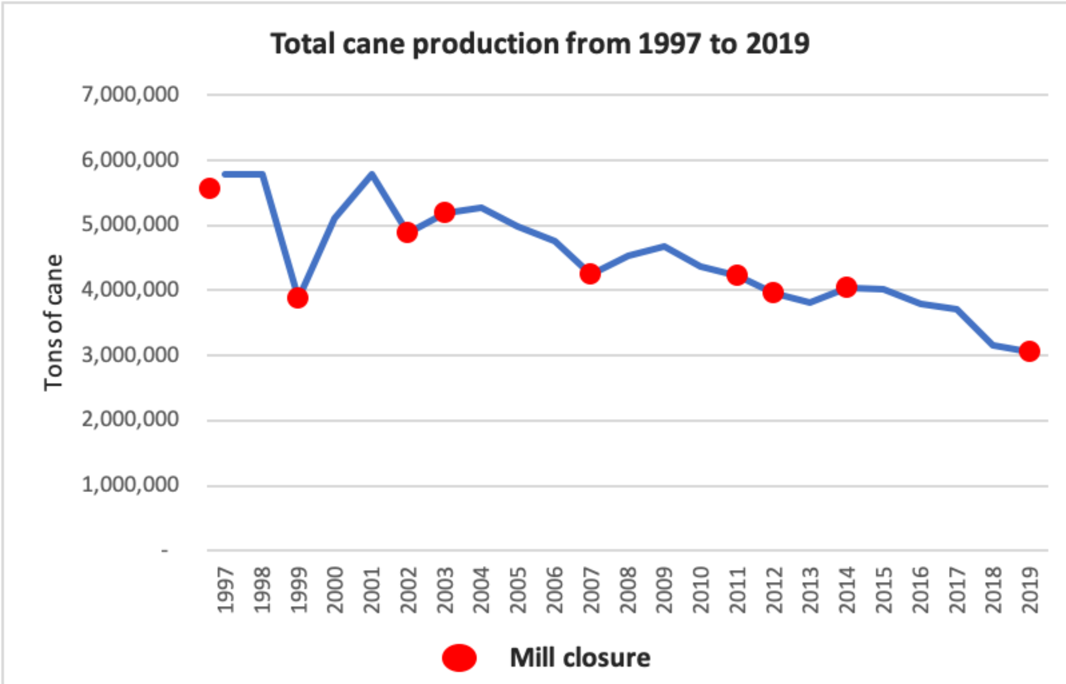


Source: Sugar Industry Statistics (MCA, 2005–2018).

42. Land abandonment has led to the continuous decline of cane production and milling activity—two mutually reinforcing trends. In 2019, planters harvested around 3.3 million tons of cane, down from 5.3 million in 2004 (see Figure 7). Since 1997, 14 mills have shut down, and the ongoing decline of production threatens the closure of the remaining facilities if the supply of cane falls below a minimum milling processing break-even threshold.[25] Yet, this projection works both ways, as the closure of mills also triggers a slump in cane production. Historically, the year a mill ceases operating in Mauritius, cane production declines by approximately 8%—and later picks up by only 7%.

Figure 7. Total cane production in Mauritius from 1997 to 2018

[25] From different interviews, the required thresholds of mills in Mauritius are between 700'000 to 1 million tons of sugarcane.



Source: FAOSTAT (2020)

43. Current trends in cane production and milling activity also affect the production of electricity from bagasse. While the Renewable Energy Roadmap 2030 launched in 2019 set a target to reach 35% of renewable energy by 2025, declining cane production and increasing energy consumption (by 2% annually), have haltered these efforts. Instead, the share of renewable energy from bagasse declined from 75% in 2015 to 66% in 2018. Likewise, the roadmap set a goal to increase the share of electricity produced from cane trash (a residue from dried cane leaves that typically remain in the field) from 0.6% in 2020 to 1.8% by 2030, which has yet to be met as viable remuneration and regulatory arrangements have not been established (Nodalis Conseil, 2019).

1.3 Motivation for the Sector Competitiveness Analysis

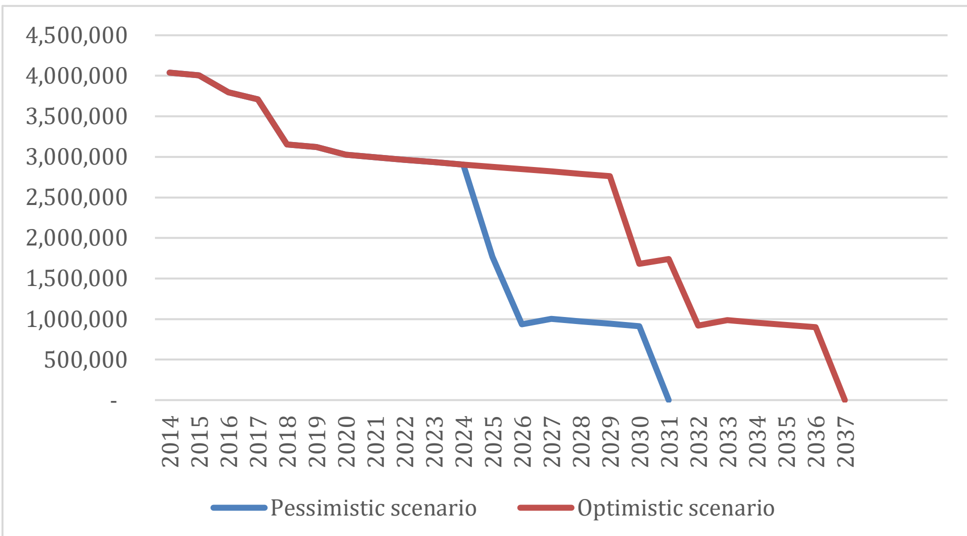
1.3.1 Business-as-usual Sector Projections

44. In a business-as-usual scenario, if another mill were to cease its operations in Mauritius, it can be expected that planters (especially small planters), under least viable conditions would leave the sugarcane sector. Those farming in marginal land—plots challenged by hilly or rocky terrains, limited accessibility, and environmental or socioeconomic strains (LMC International, 2015)—would be forced out of cane first. In particular, research from 2005 estimates that some 12,400 hectares of cultivated land are non-mechanizable (Nodalis Conseil, 2019).

45. Moreover, the geographic spread of the three remaining facilities makes the outlook for another mill closure direr. Given their geographic spread, the closure of another mill would result in an increased number of loading zones and a related rise in transportation costs in the impacted region. Nonetheless, Mauritius is currently testing a system of compensation of transport costs to planters to encourage the direct delivery of cane to mills and gradually eliminate loading zones.

46. Assuming that no measures to improve the competitiveness of the industry are taken and that current rate of decline in sugarcane production (2%) continues, milling operations could cease between 2030 and 2037 in a pessimistic scenario (see Figure 8). This highlights the extreme urgency for strategic measures to address the competitiveness of the sector.

Figure 8. Projected sugarcane produced under business-as-usual scenarios (MTs)



2 Competitiveness Analysis Methodology

2.1 Data Sources

47. This analysis was only possible with the collaboration of all key actors involved in the sector, who provided valuable data to the World Bank team. Table 9 lists the stakeholders and institutions consulted, and the type of information they provided.

2.1.1 Background Information

48. Background information was requested on a historical basis, from 2005 to 2018. Data on total cane production—by farm type and production zone—was reported by MCIA, along with sugar pricing, land use and labor acts, information on the responsibilities of millers, and previous studies relevant to this consultation. Total production of sugar, molasses, and bagasse was reported by the Control and Arbitration Department (CAD), while MSS provided data on sugar exports, prices paid to planters for sugar, molasses, and bagasse, and background details on Fairtrade sugar in Mauritius. Finally, information about the location of factories, loading zones, main production areas, and agro-ecological zones was detailed by MSIRI.

2.1.2 Policy Level

49. On a high policy level, the Ministry of Finance, Economic Planning, and Development (MOFED) and MCIA provided a list of subsidies and programs involving the sugarcane sector—including transport, irrigation, replanting, and input-related schemes. On a micro-level, planters were surveyed with respect to the unit costs of cane transport, irrigation, de-rocking, land preparation, planting, and harvesting—detailing the share paid by growers, millers and the government. This information was collected via a spreadsheet questionnaire and corroborated with individual interviews. In addition, consultations with Trade Unions provided insightful information regarding type of labor, costs, and workers' expectations.

Table 9. Institutions consulted and data provided

Institution	**Information**
MCIA	• Total cane production by farm type and production zone (2005–2018) • Sugar pricing, land use and labor acts • Information on the responsibilities of millers • Previous studies relevant to this consultation • List of subsidies and programs involving the sugarcane sector as stipulated in the national budget (2017-2020)
CAD	• Production levels of sugar, molasses, and bagasse (2005–2018)

	• Conversion rates from cane to sugar, molasses, and bagasse
MSS	• Sugar export levels and markets • Prices paid to planters for sugar, molasses, and bagasse • Background details on Fairtrade sugar • Sugar marketing and export costs
MSIRI	• Location of factories, loading zones, and main production areas
SIFB	• Types of planters • Number of hectares dedicated to sugarcane • Yields per type of planter • Costs charged by service providers • Opportunities to improve cane production at the field level • Sugar marketing and export costs.
FSA	• Per hectare costs and revenues collected from small planters, including data on service provider rates.
MEPU	• Conversion rates from cane to sugar, molasses, and bagasse
MOFED	• List of subsidies and programs involving the sugarcane sector, including transport, irrigation, replanting, and input-related schemes
MCAF	• Unit costs of cane transport, irrigation, de-rocking, land preparation, planting, and harvesting • List of specific subsidies and benefits targeting Cooperative Sugarcane Societies (CSS)
MCA	• Overall production and trends from MCA members
Trade Unions	• Type of labor contracts (fixed vs. casual labor costs)
Private mills/IPP	• Conversion rates from cane to sugar, molasses, and bagasse • Costs of milling, refining, bagging, and producing electricity
Independent Planters	• Yields and revenue, subsidies received, annual variable costs since 2012 (land preparation, planting, irrigation, harvesting and transport) • Capital equipment and overhead costs (through questionnaires)

2.1.3 Sector Level

50. CAD and the Ministry of Energy and Public Utilities (MEPU) reported conversion rates from cane to sugar, molasses, and bagasse—based on harvest time, irrigation level, and type of producer. This information was crosschecked with ratios reported by Terra, Alteo and Omnicane, who also released data on costs of milling, refining, bagging, and producing electricity. Finally, SIFB and MSS reported sugar marketing and export costs—including freight, storage, and administrative expenses.

2.1.4 Farm Level

51. **Farm-level information about the different types of planters, the number of hectares dedicated to sugarcane, and their geographical distribution were provided by the Sugar Insurance Fund Board (SIFB), along with figures on yields, costs charged by service providers, and opportunities to improve cane production at the field level.** Per hectare costs and revenues for planters and estates were provided by: (i) the Farmers Service Agency (FSA), alongside costs of cane establishment—including land preparation, seed cane, fertilizer, chemicals, labor, and irrigation—and variable costs during production based on ratoon cycles; and (ii) a survey of large and small planters who were asked to fill a questionnaire in the form of a spreadsheet template that provided space to specify annual variable costs, capital equipment, and overhead costs. The survey results were compared for consistency and crosschecked with other available data on costs of cane production in Mauritius. Yield estimates are similarly based on data collected through the survey and other industry sources including detailed discussions with individual firms and the MSIRI. The MSS, CAD, and CEB provided pricing information, among others.

2.2 Modeling dynamics

2.2.1 Sector Level

52. **The sector-level analysis aggregates total costs and revenues, analyzing the entire value chain as if it were one single company ("Mauritius Inc.").** On the costs side, it includes farming, milling, refining, and cogeneration expenses, in addition to export, marketing, and institutional support payments. Farming costs flow directly from the farm-level analysis, establishing farming conditions based on assumptions informed by the sugarcane sector. Based on current production levels of approximately 3.3 million tons of cane, it assigns a share of 19% of production to small planters, and 81% to medium and large planters and estates, with varied mechanization, irrigation, and variety levels.

53. **Milling, refining, and cogeneration costs are largely based on sugarcane sector-reported figures.** The former is broken down into labor, cane supply, repair and maintenance, laboratory, services, logistics, management, insurance, depreciation, and financing costs, among other expenses. Refining costs are aggregated and can be expected to vary significantly in the upcoming year with the closure of one of the two existing facilities. Estimated cogeneration expenses stem from the per kilowatt-hour (kWh) cost reported by IPPs, bagasse production reported by the mills, and the average conversion rate to produce electricity from bagasse.

54. **Commercial costs are based on figures reported by MSS and divided into export and institutional expenses.** The former includes a wide range of expenses borne by MSS in the process of selling raw, refined, and specialty sugars—such as importing and re-exporting NOS sugar, freight and logistics, brokerage, quality assurance, and storage. The latter include marketing, overseas representation, legal fees, rent, and other administrative expenses, in

addition to payments to service providing institutions like MCIA and to the Sugar Insurance Reserve Fund.

55. **The revenue calculations aggregate total proceeds from sugar sales, compensation for molasses and bagasse, and returns from the sale of electricity from bagasse.** Total proceeds from sales are based on MSS-reported figures for 2019. The compensation for molasses is derived from sugarcane sector-reported production levels and the price of molasses. The compensation for bagasse is based on total bagasse production and the BTPF price. Finally, electricity sales are based on a weighted average price per kWh paid by CEB, and the exported electricity reported. While these payments are distributed to different actors along the value chain, this analysis combines all returns to assess the total revenue stream flowing into the sugarcane sector.

2.2.2 Farm Level

56. **Understanding the cost and profits at the farm level is fundamental to assess the competitiveness of the sugarcane sector.** This section presents the results of a competitiveness analysis that looked in detail at how the costs and returns from sugarcane compare for different types of growers and farm management systems. The analysis seeks to model potential market changes and public policies and investments. Building on this farm-level analysis, a sector-wide competitiveness analysis was undertaken to look at the entire sugarcane value chain, including milling, refining, cogeneration, and distillation stages of the industry.

57. **The base model is structured around 16 farm variations covering large corporate estates and small planters.** For each farm sector, there are variations by degree of mechanization, use of irrigation, and variety type. These variations were chosen to reflect common differences in on-farm management in Mauritius. For obvious reasons not all the different variables could be reflected nor the climatic and geographical references included, so 16 representative farm variations were selected based on the data gathered. Specific variations in climate zone and soil type were not covered in this first analysis due to insufficient data, but could be developed if a more detailed analysis is warranted.

58. **The analysis is not meant to predict costs and returns on specific plots or to recommend strategies for individual cane growers.** Many planters are already producing with very good varieties using full mechanization and other cost-saving technologies. Thus, while new and more specific farm-level variations could always be prepared to gain additional insight to farm-level viability, the aim of the analysis here is to model a continuum of possibilities that show how different types of improved and unimproved sugarcane systems compare from a general production perspective.

59. **Furthermore, the 16 farm models are used in various sensitivity tests to look at how new pricing and other changes would impact sector competitiveness.** On the input

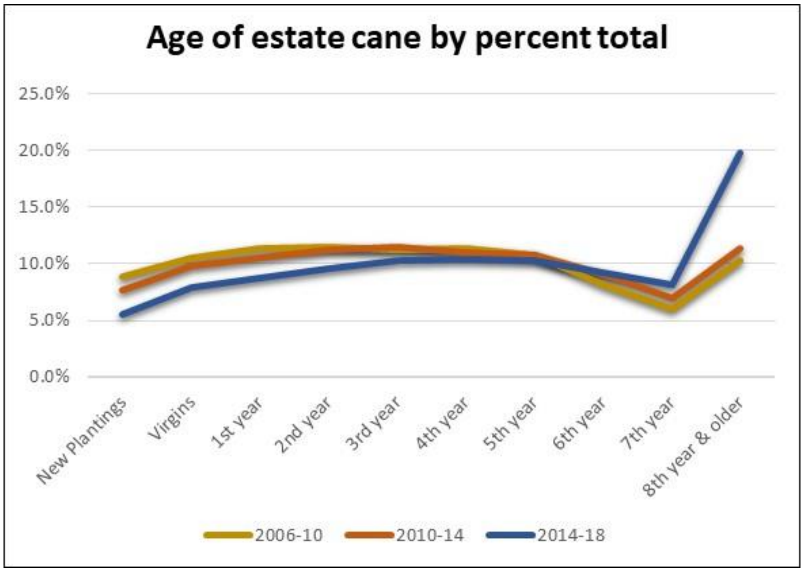
side, variations look at the benefit of timelier replanting of old cane stands and at how reforms that bring labor costs in line with wages in other economic sectors would impact farm-level viability. On the output side, the tool is used to look at alternative pricing arrangements for bagasse and molasses and how changes in world sugar prices (including measures that increase the share of special sugars in the export basket) could affect profits for farmers.

60. The analysis covers corporate estates and small planters. Corporate estates are assumed to farm cane over a larger area, using in most cases their own pool of equipment. Manual variations are based on manual harvesting and loading. Other operations including field preparation, application of fertilizers and herbicides, and bed maintenance are done using a combination of labor and machinery. Mechanized variations for corporate estates are based on fully integrated mechanical harvesting and loading of cane, and only a small amount of labor for field operations.

61. For the purpose of this competitiveness analysis, small planters were defined according to the sugar revenue-sharing agreement in place since 2019, which establishes a pricing formula for growers producing less than 60 tons of sugar on less than 10 hectares. Manual variations are based on manual cutting and loading of cane with only a very small amount of supplemental machine services mainly for light de-rocking in the planting year. Mechanical variations for small planters are based on a combination of mechanical and manual harvesting and loading. According to the Mauritius Chamber of Agriculture (MCA), small planters currently account for about 19% of total cane area and 14% of sugar accrued.

62. Despite variations in the standard sugarcane ratoon cycle being between the sixth and eighth ratoon, this base analysis assumes a 10-year ratoon cycle in which there are eleven cuttings of cane including cutting in the plant cane (PC) year. The optimal replanting schedule can vary significantly from field to field depending on yield performance and marginal cost of replanting. Until recently, conventional practice in Mauritius has been to replant most cane fields somewhere between the sixth and eighth ratoon (i.e., 6R to 8R). Because of current financial stress, however, many growers are finding it difficult to keep to this schedule leading to an increased number of plantings left in production after the normal useful life (see Figure 9). Sensitivity analysis looks at the potential benefits of timelier replanting compared to the current pattern of extended ratoon cycles.

Figure 9. Average age of cane by % total cane 2006-10, 2010-14, and 2014-18

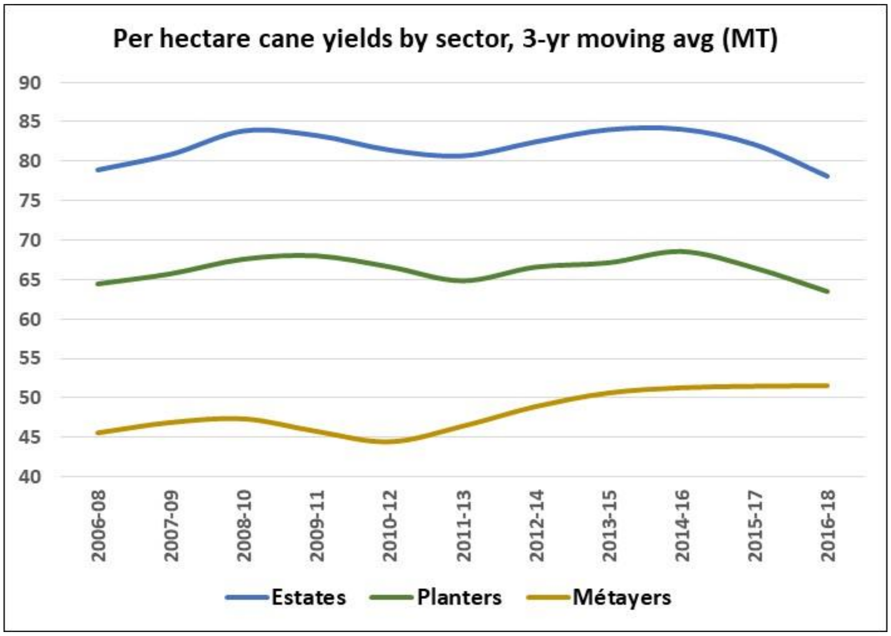


Source: Sugar Industry Statistics (MCA, 2005–2018).

63. **Yield assumptions are based on patterns across a 10-year ratoon cycle reported for corporate estates and small planters with adjustments by irrigation use, variety type, and mechanization.** Data gathered shows that the overall yield pattern in Mauritius is characterized by a drop of about 10-16% between the plant cane (PC) year and first ratoon (1R), followed by losses of about 5-7% in the second and fourth ratoons (2R to 4R) before losses flatten out somewhat to 4-5% between the fifth and seventh ratoons (5R to 7R). From the seventh ratoon, yield losses typically accelerate due to age, mounting damage from machinery, and soil compaction. In practice, many fields experience a more rapid decline in yield and would be the ones replanted first, while other very good fields that are well cared for may produce stable yields even beyond the tenth ratoon and would be left in the field for longer.

64. **In Figure 10, the average cane yield for estates has fluctuated around 82 tons of cane per hectare (TCH) since 2006 while large and small planters achieved an average of 63 TCH.** The SIS data are averages for all ages of cane.

Figure 10. Average cane yields by sector (tons cane per hectare, 2006-08 to 2016-18)



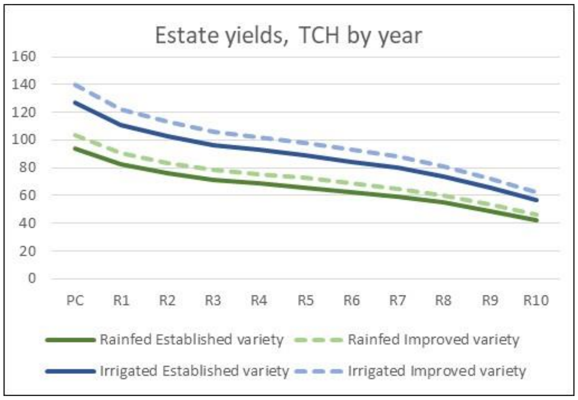
Source: Sugar Industry Statistics (MCA, 2005–2018).

65. **Based on data gathered, a set of assumptions on sugarcane yields in each year of the ratoon cycle was prepared (see Figure 11).** In these charts, the average yield for non-irrigated established variety systems up to the 7th ratoon is slightly below the national averages reported in the SIS, which include irrigated production and fields with very good varieties. When counting the full 10-year ratoon cycle, average yields (PC-10R) are even further below the SIS national averages. Because the SIS defines planters by their history of mill ownership rather than size or type of landholding, yields for the "small planter" sector are further adjusted downward to account for poorer quality land generally attributed to the small planter segment.[26]

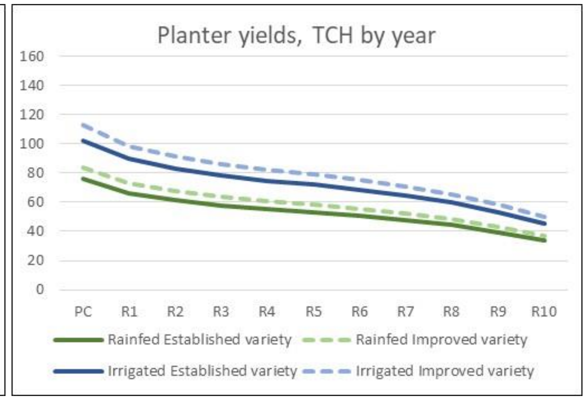
Figure 11. Yield assumptions without mechanization for (a) corporate estates and (b) small planters (tons of cane per ha, TCH)

[26] While some small planters may achieve yields that are as good or even better compared to certain fields on corporate estates, small planters in Mauritius are generally regarded as occupying poorer quality land compared with large planters. This is why the average for this sector was placed below the average for all "planters" (i.e., large and small growers without a history of mill ownership) reported by the SIS.

(a) Corporate estates



(b) Small planters



Source: Authors' calculations from industry data.

Irrigation, Variety Improvement and Mechanization

66. **Adjustments are made to account for the introduction of irrigation and variety improvement, assumed to lead to a 35% and 10% yield improvement, respectively, for both small planters and corporate estates.** As with other parts of the yield assumptions, these adjustments are based on data gathered. Specifically, for both corporate estates and small planters, irrigation is assumed to lead to a 35% yield improvement compared with non-irrigated production, and variety improvement is assumed to lead to a 10% yield improvement. For small planters, the costs of irrigation are based on services by the Irrigation Authority; for the corporate sector, costs are mostly based on own infrastructure development and operation and maintenance costs—though corporate estates also rely on infrastructure and services from the Irrigation Authority.

67. **Mechanized systems are further assumed to produce 3% more yield than non-mechanized systems.** Mechanization is only possible in fields that have been mostly de-rocked; without rocks, there is more space for cane.

Industrial Recoverable Sucrose Content (IRSC)

68. **Industrial recoverable sucrose content (IRSC) is used to measure the sugar content of sugarcane and to calculate farmer payments.** The assumed IRSC is 10.05% for established varieties and 10.25% for improved varieties. In the model, multiplying tons of cane per hectare (TCH) by the IRSC leads to total bulk sugar per hectare. For payment purposes, total bulk sugar is then multiplied by the accrued share of planters and millers, with 78% of sugar revenues corresponding to planters and 22% to mills. The figure for tons of accrued sugar is then multiplied by the final ex-Syndicate price paid by the Mauritius Sugar Syndicate (MSS).

Variable Costs

69. **Variable costs are annual expenses that change with total production and management system.** By entering costs in different parts of the model, the analysis splits variable costs into several categories that are useful to understanding the structure of production costs. Per hectare costs can be expressed in equivalent per ton of cane, per ton of total bulk sugar, and per ton accrued sugar terms.

Fixed Costs

70. **Fixed costs include depreciation on capital investments with a useful life spread over more than one season and overhead charges including office costs, insurance, and other sundry expenses.** Depreciation costs on fixed assets were calculated using the capital recovery method in which the capital recovery cost is the amount that will repay the price of fixed investments and provide an economic return on the investment over its useful life. For this farm-level analysis, per hectare capital recovery costs were estimated for different sets of equipment used by large corporate estates for non-mechanized production, mechanized production, and irrigated production. For small planters, a similar set of estimates was made including hand tools and share of a vehicle used for farm operations.

Overhead Costs

71. **Overhead costs were also estimated from survey data on a per hectare basis for estates and small planters.** These costs include SIFB and other insurance premiums, repairs and maintenance on buildings and equipment, field supervisors and office staff, staff bonuses and statutory contributions, and administrative charges. For small planters, overheads include administrative charges, land rent (charged at 10% of gross proceeds), and irrigation dues, where applicable.

De-rocking

72. **Heavy de-rocking is done to allow for mechanization and is treated as a capital cost in mechanized variations only.** When done, heavy de-rocking is normally performed over a series of replanting cycles and, once completed, the field has a very long useful life. By applying the capital recovery method, only the annual per hectare share of the total cost is applied to the calculations of costs and profits—particularly since many rocks are sold in the market after this process. Corporate estates are assumed to use their own equipment for heavy de-rocking whereas small planters use equipment hired from the Agricultural Mechanization Unit (AMU) as well as from private service providers. Light de-rocking is included as a variable cost in the plant cane year of all variations.

Prices

73. **Input prices are based on data covering 2018–2019 period as reported in the farmer survey.** To provide as consistent and reliable overall picture as possible, these prices

and cost structures were crosschecked for consistency with other available information on sugar costs in Mauritius.

74. On the output side, total revenue from sugarcane includes revenues from sugar, bagasse, and molasses. For sugar, the analysis is based on an average of the 2017–2019 price paid by the Mauritius Sugar Syndicate (MSS).[27] This helps to even out annual variations and provides a longer-term view of the profitability of sugarcane. Molasses and bagasse are priced in 2018 terms.[28] As the study was being finalized, the new 2019 price for bagasse was announced but the 2020 price for molasses was still to be determined. For bagasse it was further assumed estates and small planters are in the Bagasse Transfer Price Fund (BTPF) Category B (i.e., planters without a mill). Category A planters (i.e., planters with a mill) would receive a lower price from the BTPF.

75. In addition to revenue from sugarcane, estates and small planters receive payments from a variety of other sources termed "supplements" in this analysis. Supplements include additional payments for bagasse, payments from the Sugarcane Stability Fund (SCSF), and, preferential revenue sharing agreement for small planters producing less than 60 tons of sugar.[29] Supplemental payments can vary from year to year. For this analysis, these are calculated in 2018 terms, as this was the data available when the model was first developed. 2019 data has since become available, so an update of the data in the model could be done in the future.

76. Payments from the Sugar Insurance Fund Board (SIFB), come from money the MSS sets aside to insure against natural disasters and that the SIFB decided to use instead as compensation for low sugar prices. SIFB payments due to low sugar prices were made in 2014, 2015, 2017 and 2018. Incremental payments for bagasse were described as a transitional arrangement from the current BTPF system to a new pricing formula for bagasse.

Exchange Rate

77. Consistent with the use of 2018–2019 prices, the following exchange rates were assumed:

- US$1 = Rs36.00
- EUR 1 = Rs40.50

78. As of November 2020, the rupee is trading at around Rs39.85 to the US$ and Rs47.25 to the Euro. The impact of this devaluation on the profitability of cane and costs of cane production was not considered for the farm-level analysis. Therefore, while further

[27] Specifically, 2017-19 average = Rs10,261.90 per ton (of which 78 percent accrues to planters and 22 percent to mills).
[28] Specifically, Category B BTFP price for bagasse = Rs161.05 per ton of accrued sugar; molasses composite price from all sources = Rs 3,840.44 per ton of molasses @ 3.28% molasses from cane.
[29] Since 2019, around 10,500 small planters benefit from the sugar revenue sharing agreement, which establishes a pricing formula for growers producing less than 60 tons of sugar.

detailed analysis of how the devaluation will impact the profitability of sugarcane is possible, this would require detailed information on new price levels as well as the imported share of different input costs. For present purpose, the approach was to work in the constant terms described above with the notion that future prices retain similar general relations.

Financial Indicators

80. Profits are measured in gross (revenues minus variable costs) and net (revenues minus total costs including capital costs and overhead charges) terms by revenue from sugarcane and total revenue including supplements.

81. A useful way to summarize the results of the model is to consider the net present value (NPV) of the different farm systems. In financial analysis, NPV is the difference between the present value of cash inflows and the present value of cash outflows over time, in which the decrease in the current value of future cash flows is based on a chosen rate of return or discount factor. For this analysis, NPVs are calculated on the gross and net profits from sugarcane and total revenue including supplements using a 12% discount factor.[30] This is different from the approach taken for individual business planning, which would normally look at annual cash flows by calculating opening and closing balances, and retained earnings and deficits over time. The approach of looking at NPVs on annual gross and net profits was adequate in showing the overall viability of sugarcane in the country, and a farmer's ability to cover the cost of financing and to reach an acceptable rate of return over time.

Alternative Scenarios

82. To illustrate how new parameters might affect the profitability of sugarcane, the base models were used to present a range of alternative scenarios. These include (i) alternative pricing of bagasse; (ii) alternative pricing of molasses; (iii) replanting after the 6th ratoon instead of the 10th; (iv) increased share of special sugars in the export basket; and (v) adoption of labor reforms. An analysis of revenues and profits in per ton of cane equivalent terms was also prepared. These scenarios are described following the main findings of the analysis.

3. Findings

83. Data and results of the modeling exercise were presented in a series of consultations with industry stakeholders and international experts. Based on the

[30] The choice of a 12 percent discount rate was selected to be high enough to cover interest on borrowing and still deliver a reasonable return on investment. In 2019 prime lending rates quoted by the Bank of Mauritius (https://www.bom.mu/sites/default/files/int0720.pdf) ranged from 5.5% – 8.5%. Now in 2020, lending rates are slightly lower at a range of 4% – 6.85%.

feedback received, several adjustments were made including adjustments to the data used, assumptions and some input costs and output prices.

3.1 Sector Level

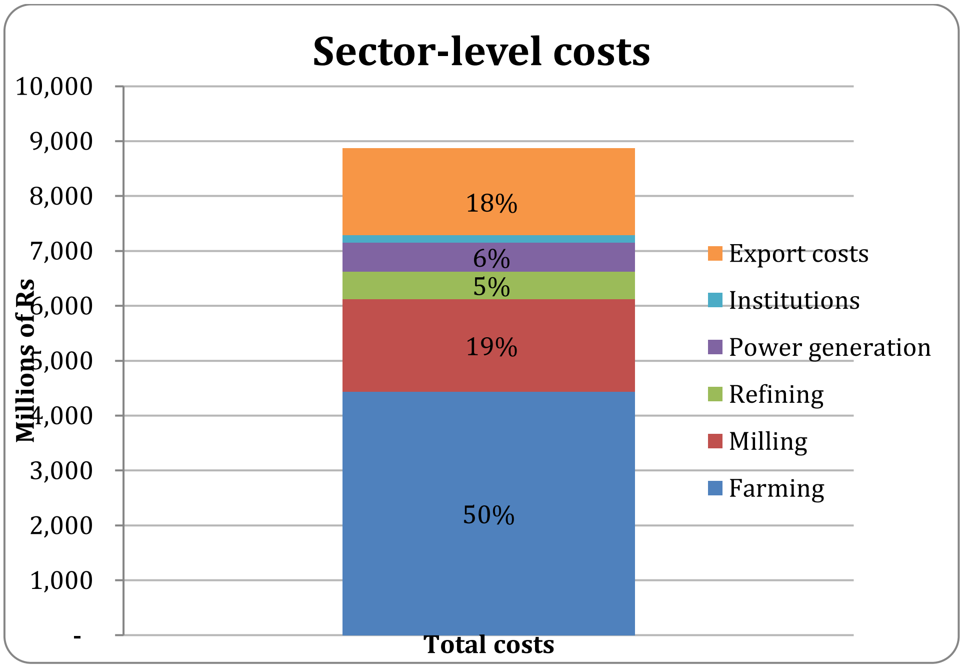
84. **Based on 2019 figures, the sector spends approximately Rs8.87 billion every year to grow sugarcane, and process and commercialize derived products.** Sector-level costs are heavily concentrated at the farm level, with an estimated Rs4.43 billion—around 49% of total costs. Second to farming, milling costs represent about 19% of the total bill, at Rs1.69 billion. Export costs stand closely at 1.58 billion, or 18% of the total. Cogeneration expenses represent about 5.9% of the total share, at approximately Rs0.53billion, while refining constitutes the smallest portion of production costs, at 5.6%, or Rs0.50 billion. Finally, institutional costs equal Rs0.13 billion, less than 2% of the total.

85. **On the revenue side, the sugarcane sector earns around Rs7.5 billion annually from the sales of sugar, molasses, electricity, and bagasse.** Sugar heavily dominates the revenue stream, with 82.9% of returns or Rs6.2billion. Electricity from bagasse generates approximately Rs0.84 billion, or around 12% of the total, while compensation for bagasse—through the BTPF—attracts around Rs0.55 billion. Finally, payments for molasses stand at approximately Rs0.39 billion, or 5% of total returns—though value-added products like ethanol, animal feed, and alcohol presumably contribute a larger share that is not accounted for in this analysis as no detailed information was obtained.[31]

86. **The sugarcane sector incurs losses of approximately Rs1.35 billion annually.** On a subsector level, nearly all the losses are borne by planters, followed by millers. Under 2019 conditions, refining and electricity generation from bagasse were the only profitable activities for the sector. Figures 12 and 13 summarize the cost and revenue structures for the sugarcane sector in Mauritius, while Figure 14 illustrates net profits and losses by subsector.

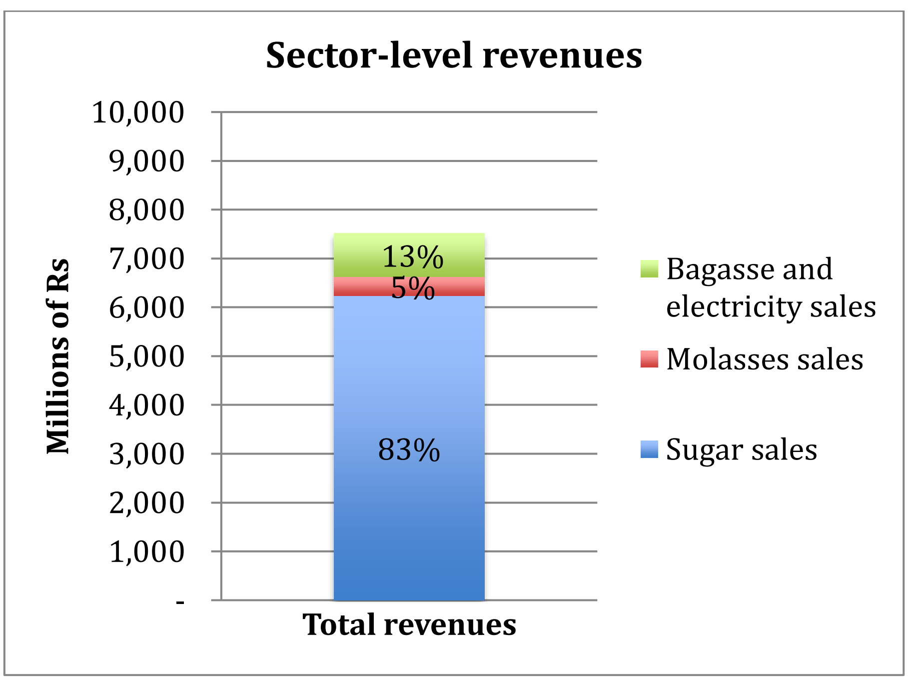
[31] Placeholders in the models were left to add the information in case it becomes available.

Figure 12. Sugarcane sector costs 2018-19



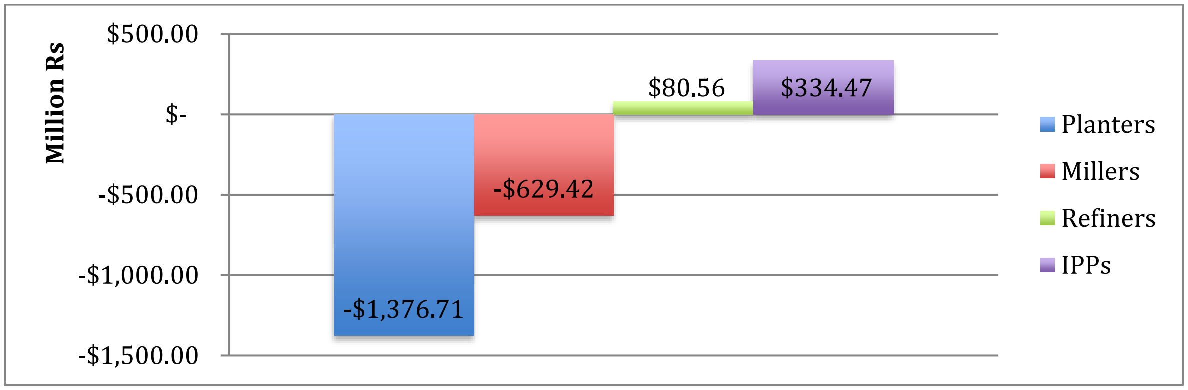
Source: Sugarcane sector-reported figures

Figure 13. Sugarcane sector revenues 2019



Source: Sugarcane sector-reported figures

Figure 14: Net profits/losses by subsector



Source: sugarcane sector-reported figures

3.2 Farm Level

87. **Costs used in the farm-level model are summarized in Table 10 with variations for corporate estates and small planters using mostly manual and mechanical methods**. The estimated costs for small planters are based on using FSA services and could be much higher than using a private contractor. Corporate estates do not have access to subsidized FSA services so they generally pay more per hectare than small planters.

Table 10. Estimated planting costs (Rs per ha)

	Corporate		Small Planter	
	Mostly manual	Highly mechanical	Highly manual	Semi-mechanical
Materials				
Cane sets (treated)	21,703	21,703	6,588	6,588
NPK	16,000	16,000	14,500	14,500
Herbicide	4,000	4,000	3,600	3,600
Subtotal materials	**41,703**	**41,703**	**24,688**	**24,688**
Mechanical Operations				
Clearing	2,800	3,150	-	2,800
Heavy derocking	-	90,000	-	65,000
Light derocking	9,000	22,500	4,800	14,000
Furrowing and bed formation	1,600	8,000	-	1,600
Plant and cover	940	4,700	-	2,350
Apply fert & chem	520	2,600	-	1,300
Transport & other machine	500	2,500	1,250	2,000
Subtotal mechanical operations	**15,360**	**133,450**	**6,050**	**89,050**
Labor				
Clearing	5,200	350	12,000	5,200
Light derocking	3,000	2,500	7,200	6,000
Furrowing and bed formation	21,750	4,350	21,750	17,400
Prep, plant & cover cane sets	17,000	9,800	17,000	12,500
Apply fert & chem	1,500	375	8,512	4,256
Weeding and other operations	8,700	4,800	6,762	3,381
Subtotal labor	**57,150**	**22,175**	**73,224**	**48,737**
TOTAL PLANT CANE	**114,213**	**197,328**	**103,962**	**162,475**
Materials	37%	21%	24%	15%
Mechanical operations	13%	68%	6%	55%
Labor	50%	11%	70%	30%

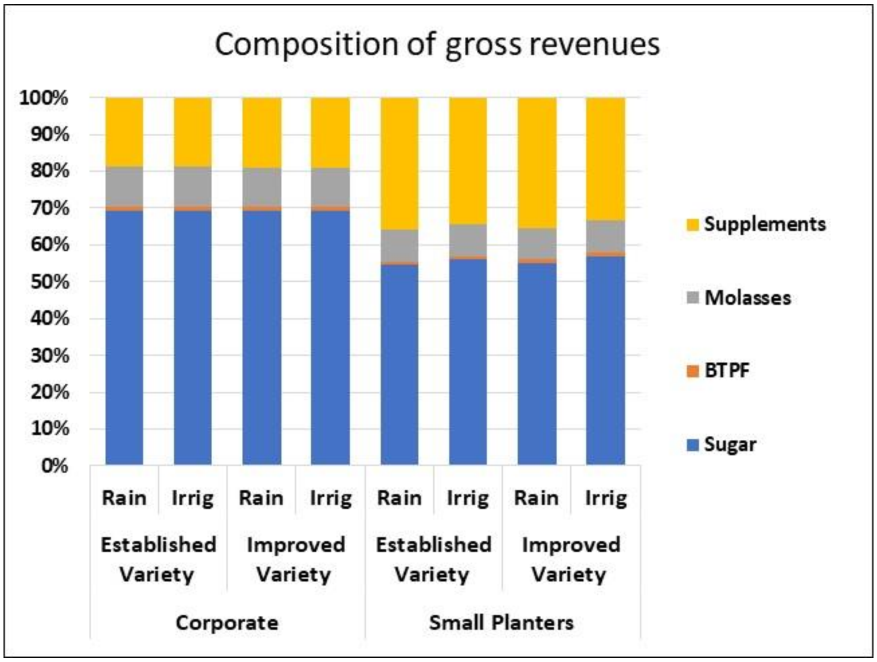
Source: Authors' calculations from the competitiveness model.

88. **Planting sugarcane can reach up to 75% of total cane revenue. At an estimated range of Rs114,000 to almost Rs200,000 per hectare for corporate estates, the cost of planting with heavy de-rocking works out to around 70% to 75% of total cane revenue (i.e., revenue from sugar, BTPF, and molasses) over the first three harvests (PC-2R).** When supplemental payments are added, planting costs work out to around 55% to 60% of revenue over the first three harvests. For planters using FSA services, the cost of replanting is also around 70% or 75% of cane revenue over the first three harvests. Because small planters receive additional supplements, however, the costs of planting as a share of total revenue works out somewhat less at 50%–55% of total revenues over the first three harvests.

3.2.1 Gross Revenues

89. **Supplemental revenues account for 19% of total gross revenues for corporate estates and 33% to 36% of gross revenues for small planters.** Figure 15 shows the overall composition of gross revenues in percentage terms for corporate estates and small planters. These supplements serve a useful purpose in covering up annual losses in gross terms but are not enough to cover total losses in net terms.

Figure 15. Composition of annual average gross revenues over 10-year ratoon cycle using 2018 formulas for supplemental payments



Source: Authors' calculations from the competitiveness model.

90. The supplements come from different sources, including fees that MSS discounts from sector revenues, but are paid as basic income support. While the need for supplements became especially acute in 2018 when world sugar prices were very low, these payments have been around in different forms since at least 2014 (see figure 16). Breaking the cycle of dependence on supplemental payments in an age of lower sugar prices is a significant challenge to the sector.

91. Table 11 provides details of composition of annual per hectare revenues by management system. Gross revenues are significantly higher with irrigation, variety improvement, and mechanization, compared to more basic systems. A graphic representation of these data is provided figure 16. showing the difference made by improving farm management.

92. Table 11 also shows that supplements account for 19% of the total per hectare revenue for corporate estates and 33% to 36% of per hectare revenue for small planters. Based on the per hectare values shown and total area planted to sugarcane, the total cost of these supplements to the government and the sector works out to around Rs961.8 millions or about US$27.8 millions annually.[32] Ultimately, the challenge of farm

[32] Calculations made using assumptions from the industry model about the percentage of total cane area under each management system.

management is to strike the right balance between the incremental costs and the marginal benefits in the different management systems.

Table 11. Annual average gross revenues (Rs per ha)

(a) Corporate estates

Corporate estates: Average annual gross revenues (Rs per ha), replant after 10R

		Mostly Manual				Fully Mechanized			
		Established Variety		Improved Variety		Established Variety		Improved Variety	
		Rain	Irrig	Rain	Irrig	Rain	Irrig	Rain	Irrig
Yield (average TCH)		**66.0**	**89.0**	**72.6**	**97.9**	**67.9**	**91.7**	**74.7**	**100.9**
Revenue from cane (current system)									
Sugar	Rs/ha	53,059	71,629	59,532	80,368	54,650	73,778	61,318	82,779
BTPF	Rs/ha	833	1,124	934	1,261	858	1,158	962	1,299
Molasses	Rs/ha	8,308	11,216	9,139	12,338	8,558	11,553	9,413	12,708
Total revenue from cane	**Rs/ha**	**62,200**	**83,970**	**69,605**	**93,967**	**64,066**	**86,489**	**71,693**	**96,786**
Supplemental revenue (2018)									
Additional BTPF payment	Rs/ha	6,463	8,725	7,252	9,790	6,657	8,987	7,469	10,083
SCSF	Rs/ha	1,551	2,094	1,740	2,349	1,598	2,157	1,793	2,420
SIFB assistance	Rs/ha	6,463	8,725	7,252	9,790	6,657	8,987	7,469	10,083
Special govt assistance	Rs/ha	0	0	0	0	0	0	0	0
Total supplemental revenue	**Rs/ha**	**14,477**	**19,544**	**16,243**	**21,929**	**14,911**	**20,131**	**16,731**	**22,586**
Total gross revenue	**Rs/ha**	**76,677**	**103,514**	**85,849**	**115,896**	**78,977**	**106,619**	**88,424**	**119,372**
Of which revenue from cane		81%	81%	81%	81%	81%	81%	81%	81%
Of which supplemental revenue		19%	19%	19%	19%	19%	19%	19%	19%

(b) Small planters

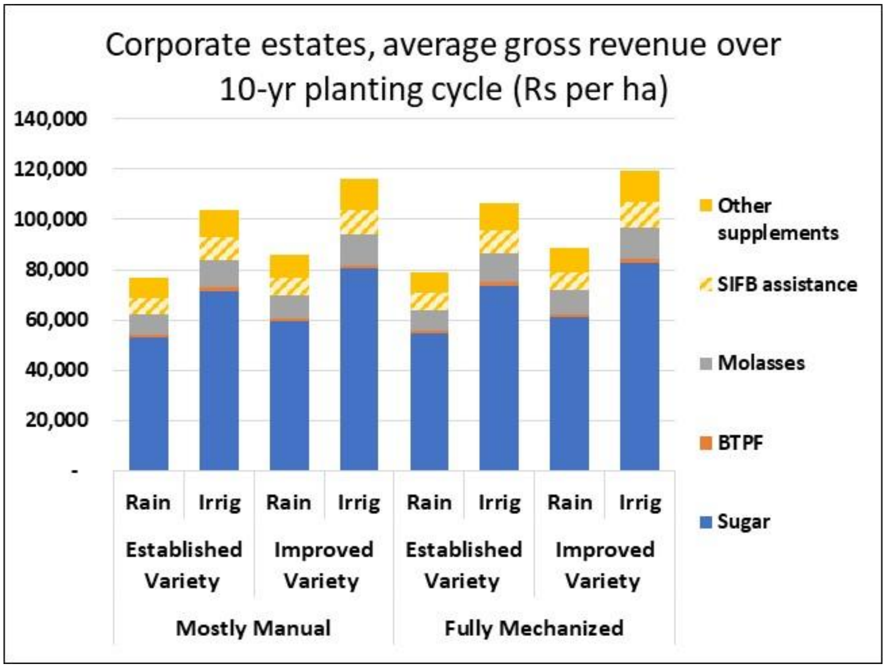
Small Planters: Average annual gross revenues (Rs per ha), replant after 10R

		Manual				Semi Mechanized			
		Established Variety		Improved Variety		Established Variety		Improved Variety	
		Rain	Irrig	Rain	Irrig	Rain	Irrig	Rain	Irrig
Yield (average TCH)		**52.6**	**71.0**	**57.9**	**78.1**	**54.2**	**73.2**	**59.6**	**80.5**
Revenue from cane (current system)									
Sugar	Rs/ha	42,334	57,151	47,499	64,123	43,604	58,865	48,924	66,047
BTPF	Rs/ha	664	897	745	1,006	684	924	768	1,036
Molasses	Rs/ha	6,629	8,949	7,292	9,844	6,828	9,218	7,511	10,140
Total revenue from cane	**Rs/ha**	**49,627**	**66,997**	**55,536**	**74,974**	**51,116**	**69,007**	**57,202**	**77,223**
Supplemental revenue (2018)									
Additional BTPF payment	Rs/ha	5,157	6,961	5,786	7,811	5,311	7,170	5,959	8,045
SCSF	Rs/ha	4,538	6,126	5,091	6,874	4,674	6,310	5,244	7,080
SIFB assistance	Rs/ha	5,157	6,961	5,786	7,811	5,311	7,170	5,959	8,045
Special govt assistance	Rs/ha	13,027	14,872	13,838	15,124	13,291	14,965	14,043	15,200
Total supplemental revenue	**Rs/ha**	**27,878**	**34,921**	**30,501**	**37,620**	**28,588**	**35,615**	**31,206**	**38,370**
Total gross revenue	**Rs/ha**	**77,505**	**101,918**	**86,037**	**112,593**	**79,704**	**104,622**	**88,408**	**115,593**
Of which revenue from cane		64%	66%	65%	67%	64%	66%	65%	67%
Of which supplemental revenue		36%	34%	35%	33%	36%	34%	35%	33%

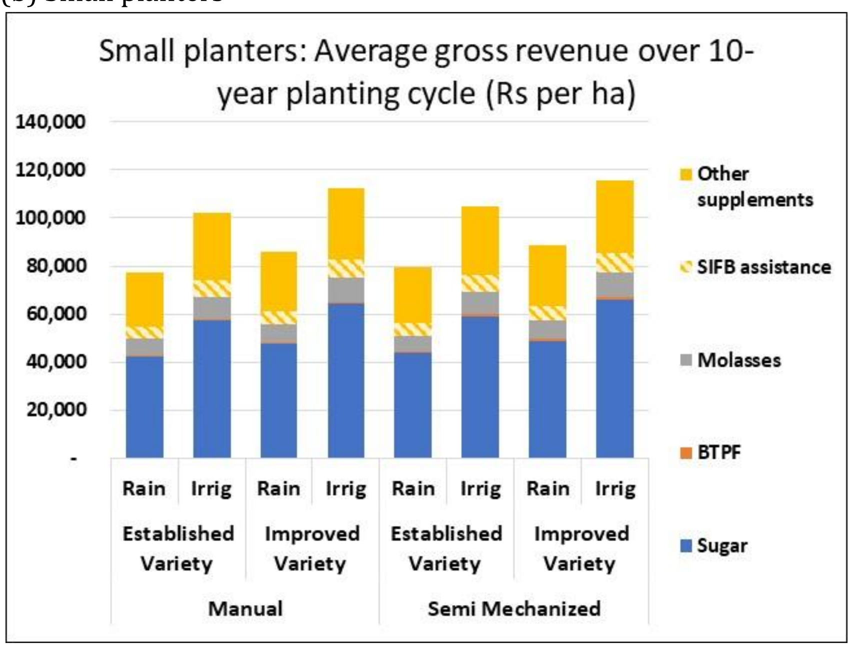
Source: Authors' calculations from the competitiveness model.

Figure 16. Annual average gross revenues by management system (Rs per ha)

(a) Corporate estates



(b) Small planters



Source: Author's calculations from industry data.

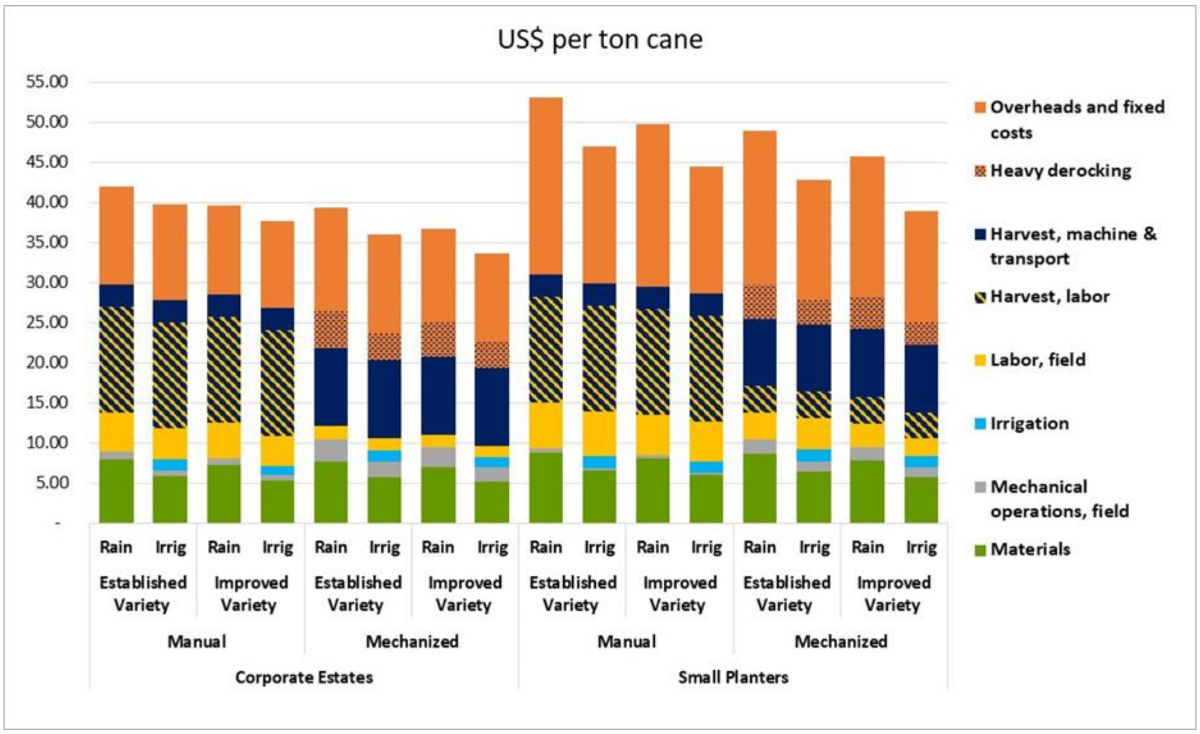
3.2.2 Cost per ton of sugarcane

93. **The next two parts of the analysis look at costs in per ton terms, first at costs per ton of sugarcane, and then at costs per ton of sugar in accrued and total bulk terms.** Per ton measures allow the cost competitiveness of different farm systems to be compared directly with each other. These cost measures are different from per hectare indicators, which

individual farmers may be most concerned with. Per ton costs do not show which systems are the most and least profitable.[33] Rather, the focus of this measure is on overall cost competitiveness.

94. Figure 17 summarizes the costs of producing a ton of sugarcane in US$ terms according to the 16 base models prepared here.[34] Corporate estates are shown to produce sugarcane for significantly less than small planters. The difference, according to these estimates is around US$5–US$11 per ton, making small planter cane 16% to 26% more expensive than corporate cane. According to the Mauritius Chamber of Agriculture (MCA), small planters currently account for 19% of the total cane area, meaning that roughly a fifth of cane supply is of this structurally higher production cost type.

Figure 17. Cost per ton cane (average US$ over 10-year ratoon cycle)



Source: Authors' calculations from the competitiveness model.

Table 12. Annual average costs per ton of cane (US$ per ton and Rs per ton)

[33] These data are available in the detailed models and could be extrapolated for further analysis if users wish.
[34] The data used to create Figure 17 are presented in tabular form in Table 12 in both US$ and Rs terms. Also, since the annual averages presented include significant year-on-year variations by age of cane, detailed calculations of costs in each year of the ratoon cycle are provided Table 13.

Average annual costs per ton cane (US$)

	Corporate Estates								Small Planters							
	Manual				Mechanized				Manual				Mechanized			
	Established Variety		Improved Variety		Established Variety		Improved Variety		Established Variety		Improved Variety		Established Variety		Improved Variety	
	Rain	Irrig	Rain	Irrig	Rain	Irrig	Rain	Irrig	Rain	Irrig	Rain	Irrig	Rain	Irrig	Rain	Irrig
Materials	7.98	5.91	7.25	5.37	7.74	5.74	7.04	5.22	8.85	6.56	8.05	5.96	8.59	6.37	7.81	5.79
Mechanical operations, field	0.94	0.70	0.85	0.63	2.70	2.00	2.45	1.82	0.46	0.34	0.42	0.31	1.82	1.35	1.66	1.23
Irrigation	0	1.31	0	1.19	0	1.27	0	1.16	-	1.48	-	1.34	-	1.44	-	1.31
Labor, field	4.87	4.00	4.42	3.63	1.64	1.60	1.49	1.45	5.73	5.61	5.00	5.10	3.41	3.94	3.00	2.22
Harvest, labor	13.19	13.19	13.19	13.19	-	-	-	-	13.19	13.19	13.19	13.19	3.30	3.30	3.30	3.30
Harvest, machine & transport	2.78	2.78	2.78	2.78	9.72	9.72	9.72	9.72	2.78	2.78	2.78	2.78	8.40	8.40	8.40	8.40
Heavy derocking	-	-	-	-	4.74	3.51	4.31	3.19	-	-	-	-	4.29	3.18	3.90	2.89
Overheads and fixed costs	12.32	11.91	11.20	10.83	12.83	12.21	11.67	11.10	22.12	17.06	20.39	15.79	19.07	14.81	17.62	13.74
Total	**42.07**	**39.80**	**39.70**	**37.63**	**39.37**	**36.05**	**36.68**	**33.65**	**53.13**	**47.03**	**49.83**	**44.49**	**48.89**	**42.78**	**45.70**	**38.88**

Average annual costs per ton cane (Rs)

	Corporate Estates								Small Planters							
	Manual				Mechanized				Manual				Mechanized			
	Established Variety		Improved Variety		Established Variety		Improved Variety		Established Variety		Improved Variety		Established Variety		Improved Variety	
	Rain	Irrig	Rain	Irrig	Rain	Irrig	Rain	Irrig	Rain	Irrig	Rain	Irrig	Rain	Irrig	Rain	Irrig
Materials	287.2	212.7	261.1	193.4	278.8	206.5	253.5	187.8	318.7	236.1	289.7	214.6	309.4	229.2	281.3	208.3
Mechanical operations, field	33.9	25.1	30.8	22.8	97.0	71.9	88.2	65.3	16.7	12.4	15.2	11.3	65.6	48.6	59.7	44.2
Irrigation	-	47.2	-	42.9	-	45.8	-	41.7	-	53.2	-	48.4	-	51.7	-	47.0
Labor, field	175.2	143.9	159.3	130.9	59.0	57.5	53.7	52.3	206.2	202.1	180.0	183.7	122.9	141.9	108.1	80.1
Harvest, labor	475.0	475.0	475.0	475.0	-	-	-	-	475.0	475.0	475.0	475.0	118.8	118.8	118.8	118.8
Harvest, machine & transport	100.0	100.0	100.0	100.0	350.0	350.0	350.0	350.0	100.0	100.0	100.0	100.0	302.5	302.5	302.5	302.5
Heavy derocking	-	-	-	-	170.6	126.4	155.1	114.9	-	-	-	-	154.4	114.4	140.4	104.0
Overheads and fixed costs	443.4	428.7	403.0	389.7	461.9	439.6	420.0	399.6	796.1	614.2	734.0	568.6	686.6	533.0	634.4	494.8
Total	**1,514.6**	**1,432.7**	**1,429.2**	**1,354.7**	**1,417.4**	**1,297.6**	**1,320.4**	**1,211.5**	**1,912.7**	**1,692.9**	**1,793.8**	**1,601.5**	**1,760.2**	**1,540.1**	**1,645.0**	**1,399.6**

Source: Author's calculations from the competitiveness model.

Table 13. Variable and total costs per ton of cane in each year of the ratoon cycle (US$ and Rs)

US$ per ton cane (variable costs)

		PC	1R	2R	3R	4R	5R	6R	7R	8R	9R	10R	Average all years	Avg excl. PC
Corporate														
Mostly manual														
Established variety	Rainfed	49.72	26.15	26.97	27.06	26.93	27.26	26.74	27.37	27.99	29.47	31.67	**29.76**	27.76
	Irrigated	42.11	24.81	25.53	25.68	25.65	25.96	25.66	26.22	26.83	28.17	30.15	**27.89**	26.46
Improved variety	Rainfed	46.65	25.22	25.97	26.05	25.94	26.24	25.76	26.33	26.89	28.24	30.24	**28.50**	26.69
	Irrigated	39.73	24.01	24.66	24.80	24.77	25.05	24.78	25.29	25.84	27.06	28.86	**26.80**	25.51
Fully mechanized														
Established variety	Rainfed	40.51	18.29	18.77	18.91	18.92	19.18	19.29	19.72	20.53	21.86	23.84	**21.80**	19.93
	Irrigated	33.64	17.33	17.79	17.98	18.05	18.31	18.47	18.88	19.62	20.85	22.66	**20.33**	18.99
Improved variety	Rainfed	37.72	17.51	17.95	18.08	18.09	18.32	18.42	18.81	19.54	20.76	22.55	**20.70**	19.00
	Irrigated	31.46	16.64	17.06	17.23	17.29	17.53	17.68	18.05	18.72	19.83	21.48	**19.36**	18.15
Small planters														
Manual														
Established variety	Rainfed	54.48	26.25	27.08	27.31	27.56	28.04	27.77	28.46	29.47	31.14	33.61	**31.02**	28.67
	Irrigated	44.66	25.89	26.69	27.02	27.31	27.79	27.74	28.43	29.43	31.10	33.56	**29.97**	28.50
Improved variety	Rainfed	48.70	25.32	26.07	26.28	26.50	26.94	26.70	27.32	28.24	29.76	32.01	**29.44**	27.51
	Irrigated	42.05	24.99	25.72	26.02	26.28	26.71	26.67	27.29	28.21	29.72	31.96	**28.69**	27.36
Semi-mechanized														
Established variety	Rainfed	46.75	21.22	22.00	22.18	22.40	22.85	22.56	23.19	24.12	25.66	27.93	**25.53**	23.41
	Irrigated	38.72	20.99	21.75	22.04	22.31	22.75	22.68	23.32	24.26	25.82	28.11	**24.80**	23.40
Improved variety	Rainfed	42.46	20.36	21.06	21.23	21.43	21.83	21.57	22.15	22.99	24.39	26.45	**24.17**	22.35
	Irrigated	35.36	19.11	19.71	19.91	20.10	20.45	20.32	20.82	21.56	22.78	24.58	**22.25**	20.93

Rs$ per ton cane (variable costs)

		PC	1R	2R	3R	4R	5R	6R	7R	8R	9R	10R	Average all years	Avg excl. PC
Corporate														
Mostly manual														
Established variety	Rainfed	1,790.0	941.3	971.0	974.1	969.6	981.5	962.6	985.2	1,007.5	1,060.9	1,140.0	**1,071.2**	999.4
	Irrigated	1,516.0	893.2	919.0	924.5	923.4	934.5	923.6	943.9	965.7	1,014.0	1,085.5	**1,003.9**	952.7
Improved variety	Rainfed	1,679.6	908.0	935.0	937.8	933.7	944.5	927.4	947.9	968.2	1,016.7	1,088.7	**1,026.1**	960.8
	Irrigated	1,430.5	864.3	887.7	892.7	891.7	901.8	891.9	910.4	930.2	974.1	1,039.1	**964.9**	918.4
Fully mechanized														
Established variety	Rainfed	1,458.5	658.4	675.7	680.9	681.3	690.6	694.6	709.7	738.9	787.0	858.1	**784.9**	717.5
	Irrigated	1,210.9	623.9	640.4	647.4	649.8	659.1	665.0	679.7	706.4	750.5	815.7	**731.7**	683.8
Improved variety	Rainfed	1,357.8	630.3	646.1	650.8	651.1	659.7	663.3	677.0	703.6	747.3	811.9	**745.4**	684.1
	Irrigated	1,132.6	599.0	614.0	620.4	622.6	631.0	636.4	649.7	674.0	714.1	773.3	**697.0**	653.4
Small planters														
Manual														
Established variety	Rainfed	1,961.2	945.0	975.0	983.2	992.0	1,009.4	999.8	1,024.5	1,061.0	1,121.0	1,209.9	**1,116.5**	1,032.1
	Irrigated	1,607.6	932.0	961.0	972.8	983.3	1,000.3	998.6	1,023.3	1,059.7	1,119.6	1,208.2	**1,078.8**	1,025.9
Improved variety	Rainfed	1,753.2	911.4	938.6	946.1	954.1	969.9	961.2	983.7	1,016.8	1,071.4	1,152.2	**1,059.9**	990.5
	Irrigated	1,513.7	899.6	925.9	936.6	946.2	961.6	960.1	982.5	1,015.6	1,070.0	1,150.6	**1,033.0**	984.9
Semi-mechanized														
Established variety	Rainfed	1,683.1	764.0	791.8	798.7	806.4	822.5	812.1	834.8	868.4	923.6	1,005.4	**919.2**	842.8
	Irrigated	1,394.0	755.7	782.8	793.4	803.0	819.0	816.6	839.6	873.5	929.4	1,012.1	**892.6**	842.5
Improved variety	Rainfed	1,528.6	732.9	758.2	764.3	771.4	786.0	776.6	797.2	827.7	878.0	952.3	**870.3**	804.5
	Irrigated	1,272.9	688.0	709.6	716.6	723.6	736.2	731.5	749.6	776.2	820.1	885.0	**800.8**	753.6

Source: Author's calculations from the competitiveness model.

95. The data in Figure 17 also provide an insight into the structure of production costs and types of savings (or increments) that may be available by switching from one

system to another. An important finding of this part of the analysis is therefore the significant differences that emerge between management systems and the importance of farm-level management as a determinant of competitiveness. From a national perspective, these results emphasize the importance of individual planters adopting the best management practices.

3.2.3 Mechanization

96. Figure 17 shows that mechanization can provide significant savings on per ton costs. In the model, large commercial costs are US$2.70 to US$4.00 per ton (6% to 11%) lower with full mechanization compared to mostly manual systems using manual harvest. For small planters, per ton costs are US$4.25 to US$5.60 lower with semi-mechanization compared to fully manual harvest. Small planters are not subjected to the same labor laws as corporate estates so they benefit from greater flexibility in the use of workers, and can sometimes pay lower wage rates. However, the model shows that small planters spend more on labor than corporate estates per ton of sugarcane.

3.2.4 Irrigation

97. The model shows that, where applicable, investments in irrigation lead to increased yields that enhance sector competitiveness. From data provided by MSIRI and validated by different planters, the yield increase from irrigation can reach up to 35% compared with rain-fed production in the same geographical area.

98. However, if most farms benefit from the infrastructure and services from the Irrigation Authority (which entail institutional costs not counted by this model), investments in irrigation can generate important savings in the overall production cost. For corporate estates, per ton costs are US$2.70–US$3.10 (5–8 %) lower with irrigation while cost for small planters are US$5.35–US$6.80 (11–15 %) lower. If the cost of subsidies from the Irrigation Authority were counted, the difference in costs between the sectors may be less than shown.[35]

3.2.5 Variety Improvement

99. Regarding variety improvement, the model shows that costs per ton of sugarcane production are US$2.40 to US$3.90 lower with improved varieties compared with less productive established varieties. While relatively little data are available on specific numbers of hectares planted to different types, small planter are reported to be reluctant to adopt new varieties as they are perceived as untested, in particular under manual harvesting.[36] Some large corporate growers, on the other hand, insist they

[35] Currently, the Irrigation Authority provides infrastructure and services to small planters
[36] The FSA is currently setting up a Farmers Information Management System, which will include data on varieties and their performance in small planters' fields. The FSA is currently reviewing its operations with a view to benchmarking it more responsive to the current needs of planters by leveraging on IT solutions for effective communication.

already use the most suitable varieties for their fields and say there is little scope for further improvement.

3.2.6 Cost per Ton of Sugar

Costs per Ton of Accrued Sugar

100. Cost per ton of accrued sugar is the way that most sector participants look at costs since this is how planters are paid. However, the sugar price is not the only revenue stream from sugarcane, and costs per ton of sugar cannot be interpreted as a "viability price" since other streams must be accounted for in calculating profits. The average costs per ton of accrued sugar estimated by the model over a 10-year ratoon cycles are summarized in Table 14. As shown, there are important differences in the per ton costs of different systems, and costs for small planters are significantly higher than for corporate estates. In this table, the relative cost of different systems and the structure of cost categories exactly mirror the pattern illustrated in Figure 16. The only difference is the scale (i.e., from US$ per ton cane, to Rs per ton accrued sugar).

Table 14. Cost per ton of accrued sugar (average Rs over 10-year ratoon cycle)

(a) Corporate estates

Corporate (Rs per ton accrued sugar)

	Manual				Mechanized			
	Established Variety		Improved Variety		Established Variety		Improved Variety	
	Rain	Irrig	Rain	Irrig	Rain	Irrig	Rain	Irrig
Materials	3,663	2,714	3,265	2,419	3,557	2,635	3,170	2,348
Mechanical operations, field	432	320	385	285	1,238	917	1,103	817
Irrigation	-	602	-	537	-	584	-	521
Labor, field	2,235	1,836	1,992	1,637	753	733	671	654
Harvest, labor	6,059	6,059	5,941	5,941	-	-	-	-
Harvest, machine & transport	1,276	1,276	1,251	1,251	4,465	4,465	4,377	4,377
Heavy derocking	-	-	-	-	2,176	1,612	1,939	1,437
Overheads and fixed costs	5,656	5,469	5,041	4,874	5,893	5,608	5,252	4,998
Total	**19,321**	**18,276**	**17,874**	**16,943**	**18,082**	**16,554**	**16,513**	**15,152**

(b) Small planters

Small planters (Rs per ton accrued sugar)

	Manual				Mechanized			
	Established Variety		Improved Variety		Established Variety		Improved Variety	
	Rain	Irrig	Rain	Irrig	Rain	Irrig	Rain	Irrig
Materials	4,065	3,011	3,623	2,684	3,947	2,924	3,518	2,606
Mechanical operations, field	213	158	190	141	837	620	746	553
Irrigation	-	679	-	605	-	659	-	588
Labor, field	2,630	2,578	2,251	2,298	1,568	1,810	1,352	1,001
Harvest, labor	6,059	6,059	5,941	5,941	1,515	1,515	1,485	1,485
Harvest, machine & transport	1,276	1,276	1,251	1,251	3,859	3,859	3,783	3,783
Heavy derocking	-	-	-	-	1,970	1,459	1,756	1,300
Overheads and fixed costs	10,156	7,835	9,180	7,111	8,759	6,800	7,934	6,188
Total	**24,400**	**21,596**	**22,435**	**20,030**	**22,454**	**19,646**	**20,574**	**17,504**

Source: Authors' calculations from the competitiveness model.

101. **As mentioned earlier, base numbers above represent average costs over a 10-year ratoon cycle.** To the extent that sugarcane yields drop off in the out years beyond the 7th ratoon, timelier planting could help bring these costs down. Results of a sensitivity analysis comparing the base results above with costs per ton with replanting after the 6th ratoon are provided in Table 15. The sensitivity analysis works on the same yield pattern shown in Figure 11; if yields were to decline more rapidly after the 6th ratoon, the potential savings in per ton costs could be greater than shown. The inverse is also true; if yields remain more stable in the out years, early replanting would provide fewer savings. As shown, when yields decline as assumed, timelier replanting can lead to savings of about 3% to 6% on per ton of accrued sugar costs.

Table 15. Potential savings in cost of producing accrued sugar from timelier replanting (Rs/ton, average values over 10R and 6R cycles)

	Manual				Mechanized			
	Established Variety		Improved Variety		Established Variety		Improved Variety	
	Rain	Irrig	Rain	Irrig	Rain	Irrig	Rain	Irrig
Corporate estates								
Full 10R cycle (base analysis)	19,321	18,276	17,874	16,943	18,082	16,554	16,513	15,152
Early replant (after 6R)	18,683	17,510	17,305	16,260	17,017	15,480	15,565	14,195
Savings from early replanting	**638**	**766**	**569**	**683**	**1,064**	**1,073**	**949**	**957**
Percent change	-3%	-4%	-3%	-4%	-6%	-6%	-6%	-6%
Small planters								
Full 10R cycle (base analysis)	24,400	21,596	22,435	20,030	22,454	19,646	20,574	17,504
Early replant (after 6R)	23,217	20,479	21,327	19,033	21,180	18,489	19,412	16,561
Savings from early replanting	**1,183**	**1,118**	**1,108**	**996**	**1,274**	**1,157**	**1,161**	**944**
Percent change	-5%	-5%	-5%	-5%	-6%	-6%	-6%	-5%

Source: Authors' calculations from the competitiveness model.

Costs per Ton of Total Bulk Sugar

102. A second useful way of looking at per ton of sugar costs is by considering costs per ton of total bulk sugar. This is a different perspective than planters usually take but allows farm-level costs to be compared directly with MSS total proceeds as a measure of overall sector revenues (see Table 16).

Table 16. Costs per ton of total bulk sugar (average Rs over 10-year ratoon cycle)

(a) Corporate estates

Corporate (Rs per ton total bulk sugar)

	Manual				Mechanized			
	Established Variety		Improved Variety		Established Variety		Improved Variety	
	Rain	Irrig	Rain	Irrig	Rain	Irrig	Rain	Irrig
Materials	2,857	2,117	2,547	1,887	2,774	2,055	2,473	1,832
Mechanical operations, field	337	250	300	222	965	715	861	637
Irrigation	-	470	-	419	-	456	-	406
Labor, field	1,743	1,432	1,554	1,277	588	572	524	510
Harvest, labor	4,726	4,726	4,634	4,634	-	-	-	-
Harvest, machine & transport	995	995	976	976	3,483	3,483	3,414	3,414
Heavy derocking	-	-	-	-	1,697	1,257	1,513	1,121
Overheads and fixed costs	4,411	4,266	3,932	3,802	4,596	4,374	4,097	3,898
Total cost per ton	**15,071**	**14,255**	**13,942**	**13,215**	**14,104**	**12,912**	**12,880**	**11,818**
As % MSS proceeds from own sugar	73%	69%	68%	64%	68%	63%	62%	57%

(b) Small planters

Small planters (Rs per ton total bulk sugar)

	Manual				Semi-mechanized			
	Established Variety		Improved Variety		Established Variety		Improved Variety	
	Rain	Irrig	Rain	Irrig	Rain	Irrig	Rain	Irrig
Materials	3,171	2,349	2,826	2,093	3,079	2,280	2,744	2,032
Mechanical operations, field	166	123	148	110	653	484	582	431
Irrigation	-	530	-	472	-	514	-	458
Labor, field	2,051	2,011	1,756	1,792	1,223	1,412	1,055	781
Harvest, labor	4,726	4,726	4,634	4,634	1,182	1,182	1,158	1,158
Harvest, machine & transport	995	995	976	976	3,010	3,010	2,951	2,951
Heavy derocking	-	-	-	-	1,536	1,138	1,369	1,014
Overheads and fixed costs	7,922	6,111	7,160	5,546	6,832	5,304	6,189	4,827
Total cost per ton	**19,032**	**16,845**	**17,499**	**15,623**	**17,514**	**15,324**	**16,048**	**13,653**
As % MSS proceeds from own sugar	92%	82%	85%	76%	85%	74%	78%	66%

Source: Authors' calculations from the competitiveness model.

103. In 2019, MSS derived Rs20,631 per ton from the sale of Mauritian-grown sugar (i.e., all sugar excluding NOS).[37] At this level, the analysis shows that farm-level costs on corporate estates amounted to 57%—73% of MSS per ton of sales proceeds while costs for small planters amounted to 66%—92% of per ton of sales proceeds. These percentages are for farm-level production only and point to the very large share of total available value from sugar sales taken up by farm-level costs. This is particularly true for small planters.

[37] The aggregate proceeds from all types of sugar in 2019 including NOS was Rs20,233/ton and proceeds from NOS alone were Rs17,858.40/tons.

3.2.7 Per Hectare Profits and Losses

104. Because revenues from sugarcane come from many sources, profits are measured with reference to current revenues that derive specifically from sugarcane (i.e., sugar, BTPF payments for bagasse, and molasses) and with reference to total revenues including supplements. As described, supplements include many different payments (such as SIFB support) and additional payments for bagasse cannot be interpreted strictly as subsidies (see Table 17 for details). Two illustrative examples for standard corporate and small planter models are provided below (Table 17). As shown, sugarcane returns strong net losses in gross and net terms when measured by revenues arising specifically from sugarcane.

105. An important finding is that when supplemental payments are included, gross profits become positive, but these payments are still not enough to cover overheads and depreciation on fixed assets. This means that even if heavily subsidized, in net terms, the farming activity continues to deliver a loss. Other variations based on more advanced management practices do better, but in every case, the net profits on cane revenue alone remain negative and, only in some small number of cases with multiple interventions and favorable market conditions, do net profits on total revenue including supplements turn positive.

Table 17. Annual gross and net profits for selected corporate estates and small planter variations (Rs per hectare)

(a) Corporate estates

CORPORATE: Mechanized, Established Variety, Rainfed

		PC	1R	2R	3R	4R	5R	6R	7R	8R	9R	10R	Total	Average
Gross Profit														
Cane revenue - var costs	Rs/ha	(49,911)	24,115	20,947	19,308	18,511	17,134	16,021	14,217	11,506	7,829	3,663	103,340	9,395
Total revenue - var costs	**Rs/ha**	**(28,660)**	**42,709**	**38,147**	**35,476**	**34,032**	**32,034**	**30,176**	**27,594**	**23,880**	**18,842**	**13,134**	**267,366**	**24,306**
Net Profit														
Cane revenue - total costs	Rs/ha	(90,815)	(16,790)	(19,958)	(21,596)	(22,393)	(23,771)	(24,884)	(26,687)	(29,398)	(33,075)	(37,241)	(346,606)	(31,510)
Total revenue - total costs	**Rs/ha**	**(69,564)**	**1,805**	**(2,757)**	**(5,428)**	**(6,872)**	**(8,870)**	**(10,728)**	**(13,310)**	**(17,024)**	**(22,063)**	**(27,770)**	**(182,580)**	**(16,598)**

(b) Small planters

PLANTERS: Manual, Established Variety, Rainfed

		PC	1R	2R	3R	4R	5R	6R	7R	8R	9R	10R	Total	Average
Gross Profit														
Cane revenue - var costs	Rs/ha	(76,360)	(130)	(1,942)	(2,292)	(2,682)	(3,489)	(2,836)	(3,847)	(5,151)	(6,918)	(8,921)	(114,568)	(10,415)
Total revenue - var costs	**Rs/ha**	**(39,774)**	**33,809**	**30,609**	**28,475**	**26,855**	**24,867**	**24,101**	**21,609**	**18,396**	**14,038**	**9,102**	**192,087**	**17,462**
Net Profit														
Cane revenue - total costs	Rs/ha	(118,591)	(41,477)	(42,824)	(42,831)	(43,006)	(43,606)	(42,706)	(43,458)	(44,427)	(45,742)	(47,231)	(555,899)	(50,536)
Total revenue - total costs	**Rs/ha**	**(82,005)**	**(7,538)**	**(10,274)**	**(12,064)**	**(13,469)**	**(15,251)**	**(15,768)**	**(18,002)**	**(20,880)**	**(24,785)**	**(29,208)**	**(249,244)**	**(22,659)**

Source: Authors' calculations from the competitiveness model.

3.2.8 Net Present Values

106. The NPV calculations made for this study are presented in Table 18. The table includes separate NPV calculations for annual gross and annual net profits based on the revenues from sugarcane (sugar, BTPF, and molasses) and total revenues including supplements. From a viability point of view, the third column (where NPVs are calculated on net profits from sugarcane revenue excluding supplements) is the most informative. As shown, all management scenarios for corporate estates and small planters return a net loss on the revenue from sugarcane alone. Systems with improved management generally provide better returns, but the overall picture of net losses is clear.

Table 18. Summary of net present value calculations (NPVs at 12% discount rate in US$)

	NPV on Gross Profit		NPV on Net Profit	
	Cane Only	All Revenue	Cane Only	All Revenue
Estates - mostly manual				
Established variety				
Dryland	($2,313)	$254	($6,904)	($4,337)
Irrigated	($1,664)	$1,802	($7,658)	($4,191)
Improved variety				
Dryland	($1,672)	$1,208	($6,264)	($3,383)
Irrigated	($799)	$3,090	($6,792)	($2,903)
Estates - highly mechanized				
Established variety				
Dryland	$1,159	$3,804	($5,587)	($2,943)
Irrigated	$2,803	$6,373	($5,346)	($1,776)
Improved variety				
Dryland	$2,090	$5,058	($4,656)	($1,689)
Irrigated	$4,060	$8,066	($4,089)	($83)
Planters - mostly manual				
Established variety				
Dryland	($2,330)	$2,571	($9,010)	($4,108)
Irrigated	($2,173)	$3,876	($9,160)	($3,111)
Improved variety				
Dryland	($1,651)	$3,682	($8,435)	($3,102)
Irrigated	($1,483)	$5,024	($8,611)	($2,105)
Planters - moderately mechanized				
Established variety				
Dryland	($433)	$4,585	($7,694)	($2,676)
Irrigated	$195	$6,359	($7,384)	($1,220)
Improved variety				
Dryland	$326	$5,772	($7,044)	($1,597)
Irrigated	$1,723	$8,357	($6,001)	$632

Source: Authors' calculations from the competitiveness model.

107. The data also show that supplemental payments provide a lifeline that covers for annual gross losses. All NPV results in the second column are positive, showing that sugarcane is profitable when measured in gross terms including supplements. Although these additional payments come from many sources including from taxpayers and from MSS' overall revenues (through SIFB), supplements are paid as a form of general income support. Moreover, in net terms, revenue from supplements is not enough to cover long-term capital costs and overhead costs and the NPVs are all negative except for the most advanced small planter system that includes a high degree of special government support.

3.2.9 Ex-Syndicate Price Viability

108. Table 19 provides results of a sensitivity analysis that determines the ex-Syndicate sugar price needed for each system to reach an NPV equal to zero in gross and net terms with and without supplements. All other prices and production coefficients were held constant and the 12% discount rate was applied. As such, the results are not the same as true "break even" prices since the sugarcane farmer would deliver a 12% return at each level shown before finance costs. In terms of actual payments, planters would receive 78% of the final ex-Syndicate prices shown in Table 19 as their accrued share of total sugar production. Revenues from BTPF and molasses are included in the calculations of gross and net NPVs but were held constant and are not in the results below.

109. This shows that corporate estates require the MSS sugar price to be in the range of about Rs13,120 to Rs17,790 per ton to deliver an NPV equal to zero at a 12% discount rate. For small planters, the MSS final price would have higher at a range of Rs16,100 to Rs23,945 per ton.

Table 19. Ex-Syndicate price (Rs/ton accrued) to give NPV = 0 at 12% discount rate

	Gross Profits		Net Profits	
	Cane Only	All Revenue	Cane Only	All Revenue
Estates - mostly manual				
Established variety				
Dryland	12,785	9,985	17,791	14,991
Irrigated	11,606	8,806	16,447	13,647
Improved variety				
Dryland	11,887	9,087	16,350	13,550
Irrigated	10,837	8,037	15,152	12,352
Estates - highly mechanized				
Established variety				
Dryland	9,035	6,235	16,177	13,377
Irrigated	8,064	5,264	14,455	11,655
Improved variety				
Dryland	8,289	5,489	14,655	11,855
Irrigated	7,424	4,624	13,120	10,320
Planters - mostly manual				
Established variety				
Dryland	13,447	6,748	23,944	16,500
Irrigated	12,462	6,338	20,566	13,762
Improved variety				
Dryland	12,274	5,777	21,679	14,461
Irrigated	11,600	5,729	18,895	12,372
Planters - moderately mechanized				
Established variety				
Dryland	10,836	4,178	21,606	14,208
Irrigated	10,071	4,012	18,326	11,594
Improved variety				
Dryland	9,877	3,435	19,518	12,360
Irrigated	8,752	2,941	16,103	9,646

Source: Authors' calculations from the competitiveness model.

110. **Based on data gathered from experts, the base MSS sugar price assumed for the competitiveness analysis is Rs10,261/ton, which is a three-year average of the 2017–2019 price.** To put the results in Table 19 into perspective, target prices in the third column are 28% to 73% higher for corporate estates than the current base price and 57% to 133% higher for small planters.[38] Sugar markets may strengthen, yet changes on these orders seem improbable.

[38] In 2019, the final ex-syndicate price reached Rs 11,383.65 per ton, which was the highest since the end of EU quotas in 2017.

4. Market and Policy Changes

4.1 Methodology

111. **Based on the sector-level analysis, *Monte Carlo* simulations were run to simultaneously assess the impact of potential variations on key drivers of the sector's bottom line (either revenue, costs or both).** *Monte Carlo* simulations are used to model the probability of different outcomes in a process and understand the impact of risk and uncertainty. In practice, this technique models possible outcomes by substituting a range of values—a probability distribution—for any factor that has inherent uncertainty. It then calculates results over and over, each time using a different set of random values from the probability functions.

112. **The variables considered in the *Monte Carlo* simulations were identified during a round of consultations with a diverse set of sugarcane sector stakeholders.** Several stakeholders and experts came together in September to choose and prioritized key variables to be included in this assessment. This exercise also involved establishing parameters for each of the market and policy changes suggested. While most of these policies fell within the realm of government or private sector action, others were admittedly beyond the control of sector stakeholders. Annex 3 shows the variables that were included in the simulation and the parameters agreed upon by sector stakeholders (minimum and maximum ranges), and the probability distributions used to model changes to the sector's competitive position.

113. **Out of all variables included, the following policies that can be directly influenced by sector stakeholders:**

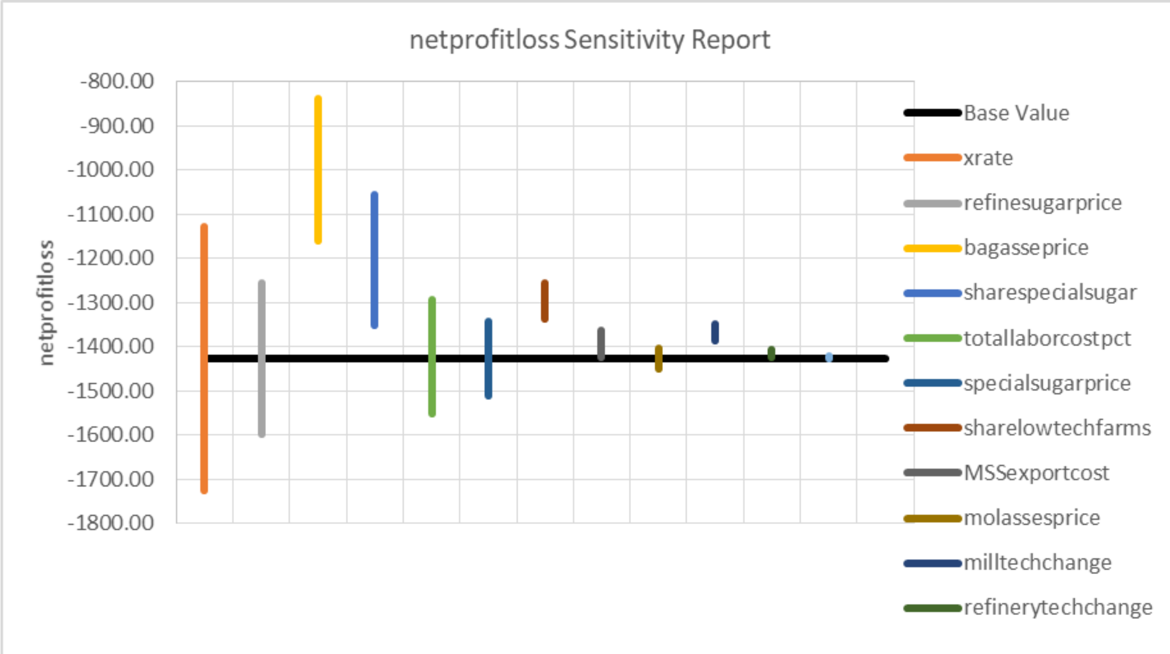
Variable code	Expected change to impact sector profits (losses)
sharespecialsugar	Increase in the share of specialty sugars exported (% of total volume exported)
MSSexportcost	Reduction in export costs (operations and logistics)
bagasseprice	Change price of electricity from bagasse paid by CEB to IPPs
sharelowtechfarms	Increase share of production from more efficient farms (% of total sugarcane production)
totallaborcostpct	Change in total labor costs (%)
IPPtechchange	Technological improvement in IPPs (% cost reduction)
molasses price	Change in the price of molasses
instcost	Reduction in institutional costs retained by MSS (MSS/MCIA)
milltechchange	Technological improvement in millers (% of cost reduction)
refinerytechchange	Technological improvement in refinery (% of cost reduction)

114. **While several policy changes were considered, some were not modeled due to their low impact on the bottom line of the sector, while others were excluded due to a lack of data for proper modeling.** Some of the overlooked policy changes include: (i) collecting and using cane trash from the fields to burn as biomass along with bagasse (this option indeed yields additional revenues but is costly to implement, leaving small net margins); (ii) switching to high-energy (high fiber content) sugarcane varieties, maximizing the production of bagasse over sugar (this option is plausible, but no data was available to model it); (iii) closing loading zones and transporting cane directly from the field to the mill (costs were made available, but the savings from this change would not be substantial for the overall sector and (iv) accessing preferential markets (althoug planter gets revenue only from bagasse and sugar
h this option can increase revenues from exported sugar, it is highly unpredictable and political, thus hard to model with a significant degree of certainty). Even if the above measures have shortcomings, it does not mean that they shouldn't be pursued or further analyzed.

4.2 Simulation Results

The simulations show that no single public policy or program can get the sector out of the red. The analysis shows that under the current production structure, no single change in market conditions through public policies or programs can make the sector profitable without direct public sector support (subsidies/supplemental payments). Figure 18 shows the current (2019) sector-level losses (Rs1.35 billion) as the black horizontal line. The policy-related changes that can produce the largest positive impact in the sector's bottom line (short of direct support) are: (i) increasing the share of specialty sugar sold; (ii) reducing export-related costs (operations and logistics); (iii) increasing the price of electricity from bagasse; (iv) reducing labor costs, and (v) improving the efficiency (yields and/or quality) of sugarcane production. While other variables may affect a given actor within the sector in a significant way, they do not have a single large impact in the overall sector's bottom line. Under this category of variables are: (i) improvements in technology at the IPPs, farms, refinery and mills; and (ii) an increase in the price of molasses.

Figure 18. Summary of simultaneous sugarcane sector public policy scenario analysis



Source: Authors' calculations from the competitiveness model.

116. Exogenous factors were considered in combination with the simulation on policy changes. These factors include: (i) changes in international sugar prices; and (ii) changes in the exchange rate. Finally, simulations were done on further reduction in the production of sugarcane, down to two mills and to one mill. Each variable is assessed separately below.

4.3 Increase in the Share of Productive Farms

117. An important simulation is what would happen to the sugarcane sector if the share of sugarcane produced in more efficient (high-tech) farms (more than 10 ha, or more than 60 MT of sugar produced) as a percentage of total sugarcane further increased from the current level of 81%. Results show that increasing the share of production from these farms improves the viability of the sugar sector, given the difference in yields due to mechanization, cane variety and access to irrigation. This scenario could lead to an increased level of overall sector level profits (up to Rs173 million) by reducing overall farming costs per MT of sugarcane produced

4.4 Increasing the Share of Specialty Sugars Sold

118. Although Mauritius can do little to influence world markets, strategies are available to capture more value from the sugar the country sells. Among these strategies is the potential to increase the sales of specialty sugars. Recently (2018/2019), 30% of sugar exported (in a per MT basis) have been specialty sugars. If current total sugar production levels are maintained and additional marketing efforts are made, this share may increase. The three millers have been working to increase the share of special sugar in the total export basket from around 150,000 tons to 180,000 in the next few years. According to MSS, based on differentials between special and ordinary sugar, the final MSS price can increase by up to Rs615/ton (equal to Rs480/ton in accrued sugar equivalent). Faitrade certification and other programs have also been suggested as ways to achieve premium prices on at least some of the total sugar production.

119. However, estimates from data gathered show that this share would not go beyond 50% at current production levels, as the global market would not be able to absorb more than the increased level of specialty sugar coming from Mauritius. The simulation shows that increasing the percentage of specialty sugars in relation to the total sugar exported could increase sector-level profits by Rs371 millions—over twice as much as the impact of increasing the share of the most productive farms.

4.5 Output Prices

4.5.1 Sugar

120. World sugar prices are highly distorted globally by subsidies and other protective measures in importing and exporting countries alike. While international sugar prices are generally regarded as cyclical in response to supply and demand, predicting future sugar prices is a complex and challenging task that extends well beyond the scope of the present competitiveness analysis. In real terms, raw and white sugar prices are expected to remain flat over the projection period, while in nominal terms, prices are projected to trend slightly upward (+2% p.a.). This is a result of a projected tighter world market balance than in the past decade. The relatively small white sugar premium (the difference between white and raw sugar prices) of US$70 per ton during the base period (2017-2019), is projected to increase in absolute terms to US$83 per ton by 2029 (OECD, 2020). Based on interviews with sugar experts, expected improvements could drive the price of sugar[39] up by 10% or more over the next few years, before the cycle reverses.

121. The expected increase in the international price of refined sugar can bring a boost in sector-level profits of over Rs170 million while specialty sugar prices can boost profits by over Rs80 million. However, although projections tend to signal an increase in prices going forward, the probability of further price reductions is not negligible, given the slump in international markets and the slowing rate of growth in sugar consumption as preferences for a healthy diet take hold around the world.

122. For the purpose of assessing the impact at farm level, Table 19 sketches out a set of broad opportunities as the basis for a "moderately optimistic" revenue scenario with an ex-Syndicate sugar price of Rs13,500. Relative to the baseline price of Rs10,262,

[39] Specifically, the EU Price of refined sugar, given that this is Mauritius' largest export market.

this is an improvement of 32%. Other revenues from cane, including payments from the BTPF and sales of molasses remain unchanged in this price analysis.

Table 19. Estimation of moderately optimistic MSS price for sensitivity analysis

	Rs/ton
Base price used in model (3yr avg 2017-19)	**10,262**
Actual 2019 price	11,384
Plus 10% further gain in positive cycle	1,138
Plus gains from greater share of special sugar	615
Plus gains from institutional savings	200
Plus gains from other market policies	163
Moderately optimistic future price	**13,500**

Source: Authors' calculations from the competitiveness model.

123. Detailed data showing annual net profits from cane excluding supplements in each year of the ratoon cycle using the moderately optimistic price are provided in Table 20. Further year-by-year analyses using an even more optimistic price (Rs15,000/ton) as well as a pessimistic price of 8,685/ton (which is what the MSS paid in 2018) are provided in Tables 21 and 22.

Table 20. Alternative price analysis: Moderate scenario (sugar price = Rs 13,500/ton)

(a) Corporate estates

CORPORATE ESTATES, Annual net profits from cane (Rs/ha) — Base price = 10,262 — Alternative price = 13,500

	PC	1R	2R	3R	4R	5R	6R	7R	8R	9R	10R
MOSTLY MANUAL											
Established variety, rainfed											
Base price	(107,454)	(27,696)	(29,966)	(30,056)	(29,659)	(30,369)	(29,062)	(30,329)	(31,363)	(33,578)	(36,088)
Alternative price	(83,594)	(6,818)	(10,654)	(11,903)	(12,232)	(13,639)	(13,169)	(15,310)	(17,470)	(21,214)	(25,455)
Change	23,860	20,877	19,312	18,153	17,427	16,730	15,893	15,019	13,893	12,365	10,633
Established variety, irrigated											
Base price	(109,048)	(30,804)	(33,868)	(34,546)	(34,518)	(35,582)	(34,699)	(36,410)	(38,015)	(41,006)	(44,395)
Alternative price	(76,837)	(2,619)	(7,798)	(10,040)	(10,991)	(12,997)	(13,243)	(16,135)	(19,260)	(24,314)	(30,039)
Change	32,211	28,185	26,071	24,507	23,526	22,585	21,456	20,276	18,755	16,692	14,355
Improved variety, rainfed											
Base price	(102,305)	(23,190)	(25,798)	(26,138)	(25,898)	(26,759)	(25,632)	(27,088)	(28,365)	(30,910)	(33,793)
Alternative price	(75,534)	234	(4,131)	(5,771)	(6,345)	(7,988)	(7,800)	(10,237)	(12,777)	(17,037)	(21,863)
Change	26,771	23,425	21,668	20,368	19,553	18,771	17,832	16,852	15,588	13,873	11,931
Improved variety, irrigated											
Base price	(102,097)	(24,721)	(28,242)	(29,258)	(29,441)	(30,708)	(30,069)	(32,035)	(33,968)	(37,404)	(41,297)
Alternative price	(65,956)	6,902	1,009	(1,762)	(3,044)	(5,368)	(5,996)	(9,285)	(12,924)	(18,676)	(25,190)
Change	36,141	31,623	29,251	27,496	26,396	25,341	24,074	22,750	21,043	18,729	16,107
FULLY MECHANICAL											
Established variety, rainfed											
Base price	(90,815)	(16,790)	(19,958)	(21,596)	(22,393)	(23,771)	(24,884)	(26,687)	(29,398)	(33,075)	(37,241)
Alternative price	(66,239)	4,714	(67)	(2,898)	(4,444)	(6,539)	(8,513)	(11,217)	(15,088)	(20,340)	(26,288)
Change	24,576	21,504	19,891	18,698	17,950	17,232	16,370	15,470	14,310	12,735	10,952
Established variety, irrigated											
Base price	(84,422)	(12,908)	(17,395)	(20,009)	(21,418)	(23,383)	(25,200)	(27,740)	(31,399)	(36,364)	(41,987)
Alternative price	(51,244)	16,122	9,458	5,232	2,814	(120)	(3,101)	(6,856)	(12,081)	(19,171)	(27,201)
Change	33,177	29,030	26,853	25,242	24,232	23,263	22,100	20,884	19,318	17,193	14,786
Improved variety, rainfed											
Base price	(83,333)	(10,243)	(13,902)	(15,903)	(16,928)	(18,524)	(19,900)	(21,977)	(25,041)	(29,198)	(33,906)
Alternative price	(55,759)	13,884	8,416	5,075	3,211	809	(1,532)	(4,620)	(8,986)	(14,909)	(21,618)
Change	27,574	24,127	22,318	20,979	20,140	19,334	18,367	17,357	16,055	14,289	12,289
Improved variety, irrigated											
Base price	(74,321)	(4,070)	(9,220)	(12,325)	(14,041)	(16,300)	(18,472)	(21,382)	(25,518)	(31,130)	(37,486)
Alternative price	(37,096)	28,502	20,909	15,997	13,148	9,800	6,324	2,050	(3,843)	(11,839)	(20,896)
Change	37,225	32,572	30,129	28,321	27,188	26,101	24,796	23,432	21,675	19,290	16,590

(b) Small planters

SMALL PLANTERS, Annual net profits from cane (Rs/ha) — Base price = 10,262 — Alternative price = 13,500

	PC	1R	2R	3R	4R	5R	6R	7R	8R	9R	10R
MANUAL											
Established variety, rainfed											
Base price	(118,591)	(41,477)	(42,824)	(42,831)	(43,006)	(43,606)	(42,706)	(43,458)	(44,427)	(45,742)	(47,231)
Alternative price	(101,457)	(26,485)	(28,957)	(29,796)	(30,492)	(31,592)	(31,293)	(32,673)	(34,451)	(36,863)	(39,595)
Change	17,134	14,992	13,867	13,035	12,514	12,013	11,413	10,785	9,976	8,879	7,636
Established variety, irrigated											
Base price	(111,993)	(42,540)	(44,359)	(44,715)	(45,108)	(45,918)	(45,269)	(46,285)	(47,593)	(49,368)	(51,379)
Alternative price	(88,863)	(22,301)	(25,638)	(27,117)	(28,214)	(29,700)	(29,862)	(31,725)	(34,125)	(37,382)	(41,071)
Change	23,130	20,239	18,721	17,598	16,894	16,218	15,407	14,560	13,468	11,986	10,308
Improved variety, rainfed											
Base price	(108,562)	(38,619)	(40,181)	(40,346)	(40,621)	(41,316)	(40,530)	(41,402)	(42,525)	(44,049)	(45,776)
Alternative price	(89,339)	(21,798)	(24,622)	(25,721)	(26,580)	(27,837)	(27,725)	(29,301)	(31,332)	(34,087)	(37,208)
Change	19,224	16,821	15,559	14,626	14,041	13,479	12,805	12,101	11,193	9,962	8,567
Improved variety, irrigated											
Base price	(107,584)	(38,682)	(40,790)	(41,360)	(41,888)	(42,826)	(42,332)	(43,509)	(45,026)	(47,083)	(49,414)
Alternative price	(81,632)	(15,974)	(19,785)	(21,615)	(22,933)	(24,629)	(25,045)	(27,173)	(29,915)	(33,635)	(37,848)
Change	25,952	22,708	21,005	19,745	18,955	18,197	17,287	16,336	15,111	13,449	11,566
SEMI-MECHANIZED											
Established variety, rainfed											
Base price	(102,980)	(32,804)	(34,971)	(35,585)	(36,140)	(37,105)	(36,642)	(37,852)	(39,411)	(41,526)	(43,922)
Alternative price	(85,332)	(17,363)	(20,688)	(22,159)	(23,251)	(24,731)	(24,887)	(26,744)	(29,136)	(32,381)	(36,057)
Change	17,648	15,442	14,283	13,426	12,889	12,374	11,755	11,109	10,275	9,145	7,865
Established variety, irrigated											
Base price	(95,391)	(30,041)	(32,967)	(34,142)	(35,048)	(36,351)	(36,294)	(37,927)	(40,032)	(42,887)	(46,121)
Alternative price	(71,567)	(9,195)	(13,684)	(16,016)	(17,648)	(19,646)	(20,424)	(22,930)	(26,160)	(30,541)	(35,504)
Change	23,824	20,846	19,283	18,126	17,401	16,705	15,869	14,997	13,872	12,346	10,618
Improved variety, rainfed											
Base price	(95,047)	(28,821)	(31,287)	(32,122)	(32,815)	(33,913)	(33,610)	(34,987)	(36,761)	(39,167)	(41,893)
Alternative price	(75,247)	(11,496)	(15,261)	(17,057)	(18,353)	(20,030)	(20,421)	(22,523)	(25,232)	(28,906)	(33,069)
Change	19,801	17,325	16,026	15,064	14,462	13,883	13,189	12,464	11,529	10,261	8,824
Improved variety, irrigated											
Base price	(85,496)	(20,914)	(24,243)	(25,716)	(26,810)	(28,292)	(28,450)	(30,309)	(32,703)	(35,952)	(39,632)
Alternative price	(58,765)	2,475	(2,608)	(5,379)	(7,287)	(9,549)	(10,645)	(13,483)	(17,139)	(22,100)	(27,720)
Change	26,731	23,389	21,635	20,337	19,524	18,743	17,805	16,826	15,564	13,852	11,913

Source: Authors' calculations from the competitiveness model.

Table 21. Alternative price analysis: Optimistic scenario (price = Rs 15,000/ton)

(a) Corporate estates

CORPORATE ESTATES, Annual net profits from cane (Rs/ha) — Base price = 10,262 — Alternative price = 15,000

	PC	1R	2R	3R	4R	5R	6R	7R	8R	9R	10R
MOSTLY MANUAL											
Established variety, rainfed											
Base price	(107,454)	(27,696)	(29,966)	(30,056)	(29,659)	(30,369)	(29,062)	(30,329)	(31,363)	(33,578)	(36,088)
Alternative price	**(72,541)**	**2,853**	**(1,708)**	**(3,494)**	**(4,159)**	**(5,890)**	**(5,806)**	**(8,353)**	**(11,034)**	**(15,486)**	**(20,529)**
Change	34,913	30,549	28,258	26,562	25,500	24,480	23,256	21,977	20,328	18,092	15,559
Established variety, irrigated											
Base price	(109,048)	(30,804)	(33,868)	(34,546)	(34,518)	(35,582)	(34,699)	(36,410)	(38,015)	(41,006)	(44,395)
Alternative price	**(61,916)**	**10,437**	**4,279**	**1,313**	**(93)**	**(2,534)**	**(3,304)**	**(6,742)**	**(10,572)**	**(16,582)**	**(23,390)**
Change	47,133	41,241	38,148	35,859	34,425	33,048	31,395	29,669	27,443	24,425	21,005
Improved variety, rainfed											
Base price	(102,305)	(23,190)	(25,798)	(26,138)	(25,898)	(26,759)	(25,632)	(27,088)	(28,365)	(30,910)	(33,793)
Alternative price	**(63,132)**	**11,086**	**5,907**	**3,665**	**2,713**	**707**	**461**	**(2,430)**	**(5,556)**	**(10,610)**	**(16,336)**
Change	39,172	34,276	31,705	29,803	28,611	27,466	26,093	24,658	22,809	20,300	17,458
Improved variety, irrigated											
Base price	(102,097)	(24,721)	(28,242)	(29,258)	(29,441)	(30,708)	(30,069)	(32,035)	(33,968)	(37,404)	(41,297)
Alternative price	**(49,214)**	**21,551**	**14,560**	**10,976**	**9,184**	**6,371**	**5,156**	**1,253**	**(3,176)**	**(10,000)**	**(17,729)**
Change	52,883	46,272	42,802	40,234	38,624	37,079	35,226	33,288	30,791	27,404	23,568
FULLY MECHANICAL											
Established variety, rainfed											
Base price	(90,815)	(16,790)	(19,958)	(21,596)	(22,393)	(23,771)	(24,884)	(26,687)	(29,398)	(33,075)	(37,241)
Alternative price	**(54,855)**	**14,676**	**9,148**	**5,763**	**3,872**	**1,444**	**(930)**	**(4,051)**	**(8,459)**	**(14,440)**	**(21,215)**
Change	35,960	31,465	29,105	27,359	26,265	25,214	23,953	22,636	20,938	18,635	16,026
Established variety, irrigated											
Base price	(84,422)	(12,908)	(17,395)	(20,009)	(21,418)	(23,383)	(25,200)	(27,740)	(31,399)	(36,364)	(41,987)
Alternative price	**(35,875)**	**29,570**	**21,897**	**16,925**	**14,039**	**10,656**	**7,137**	**2,819**	**(3,133)**	**(11,207)**	**(20,352)**
Change	48,547	42,478	39,292	36,935	35,457	34,039	32,337	30,559	28,267	25,157	21,635
Improved variety, rainfed											
Base price	(83,333)	(10,243)	(13,902)	(15,903)	(16,928)	(18,524)	(19,900)	(21,977)	(25,041)	(29,198)	(33,906)
Alternative price	**(42,985)**	**25,061**	**18,754**	**14,793**	**12,541**	**9,766**	**6,976**	**3,420**	**(1,548)**	**(8,289)**	**(15,925)**
Change	40,348	35,304	32,656	30,697	29,469	28,290	26,876	25,398	23,493	20,909	17,981
Improved variety, irrigated											
Base price	(74,321)	(4,070)	(9,220)	(12,325)	(14,041)	(16,300)	(18,472)	(21,382)	(25,518)	(31,130)	(37,486)
Alternative price	**(19,852)**	**43,590**	**34,866**	**29,116**	**25,742**	**21,891**	**17,810**	**12,905**	**6,197**	**(2,903)**	**(13,211)**
Change	54,469	47,661	44,086	41,441	39,783	38,192	36,282	34,287	31,715	28,227	24,275

Source: Authors' calculations from the competitiveness model.

(b) Small planters

SMALL PLANTERS, Annual net profits from cane (Rs/ha)					Base price =	10,262			Alternative price =		15,000
	PC	**1R**	**2R**	**3R**	**4R**	**5R**	**6R**	**7R**	**8R**	**9R**	**10R**
MANUAL											
Established variety, rainfed											
Base price	(118,591)	(41,477)	(42,824)	(42,831)	(43,006)	(43,606)	(42,706)	(43,458)	(44,427)	(45,742)	(47,231)
Alternative price	**(93,520)**	**(19,541)**	**(22,533)**	**(23,757)**	**(24,695)**	**(26,027)**	**(26,006)**	**(27,677)**	**(29,829)**	**(32,750)**	**(36,058)**
Change	**25,070**	**21,937**	**20,291**	**19,074**	**18,311**	**17,579**	**16,700**	**15,781**	**14,598**	**12,992**	**11,173**
Established variety, irrigated											
Base price	(111,993)	(42,540)	(44,359)	(44,715)	(45,108)	(45,918)	(45,269)	(46,285)	(47,593)	(49,368)	(51,379)
Alternative price	**(78,148)**	**(12,926)**	**(16,965)**	**(18,965)**	**(20,388)**	**(22,187)**	**(22,725)**	**(24,980)**	**(27,887)**	**(31,829)**	**(36,295)**
Change	**33,845**	**29,615**	**27,393**	**25,750**	**24,720**	**23,731**	**22,544**	**21,305**	**19,707**	**17,539**	**15,084**
Improved variety, rainfed											
Base price	(108,562)	(38,619)	(40,181)	(40,346)	(40,621)	(41,316)	(40,530)	(41,402)	(42,525)	(44,049)	(45,776)
Alternative price	**(80,433)**	**(14,006)**	**(17,414)**	**(18,945)**	**(20,076)**	**(21,593)**	**(21,793)**	**(23,695)**	**(26,147)**	**(29,472)**	**(33,239)**
Change	**28,129**	**24,613**	**22,767**	**21,401**	**20,545**	**19,723**	**18,737**	**17,706**	**16,378**	**14,577**	**12,536**
Improved variety, irrigated											
Base price	(107,584)	(38,682)	(40,790)	(41,360)	(41,888)	(42,826)	(42,332)	(43,509)	(45,026)	(47,083)	(49,414)
Alternative price	**(69,610)**	**(5,454)**	**(10,055)**	**(12,469)**	**(14,152)**	**(16,200)**	**(17,037)**	**(19,606)**	**(22,915)**	**(27,405)**	**(32,490)**
Change	**37,974**	**33,227**	**30,735**	**28,891**	**27,736**	**26,626**	**25,295**	**23,904**	**22,111**	**19,679**	**16,924**
SEMI-MECHANIZED											
Established variety, rainfed											
Base price	(102,980)	(32,804)	(34,971)	(35,585)	(36,140)	(37,105)	(36,642)	(37,852)	(39,411)	(41,526)	(43,922)
Alternative price	**(77,157)**	**(10,209)**	**(14,071)**	**(15,939)**	**(17,280)**	**(18,999)**	**(19,442)**	**(21,598)**	**(24,376)**	**(28,145)**	**(32,414)**
Change	**25,823**	**22,595**	**20,900**	**19,646**	**18,860**	**18,106**	**17,201**	**16,255**	**15,035**	**13,382**	**11,508**
Established variety, irrigated											
Base price	(95,391)	(30,041)	(32,967)	(34,142)	(35,048)	(36,351)	(36,294)	(37,927)	(40,032)	(42,887)	(46,121)
Alternative price	**(60,531)**	**462**	**(4,752)**	**(7,619)**	**(9,587)**	**(11,908)**	**(13,073)**	**(15,983)**	**(19,734)**	**(24,822)**	**(30,585)**
Change	**34,861**	**30,503**	**28,215**	**26,522**	**25,461**	**24,443**	**23,221**	**21,944**	**20,298**	**18,065**	**15,536**
Improved variety, rainfed											
Base price	(95,047)	(28,821)	(31,287)	(32,122)	(32,815)	(33,913)	(33,610)	(34,987)	(36,761)	(39,167)	(41,893)
Alternative price	**(66,074)**	**(3,470)**	**(7,837)**	**(10,079)**	**(11,654)**	**(13,598)**	**(14,311)**	**(16,749)**	**(19,891)**	**(24,153)**	**(28,981)**
Change	**28,973**	**25,351**	**23,450**	**22,043**	**21,161**	**20,315**	**19,299**	**18,238**	**16,870**	**15,014**	**12,912**
Improved variety, irrigated											
Base price	(85,496)	(20,914)	(24,243)	(25,716)	(26,810)	(28,292)	(28,450)	(30,309)	(32,703)	(35,952)	(39,632)
Alternative price	**(46,383)**	**13,310**	**7,414**	**4,042**	**1,758**	**(867)**	**(2,397)**	**(5,688)**	**(9,929)**	**(15,683)**	**(22,201)**
Change	**39,114**	**34,224**	**31,657**	**29,758**	**28,568**	**27,425**	**26,054**	**24,621**	**22,774**	**20,269**	**17,431**

Source: Authors' calculations from the competitiveness model.

Table 22. Alternative price analysis: Pessimistic scenario (price = Rs 8,686/ton)

(a) Corporate estates

CORPORATE ESTATES, Annual net profits from cane (Rs/ha)					Base price =	10,262			Alternative price =		8,686
	PC	**1R**	**2R**	**3R**	**4R**	**5R**	**6R**	**7R**	**8R**	**9R**	**10R**
MOSTLY MANUAL											
Established variety, rainfed											
Base price	(107,454)	(27,696)	(29,966)	(30,056)	(29,659)	(30,369)	(29,062)	(30,329)	(31,363)	(33,578)	(36,088)
Alternative price	**(119,069)**	**(37,859)**	**(39,367)**	**(38,893)**	**(38,142)**	**(38,514)**	**(36,799)**	**(37,641)**	**(38,126)**	**(39,598)**	**(41,265)**
Change	**(11,616)**	**(10,164)**	**(9,401)**	**(8,837)**	**(8,484)**	**(8,145)**	**(7,737)**	**(7,312)**	**(6,763)**	**(6,019)**	**(5,177)**
Established variety, irrigated											
Base price	(109,048)	(30,804)	(33,868)	(34,546)	(34,518)	(35,582)	(34,699)	(36,410)	(38,015)	(41,006)	(44,395)
Alternative price	**(124,730)**	**(44,525)**	**(46,560)**	**(46,477)**	**(45,971)**	**(46,577)**	**(45,145)**	**(46,281)**	**(47,146)**	**(49,133)**	**(51,383)**
Change	**(15,681)**	**(13,721)**	**(12,692)**	**(11,930)**	**(11,453)**	**(10,995)**	**(10,445)**	**(9,871)**	**(9,131)**	**(8,126)**	**(6,989)**
Improved variety, rainfed											
Base price	(102,305)	(23,190)	(25,798)	(26,138)	(25,898)	(26,759)	(25,632)	(27,088)	(28,365)	(30,910)	(33,793)
Alternative price	**(115,337)**	**(34,594)**	**(36,347)**	**(36,054)**	**(35,417)**	**(35,897)**	**(34,313)**	**(35,292)**	**(35,953)**	**(37,664)**	**(39,602)**
Change	**(13,033)**	**(11,404)**	**(10,548)**	**(9,916)**	**(9,519)**	**(9,138)**	**(8,681)**	**(8,204)**	**(7,588)**	**(6,754)**	**(5,808)**
Improved variety, irrigated											
Base price	(102,097)	(24,721)	(28,242)	(29,258)	(29,441)	(30,708)	(30,069)	(32,035)	(33,968)	(37,404)	(41,297)
Alternative price	**(119,691)**	**(40,116)**	**(42,483)**	**(42,644)**	**(42,291)**	**(43,045)**	**(41,789)**	**(43,110)**	**(44,212)**	**(46,522)**	**(49,138)**
Change	**(17,594)**	**(15,395)**	**(14,240)**	**(13,386)**	**(12,851)**	**(12,336)**	**(11,720)**	**(11,075)**	**(10,244)**	**(9,118)**	**(7,841)**
FULLY MECHANICAL											
Established variety, rainfed											
Base price	(90,815)	(16,790)	(19,958)	(21,596)	(22,393)	(23,771)	(24,884)	(26,687)	(29,398)	(33,075)	(37,241)
Alternative price	**(102,779)**	**(27,258)**	**(29,641)**	**(30,698)**	**(31,132)**	**(32,159)**	**(32,853)**	**(34,218)**	**(36,364)**	**(39,275)**	**(42,573)**
Change	**(11,964)**	**(10,469)**	**(9,683)**	**(9,102)**	**(8,738)**	**(8,389)**	**(7,969)**	**(7,531)**	**(6,966)**	**(6,200)**	**(5,332)**
Established variety, irrigated											
Base price	(84,422)	(12,908)	(17,395)	(20,009)	(21,418)	(23,383)	(25,200)	(27,740)	(31,399)	(36,364)	(41,987)
Alternative price	**(100,573)**	**(27,041)**	**(30,468)**	**(32,298)**	**(33,215)**	**(34,708)**	**(35,959)**	**(37,907)**	**(40,804)**	**(44,734)**	**(49,186)**
Change	**(16,152)**	**(14,133)**	**(13,073)**	**(12,288)**	**(11,797)**	**(11,325)**	**(10,759)**	**(10,167)**	**(9,404)**	**(8,370)**	**(7,198)**
Improved variety, rainfed											
Base price	(83,333)	(10,243)	(13,902)	(15,903)	(16,928)	(18,524)	(19,900)	(21,977)	(25,041)	(29,198)	(33,906)
Alternative price	**(96,757)**	**(21,989)**	**(24,767)**	**(26,116)**	**(26,733)**	**(27,937)**	**(28,841)**	**(30,427)**	**(32,857)**	**(36,154)**	**(39,889)**
Change	**(13,424)**	**(11,746)**	**(10,865)**	**(10,213)**	**(9,804)**	**(9,412)**	**(8,942)**	**(8,450)**	**(7,816)**	**(6,956)**	**(5,982)**
Improved variety, irrigated											
Base price	(74,321)	(4,070)	(9,220)	(12,325)	(14,041)	(16,300)	(18,472)	(21,382)	(25,518)	(31,130)	(37,486)
Alternative price	**(92,443)**	**(19,927)**	**(23,887)**	**(26,112)**	**(27,277)**	**(29,007)**	**(30,543)**	**(32,789)**	**(36,070)**	**(40,521)**	**(45,562)**
Change	**(18,122)**	**(15,857)**	**(14,668)**	**(13,788)**	**(13,236)**	**(12,707)**	**(12,071)**	**(11,407)**	**(10,552)**	**(9,391)**	**(8,076)**

Source: Authors' calculations from the competitiveness model.

(b) Small planters

SMALL PLANTERS, Annual net profits from cane (Rs/ha)					Base price =	10,262			Alternative price =		8,686
	PC	**1R**	**2R**	**3R**	**4R**	**5R**	**6R**	**7R**	**8R**	**9R**	**10R**
MANUAL											
Established variety, rainfed											
Base price	(118,591)	(41,477)	(42,824)	(42,831)	(43,006)	(43,606)	(42,706)	(43,458)	(44,427)	(45,742)	(47,231)
Alternative price	**(126,932)**	**(48,776)**	**(49,575)**	**(49,177)**	**(49,098)**	**(49,454)**	**(48,262)**	**(48,708)**	**(49,284)**	**(50,064)**	**(50,948)**
Change	**(8,341)**	**(7,298)**	**(6,751)**	**(6,346)**	**(6,092)**	**(5,848)**	**(5,556)**	**(5,250)**	**(4,857)**	**(4,322)**	**(3,717)**
Established variety, irrigated											
Base price	(111,993)	(42,540)	(44,359)	(44,715)	(45,108)	(45,918)	(45,269)	(46,285)	(47,593)	(49,368)	(51,379)
Alternative price	**(123,254)**	**(52,393)**	**(53,473)**	**(53,282)**	**(53,333)**	**(53,813)**	**(52,770)**	**(53,373)**	**(54,150)**	**(55,204)**	**(56,397)**
Change	**(11,260)**	**(9,853)**	**(9,114)**	**(8,567)**	**(8,224)**	**(7,895)**	**(7,501)**	**(7,088)**	**(6,556)**	**(5,835)**	**(5,018)**
Improved variety, rainfed											
Base price	(108,562)	(38,619)	(40,181)	(40,346)	(40,621)	(41,316)	(40,530)	(41,402)	(42,525)	(44,049)	(45,776)
Alternative price	**(117,921)**	**(46,808)**	**(47,755)**	**(47,467)**	**(47,456)**	**(47,878)**	**(46,764)**	**(47,293)**	**(47,974)**	**(48,899)**	**(49,946)**
Change	**(9,359)**	**(8,189)**	**(7,575)**	**(7,120)**	**(6,835)**	**(6,562)**	**(6,234)**	**(5,891)**	**(5,449)**	**(4,850)**	**(4,171)**
Improved variety, irrigated											
Base price	(107,584)	(38,682)	(40,790)	(41,360)	(41,888)	(42,826)	(42,332)	(43,509)	(45,026)	(47,083)	(49,414)
Alternative price	**(120,218)**	**(49,737)**	**(51,016)**	**(50,972)**	**(51,115)**	**(51,685)**	**(50,748)**	**(51,462)**	**(52,382)**	**(53,630)**	**(55,044)**
Change	**(12,634)**	**(11,055)**	**(10,226)**	**(9,612)**	**(9,228)**	**(8,859)**	**(8,416)**	**(7,953)**	**(7,356)**	**(6,547)**	**(5,631)**
SEMI-MECHANIZED											
Established variety, rainfed											
Base price	(102,980)	(32,804)	(34,971)	(35,585)	(36,140)	(37,105)	(36,642)	(37,852)	(39,411)	(41,526)	(43,922)
Alternative price	**(111,571)**	**(40,322)**	**(41,925)**	**(42,121)**	**(42,415)**	**(43,129)**	**(42,365)**	**(43,260)**	**(44,414)**	**(45,978)**	**(47,751)**
Change	**(8,591)**	**(7,517)**	**(6,954)**	**(6,536)**	**(6,275)**	**(6,024)**	**(5,723)**	**(5,408)**	**(5,002)**	**(4,452)**	**(3,829)**
Established variety, irrigated											
Base price	(95,391)	(30,041)	(32,967)	(34,142)	(35,048)	(36,351)	(36,294)	(37,927)	(40,032)	(42,887)	(46,121)
Alternative price	**(106,989)**	**(40,190)**	**(42,354)**	**(42,966)**	**(43,519)**	**(44,483)**	**(44,019)**	**(45,228)**	**(46,785)**	**(48,897)**	**(51,290)**
Change	**(11,598)**	**(10,148)**	**(9,387)**	**(8,824)**	**(8,471)**	**(8,132)**	**(7,726)**	**(7,301)**	**(6,753)**	**(6,010)**	**(5,169)**
Improved variety, rainfed											
Base price	(95,047)	(28,821)	(31,287)	(32,122)	(32,815)	(33,913)	(33,610)	(34,987)	(36,761)	(39,167)	(41,893)
Alternative price	**(104,686)**	**(37,256)**	**(39,089)**	**(39,456)**	**(39,856)**	**(40,672)**	**(40,031)**	**(41,055)**	**(42,373)**	**(44,163)**	**(46,189)**
Change	**(9,639)**	**(8,434)**	**(7,802)**	**(7,334)**	**(7,040)**	**(6,759)**	**(6,421)**	**(6,068)**	**(5,613)**	**(4,995)**	**(4,296)**
Improved variety, irrigated											
Base price	(85,496)	(20,914)	(24,243)	(25,716)	(26,810)	(28,292)	(28,450)	(30,309)	(32,703)	(35,952)	(39,632)
Alternative price	**(98,509)**	**(32,301)**	**(34,776)**	**(35,617)**	**(36,315)**	**(37,416)**	**(37,119)**	**(38,500)**	**(40,281)**	**(42,696)**	**(45,432)**
Change	**(13,013)**	**(11,387)**	**(10,533)**	**(9,901)**	**(9,505)**	**(9,124)**	**(8,668)**	**(8,191)**	**(7,577)**	**(6,744)**	**(5,799)**

Source: Authors' calculations from the competitiveness model.

124. As shown in the year-by-year analysis, if the ex-Syndicate price were to reach Rs13,500 per ton, the revenue from cane would be enough to make several mechanized variations for corporate producers profitable in the early stages of a ratoon cycle. This is encouraging since other changes such as possible adjustments to BTPF pricing arrangements were not considered for this test. On the other hand, the analysis shows that even with the most optimistic price outlook of Rs15,000 per ton and highest-level management assumptions, the annual net profits for small planters remain negative in most years of the ratoon cycle. Thus, while increasing the MSS price would surely result in smaller losses for all cane growers, it is unlikely that increased marketing of special sugars, Fairtrade sugars, or other such measures will be enough to transform cane into a viable enterprise for small planters. The cyclical nature of sugar markets must also be kept in mind.

125. Table 23 shows the NPV calculations for small planters and corporate estates at each price level including the pessimistic price (i.e., 2018 actual price), which underscore this bleak picture. Following the year-by-year analysis, results for all three price scenarios (pessimistic, moderately optimistic, and very optimistic), are summarized together in NPV terms. As shown, even in the most optimistic price scenario, the net NPV on sugarcane revenue excluding supplements remains negative except at the most advanced levels of corporate production analyzed.

Table 23. Net present values (NPVs) from three alternative sugar prices

	Pesimistic Price (Rs 8,685/ton)				Moderatly Optimistic Price (Rs 13,500/ton)				Optimistic Price (Rs 15,000/ton)			
	NPV on Gross Profit		NPV on Net Profit		NPV on Gross Profit		NPV on Net Profit		NPV on Gross Profit		NPV on Net Profit	
	Cane Only	All Revenue	Cane Only	All Revenue	Cane Only	All Revenue	Cane Only	All Revenue	Cane Only	All Revenue	Cane Only	All Revenue
Estates - mostly manual												
Established variety												
Dryland	($3,759)	($1,192)	($8,350)	($5,783)	$656	$3,224	($3,935)	($1,367)	$2,032	$4,599	($2,559)	$8
Irrigated	($3,616)	($150)	($9,610)	($6,143)	$2,345	$5,811	($3,649)	($183)	$4,202	$7,668	($1,792)	$1,674
Improved variety												
Dryland	($3,295)	($414)	($7,886)	($5,005)	$1,659	$4,540	($2,932)	($51)	$3,203	$6,083	($1,389)	$1,492
Irrigated	($2,989)	$900	($8,983)	($5,094)	$3,699	$7,588	($2,295)	$1,594	$5,782	$9,671	($211)	$3,678
Estates - highly mechanized												
Established variety												
Dryland	($330)	$2,315	($7,077)	($4,432)	$4,218	$6,862	($2,529)	$116	$5,635	$8,279	($1,112)	$1,533
Irrigated	$792	$4,362	($7,357)	($3,787)	$6,931	$10,502	($1,217)	$2,353	$8,844	$12,414	$695	$4,266
Improved variety												
Dryland	$419	$3,387	($6,327)	($3,360)	$5,522	$8,489	($1,225)	$1,743	$7,112	$10,079	$365	$3,332
Irrigated	$1,803	$5,809	($6,345)	($2,340)	$8,692	$12,698	$543	$4,549	$10,838	$14,844	$2,689	$6,695
Planters - mostly manual												
Established variety												
Dryland	($3,484)	$1,417	($10,048)	($5,146)	$39	$4,940	($6,877)	($1,976)	$1,136	$6,038	($5,890)	($988)
Irrigated	($3,730)	$2,318	($10,562)	($4,513)	$1,026	$7,074	($6,281)	($233)	$2,507	$8,556	($4,948)	$1,101
Improved variety												
Dryland	($2,946)	$2,387	($9,600)	($4,267)	$1,007	$6,340	($6,043)	($710)	$2,238	$7,571	($4,935)	$399
Irrigated	($3,230)	$3,276	($10,184)	($3,678)	$2,106	$8,613	($5,381)	$1,125	$3,768	$10,275	($3,885)	$2,621
Planters - moderately mechanized												
Established variety												
Dryland	($1,621)	$3,397	($8,764)	($3,746)	$2,008	$7,025	($5,498)	($480)	$3,138	$8,156	($4,480)	$537
Irrigated	($1,410)	$4,755	($8,828)	($2,663)	$3,489	$9,653	($4,419)	$1,745	$5,015	$11,179	($3,046)	$3,119
Improved variety												
Dryland	($1,008)	$4,439	($8,244)	($2,797)	$3,063	$8,510	($4,579)	$867	$4,332	$9,779	($3,438)	$2,009
Irrigated	($77)	$6,557	($7,621)	($988)	$5,420	$12,053	($2,674)	$3,959	$7,132	$13,765	($1,133)	$5,500

Source: Authors' calculations from the competitiveness model using 12% discount rate.

4.5.2 Bagasse

126. **The 2018-2020 weighted average price paid by CEB to IPPs for electricity from bagasse is Rs2.7/kWh, while the cost of producing electricity from HFO is Rs4.64/kWh (as per data supplied by CEB).** Modeling an increase in the unit price of electricity from bagasse to equal the opportunity cost of using HFO (the opportunity cost of coal would be less than HFO but more than bagasse) yields an boost in sector-level profits of Rs545 million. This simulation excludes any additional payments for bagasse. However, given that the farmers do receive an additional payment for bagasse, changes relevant for farm-level profits were simulated.

127. **To analyze alternative prices for bagasse and their impact at farm-level, a part of the competitiveness tool was developed to calculate BTPF payments using alternative reference prices and distribution formulas.** This simulation is not intended to pass judgment on whether the BTPF should be maintained, modified, or overhauled by a new system, but to simulate changes in the price of bagasse paid to farmers. The choice of maintaining the similar BTPF structure for the simulation was to model changes that could be understood by sector stakeholders based on the current system. For present purposes, three alternative prices and two possible distribution arrangements were considered to illustrate the impact of changes in the revenues from bagasse on the viability of sugarcane. In terms of price, the first alternative was to index bagasse against the current coal price using

the same one-third formula agreed when the BTPF was established.[40] Second was to estimate a price for bagasse with reference to heavy fuel oil (HFO), which is said to be a better reference material than coal, as HFO burns cleaner and is what the CEB uses in its own power plants. Analysis of industry data determined that a ton of bagasse has roughly 11.4% of the calorific value of a ton of HFO. The third alternative was to add a 15% "green premium" to the HFO reference price in recognition of the renewable nature of bagasse and the benefits of clean energy. The 15% green premium is a solution proposed by members of the cane industry. These calculations are summarized in Table 24 where the reference price for coal is the weighted average paid by IPPs from 2017 to 2019 and the reference price for HFO is the average of HFO landed in Port Louis from 2014 to 2018.

Table 24. Estimation of alternative bagasse prices

		Coal	HFO	HFO + 15%
Reference price	Rs/ton	3,530	13,878	15,960
Bagasse calorific equivalent	%	33.0%	11.4%	11.4%
Bagasse price	**Rs/ton**	**1,165**	**1,582**	**1,819**

Source: Authors' calculations from industry data.

128. Further, in terms of distribution of bagasse proceeds, two sets of conditions were analyzed. The first scenario was to continue with the distribution of the proceeds according to the present BTPF formula (i.e., in which 50% is paid to IPPs, 12% is paid to Category A miller/planter, and 38% is paid to Category B planters), and the second scenario was to eliminate BTFP payments to the IPPs which also receive revenue for the electricity they sell.[41] In this scenario, the current ratio of payments to Category A and Category B planters was assumed to continue but without any payment to IPPs. The new prices to be paid to Category B planters in accrued sugar terms and others are shown in Table 25.

Table 25. Prices resulting from bagasse alternatives

[40] From 2017 to 2019, the weighted average price paid for coal by TeraGen, Alteo Energy Ltd (AEL), and Omnicane Thermal Energy Operations (OTEO) was Rs 3,530/ton.
[41] Currently, IPPs are paid a lower per kWh price for electricity from bagasse than from coal and in exchange for the loss of BTPF revenue, IPPs could be paid one single price for all electricity exported to the grid.

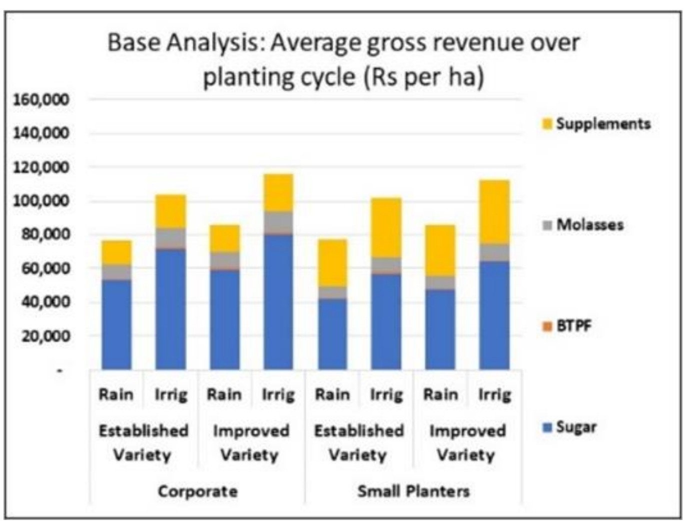
		Rs/ton accued		Rs/kWh
		CAT A	CAT B	IPP
Current situation (2018 BTPF prices)		**52.78**	**161.03**	**0.092**
Test 1 (index to coal @ Rs 1,165/ton)				
Current BTPF split	Scenaro 1	614.93	**1,875.95**	1.073
All proceeds to planters	Scenaro 2	1,229.85	**3,751.89**	-
Test 2 (index to HFO @ Rs 1,582/ton)				
Current BTPF split	Scenaro 1	835.11	**2,547.66**	1.457
All proceeds to planters	Scenaro 2	1,670.22	**5,095.32**	-
Test 3 (index to HFO + 15% green premium @ Rs 1,819/ton)				
Current BTPF split	Scenaro 1	960.38	**2,929.81**	1.675
All proceeds to planters	Scenaro 2	1,920.76	**5,859.62**	-

Source: Authors' calculations from industry data.

129. Other arrangements, including one price for all categories of planters, can be envisioned. Some members of the industry have advocated strongly that the distinction between Category A and Category B planters should be eliminated. In this case, the price paid to Category B growers would be lower than shown and price to Category A would be higher.[42] The point of the analysis here, however, is not to recommend a specific formula, which is ultimately a matter for negotiation between sector stakeholders, but to illustrate how alternative pricing could impact the viability of sugarcane.

130. Figure 19 summarizes the base situation under the existing BTPF arrangement. The slice of total revenue from bagasse is miniscule and basically inconsequential to farmers at around 1% of total revenue.[43]

Figure 19. Gross revenue per ha, current BTPF arrangements (Cat B planters)



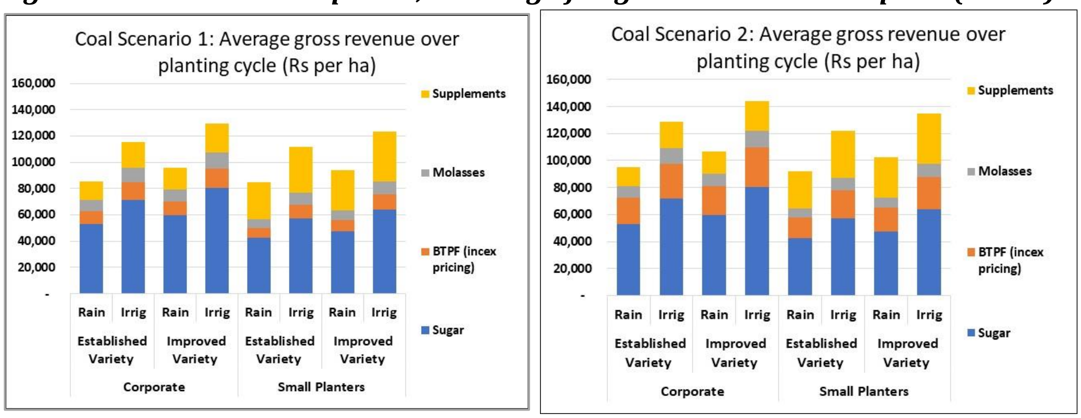
Source: Authors' calculations from the competitiveness model.

[42] Indexing of bagasse to coal with a 15 percent green premium can also be imagined. Full analysis of this possibility, however, is not needed since prices in accrued sugar terms would fall somewhere between the results for Test 1 and Test 2.
[43] In 2019, the Category B price was reduced from 161.03/ton accrued to Rs 143.06/ton accrued.

Test 1: Alternative Pricing Based on Coal

131. The composition of per hectare gross revenues from indexing bagasse to the current coal price is illustrated in Figure 20, the orange part of the bar has become much larger to the point where revenue from bagasse equals to 9% to 11% of gross revenue in Scenario 1 and 17% to 20% of total gross revenue in Scenario 2 in which IPPs are excluded from bagasse payments. All other prices, including the price of sugar, were held constant for the analysis of alternative pricing.

Figure 20. Gross revenue per ha, indexing of bagasse to recent coal price (Test 1)



Source: Authors' calculations from the competitiveness model for CAT-B planters. Current BTPF arrangements in Scenario 1; no payment to IPP in Scenario 2. Coal equivalent = Rs1,165/ton.

132. Table 26 presents the NPV results when bagasse is indexed to the current coal price. Net NPVs on revenue from cane excluding supplements remain negative when bagasse is indexed to coal, meaning that a policy change on these lines is unlikely to restore the viability of cane. The one exception is farms under the highest level of corporate management (mechanized, improved variety, irrigated) where the net NPV from cane revenue excluding supplements becomes positive when IPPs are excluded from sharing in bagasse proceeds (i.e., in Scenario 2 conditions).

Table 26. NPV results from indexing of bagasse to recent coal price (Test 1)

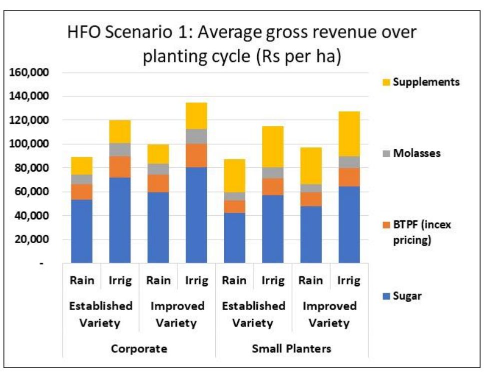
	Current Situation				Coal Scenario 1				Coal Scenario 2			
	NPV on Gross Profit		NPV on Net Profit		NPV on Gross Profit		NPV on Net Profit		NPV on Gross Profit		NPV on Net Profit	
	Cane Only	All Revenue	Cane Only	All Revenue	Cane Only	All Revenue	Cane Only	All Revenue	Cane Only	All Revenue	Cane Only	All Revenue
Estates - mostly manual												
Established variety												
Dryland	($2,313)	$254	($6,904)	($4,337)	($741)	$1,827	($5,332)	($2,764)	$980	$3,547	($3,611)	($1,044)
Irrigated	($1,664)	$1,802	($7,658)	($4,191)	$459	$3,925	($5,535)	($2,068)	$2,781	$6,248	($3,212)	$254
Improved variety												
Dryland	($1,672)	$1,208	($6,264)	($3,383)	$92	$2,973	($4,499)	($1,618)	$2,022	$4,903	($2,569)	$312
Irrigated	($799)	$3,090	($6,792)	($2,903)	$1,583	$5,472	($4,410)	($521)	$4,189	$8,078	($1,805)	$2,085
Estates - highly mechanized												
Established variety												
Dryland	$1,159	$3,804	($5,587)	($2,943)	$2,779	$5,424	($3,967)	($1,323)	$4,551	$7,196	($2,196)	$449
Irrigated	$2,803	$6,373	($5,346)	($1,776)	$4,989	$8,560	($3,160)	$411	$7,381	$10,952	($768)	$2,803
Improved variety												
Dryland	$2,090	$5,058	($4,656)	($1,689)	$3,908	$6,875	($2,839)	$129	$5,896	$8,863	($851)	$2,117
Irrigated	$4,060	$8,066	($4,089)	($83)	$6,513	$10,519	($1,636)	$2,370	$9,197	$13,203	$1,048	$5,054
Planters - mostly manual												
Established variety												
Dryland	($2,330)	$2,571	($9,010)	($4,108)	($1,076)	$3,826	($7,755)	($2,853)	$297	$5,198	($6,382)	($1,481)
Irrigated	($2,173)	$3,876	($9,160)	($3,111)	($479)	$5,570	($7,466)	($1,417)	$1,374	$7,423	($5,613)	$436
Improved variety												
Dryland	($1,651)	$3,682	($8,435)	($3,102)	($244)	$5,090	($7,027)	($1,694)	$1,296	$6,630	($5,487)	($154)
Irrigated	($1,483)	$5,024	($8,611)	($2,105)	$418	$6,925	($6,711)	($204)	$2,497	$9,004	($4,632)	$1,875
Planters - moderately mechanized												
Established variety												
Dryland	($433)	$4,585	($7,694)	($2,676)	$860	$5,877	($6,402)	($1,384)	$2,273	$7,291	($4,988)	$30
Irrigated	$195	$6,359	($7,384)	($1,220)	$1,939	$8,104	($5,639)	$525	$3,848	$10,012	($3,731)	$2,434
Improved variety												
Dryland	$326	$5,772	($7,044)	($1,597)	$1,776	$7,222	($5,594)	($147)	$3,362	$8,809	($4,007)	$1,440
Irrigated	$1,723	$8,357	($6,001)	$632	$3,681	$10,314	($4,043)	$2,590	$5,822	$12,456	($1,902)	$4,731

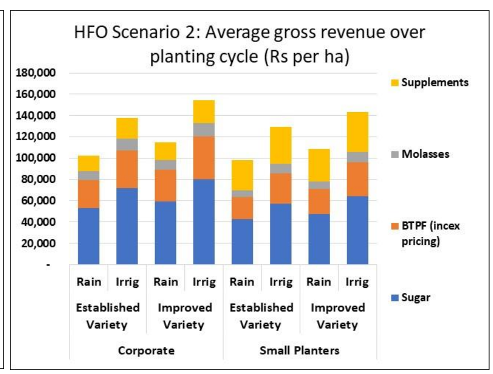
Source: Authors' calculations from the competitiveness model using 12% discount rate (CAT B planters).

Test 2: Alternative Pricing Based on HFO

133. **Test 2 looks at the effects of indexing bagasse payments to the price of HFO.** As shown in Figure 21, under these circumstances bagasse would account for around 12% or 14% of gross revenue in Scenario 1, and 22%–26% of gross revenue in Scenario 2.

Figure 21. Gross revenue per ha, indexing of bagasse to recent HFO price (Test 2)





Source: Authors' calculations from the competitiveness model for CAT B planters. Current BTPF arrangements in Scenario 1; no payment to IPP in Scenario 2. HFO equivalent = Rs1,582/ton.

134. **Table 27 summarizes the NPV results from Test 2, where bagasse is valued with reference to HFO.** As shown, NPVs on revenue from cane excluding supplements remain negative in Scenario 1 based on current sharing arrangements for the corporate sector and small planters. In Scenario 2, the NPVs on cane revenue excluding supplements for small planters continue to be negative. For the corporate sector, however, four of the eight

management variations now deliver a positive NPV term using a 12% discount rate. Overall, the analysis shows that more aggressive pricing of bagasse with reference to HFO would help but is unlikely to transform the long-term prospects for cane especially when IPPs continue to share in bagasse revenue.

Table 27. NPV results from indexing of bagasse to recent HFO price (Test 2)

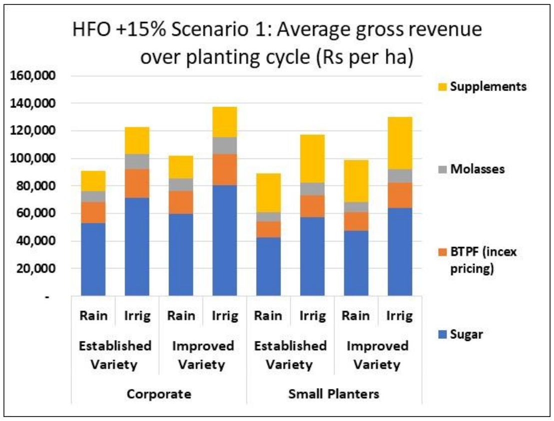
	Current Situation				HFO Scenario 1				HFO Scenario 2			
	NPV on Gross Profit		NPV on Net Profit		NPV on Gross Profit		NPV on Net Profit		NPV on Gross Profit		NPV on Net Profit	
	Cane Only	All Revenue	Cane Only	All Revenue	Cane Only	All Revenue	Cane Only	All Revenue	Cane Only	All Revenue	Cane Only	All Revenue
Estates - mostly manual												
Established variety												
Dryland	($2,313)	$254	($6,904)	($4,337)	($125)	$2,443	($4,716)	($2,148)	$2,211	$4,779	($2,380)	$188
Irrigated	($1,664)	$1,802	($7,658)	($4,191)	$1,290	$4,757	($4,703)	($1,237)	$4,444	$7,910	($1,550)	$1,917
Improved variety												
Dryland	($1,672)	$1,208	($6,264)	($3,383)	$783	$3,664	($3,808)	($927)	$3,404	$6,285	($1,187)	$1,694
Irrigated	($799)	$3,090	($6,792)	($2,903)	$2,516	$6,405	($3,478)	$411	$6,054	$9,943	$61	$3,950
Estates - highly mechanized												
Established variety												
Dryland	$1,159	$3,804	($5,587)	($2,943)	$3,413	$6,058	($3,333)	($688)	$5,820	$8,464	($927)	$1,718
Irrigated	$2,803	$6,373	($5,346)	($1,776)	$5,846	$9,416	($2,303)	$1,267	$9,094	$12,664	$945	$4,515
Improved variety												
Dryland	$2,090	$5,058	($4,656)	($1,689)	$4,620	$7,587	($2,127)	$840	$7,319	$10,287	$573	$3,540
Irrigated	$4,060	$8,066	($4,089)	($83)	$7,474	$11,480	($675)	$3,331	$11,118	$15,124	$2,969	$6,975
Planters - mostly manual												
Established variety												
Dryland	($2,330)	$2,571	($9,010)	($4,108)	($584)	$4,317	($7,263)	($2,362)	$1,279	$6,181	($5,400)	($498)
Irrigated	($2,173)	$3,876	($9,160)	($3,111)	$184	$6,233	($6,803)	($754)	$2,701	$8,749	($4,287)	$1,762
Improved variety												
Dryland	($1,651)	$3,682	($8,435)	($3,102)	$308	$5,641	($6,476)	($1,143)	$2,399	$7,732	($4,385)	$948
Irrigated	($1,483)	$5,024	($8,611)	($2,105)	$1,162	$7,669	($5,966)	$540	$3,985	$10,492	($3,143)	$3,363
Planters - moderately mechanized												
Established variety												
Dryland	($433)	$4,585	($7,694)	($2,676)	$1,366	$6,383	($5,896)	($878)	$3,285	$8,303	($3,976)	$1,042
Irrigated	$195	$6,359	($7,384)	($1,220)	$2,622	$8,787	($4,956)	$1,208	$5,214	$11,379	($2,364)	$3,800
Improved variety												
Dryland	$326	$5,772	($7,044)	($1,597)	$2,343	$7,790	($5,026)	$421	$4,497	$9,944	($2,872)	$2,575
Irrigated	$1,723	$8,357	($6,001)	$632	$4,448	$11,081	($3,277)	$3,357	$7,355	$13,989	($369)	$6,264

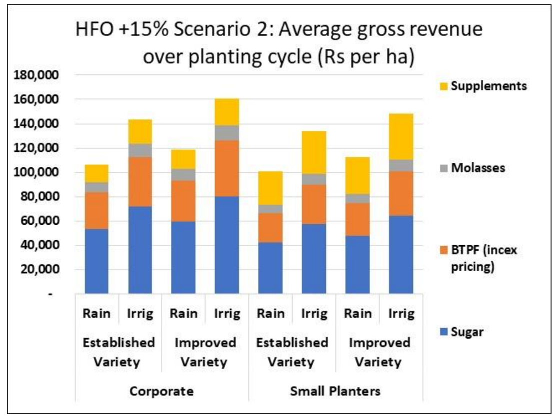
Source: Authors' calculations from the competitiveness model using 12% discount rate (CAT B planters).

Test 3: Alternative Pricing Based on HFO + Green Premium

135. **The impact of adding a 15% "green premium" to the HFO price is illustrated in Figure 22.** The green premium is an arbitrary amount equivalent to a supplemental payment to farmers for producing bagasse, but in no way represents any valuation of environmental services. At this level, bagasse would contribute 14% to 17% of gross revenue in Scenario 1 and 24% to 29% of gross revenue in Scenario 2.

Figure 22. Gross revenue per ha, indexing of bagasse to current HFO price plus 15% green premium (Test 3)





Source: Authors' calculations from the competitiveness model for CAT B planters. Current BTPF arrangements in Scenario 1; no payment to IPP in Scenario 2. HFO equivalent + 15% green premium = Rs1,819/ton.

136. The NPV results from Test 3 are in Table 28. While the results are more favorable than in the other two tests, all NPVs from cane remain negative in Scenario 1 and only certain variations provide a positive NPV in Scenario 2. Thus, while improved bagasse pricing could certainly improve the prospects for sugarcane, even the most aggressive bagasse-pricing scenario is unlikely to be enough to restore the viability of small-scale production. Only for large-scale producers using very good on-farm management does an HFO reference price with a 15% green premium transform cane from a loss- to profit-making enterprise in NPV terms.

Table 28. NPV results from indexing of bagasse to recent HFO price plus 15% green premium (Test 3)

	Current Situation				HFO + 15% Green Premium Scenario 1				HFO +15 Green Premium Scenario 2			
	NPV on Gross Profit		NPV on Net Profit		NPV on Gross Profit		NPV on Net Profit		NPV on Gross Profit		NPV on Net Profit	
	Cane Only	All Revenue	Cane Only	All Revenue	Cane Only	All Revenue	Cane Only	All Revenue	Cane Only	All Revenue	Cane Only	All Revenue
Estates - mostly manual												
Established variety												
Dryland	($2,313)	$254	($6,904)	($4,337)	$225	$2,793	($4,366)	($1,798)	$2,911	$5,479	($1,680)	$888
Irrigated	($1,664)	$1,802	($7,658)	($4,191)	$1,763	$5,229	($4,231)	($764)	$5,389	$8,855	($605)	$2,862
Improved variety												
Dryland	($1,672)	$1,208	($6,264)	($3,383)	$1,176	$4,056	($3,416)	($535)	$4,189	$7,070	($402)	$2,479
Irrigated	($799)	$3,090	($6,792)	($2,903)	$3,046	$6,935	($2,948)	$942	$7,114	$11,004	$1,121	$5,010
Estates - highly mechanized												
Established variety												
Dryland	$1,159	$3,804	($5,587)	($2,943)	$3,774	$6,419	($2,973)	($328)	$6,540	$9,185	($206)	$2,439
Irrigated	$2,803	$6,373	($5,346)	($1,776)	$6,332	$9,902	($1,817)	$1,754	$10,067	$13,637	$1,918	$5,488
Improved variety												
Dryland	$2,090	$5,058	($4,656)	($1,689)	$5,024	$7,991	($1,723)	$1,245	$8,128	$11,095	$1,381	$4,349
Irrigated	$4,060	$8,066	($4,089)	($83)	$8,020	$12,026	($129)	$3,877	$12,210	$16,216	$4,061	$8,067
Planters - mostly manual												
Established variety												
Dryland	($2,330)	$2,571	($9,010)	($4,108)	($305)	$4,596	($6,984)	($2,083)	$1,838	$6,739	($4,841)	$60
Irrigated	($2,173)	$3,876	($9,160)	($3,111)	$561	$6,610	($6,426)	($377)	$3,455	$9,503	($3,533)	$2,516
Improved variety												
Dryland	($1,651)	$3,682	($8,435)	($3,102)	$621	$5,954	($6,163)	($830)	$3,025	$8,359	($3,758)	$1,575
Irrigated	($1,483)	$5,024	($8,611)	($2,105)	$1,585	$8,092	($5,543)	$963	$4,831	$11,338	($2,297)	$4,209
Planters - moderately mechanized												
Established variety												
Dryland	($433)	$4,585	($7,694)	($2,676)	$1,653	$6,671	($5,608)	($590)	$3,861	$8,878	($3,401)	$1,617
Irrigated	$195	$6,359	($7,384)	($1,220)	$3,011	$9,175	($4,568)	$1,597	$5,991	$12,155	($1,588)	$4,577
Improved variety												
Dryland	$326	$5,772	($7,044)	($1,597)	$2,666	$8,113	($4,703)	$744	$5,143	$10,590	($2,226)	$3,220
Irrigated	$1,723	$8,357	($6,001)	$632	$4,883	$11,516	($2,841)	$3,792	$8,227	$14,860	$502	$7,136

Source: authors' calculations from the competitiveness model using 12% discount rate (CAT B planters).

4.5.3 Molasses

137. The approach to sensitivity analysis of molasses pricing was simply to model a 10% increase and 10% decrease from the base price. At the sector level, the change in prices can produce an improvement in sector-level profits of up to Rs38.78 million. At the farm level, the results are summarized in Table 29. As shown, molasses only account for 13% of total cane revenue at present and a change in the molasses price by 10% one way or the other would not have a significant impact on farm profitability. The analysis shows that a 10% change in molasses price is not enough to transform the viability of cane production

Table 29. Sensitivity analysis of molasses price

	Corporate				Small Planters			
	Established Variety		Improved Variety		Established Variety		Improved Variety	
	Rain	Irrig	Rain	Irrig	Rain	Irrig	Rain	Irrig
Base analysis (Mol = Rs 3,840/ton								
Revenue from molasses (Rs/ha)	8,308	11,216	9,139	12,338	6,629	8,949	7,292	9,844
Molasses as % cane revenue	13%	13%	13%	13%	13%	13%	13%	13%
Average net profit from cane (mechanical)	(31,510)	(31,111)	(26,260)	(24,024)	(43,540)	(42,473)	(40,039)	(34,411)
Molasses 10% higher (Mol = Rs 4,224/ton)								
Revenue from molasses (Rs/ha)	9,139	12,338	10,053	13,572	7,292	9,844	8,021	10,829
Molasses as % cane revenue	14%	14%	14%	14%	14%	14%	14%	14%
Average net profit from cane (mechanical)	(30,654)	(29,956)	(25,318)	(22,753)	(42,925)	(41,643)	(39,363)	(33,498)
Molasses 10% lower (Mol = Rs 3,456/ton)								
Revenue from molasses (Rs/ha)	7,478	10,095	8,225	11,104	5,966	8,054	6,563	8,860
Molasses as % cane revenue	12%	12%	12%	12%	12%	12%	12%	12%
Average net profit from cane (mechanical)	(32,365)	(32,267)	(27,201)	(25,295)	(44,154)	(43,302)	(40,714)	(35,323)

Source: Authors' calculations from the competitiveness model.

138. Table 30 shows the NPV calculations using alternative molasses prices. These results further underscore the minimal impact alternative molasses pricing would have on the viability of farm production. Current molasses prices are determined with reference to international prices and, as a leverage point for restoring farmer profits, changes in molasses pricing carry relatively minor consequence compared to bagasse or other possible changes in marketing and farm management arrangements.

Table 30. NPV results using alternative molasses prices

	Base analysis (Mol = Rs 3,840/ton)				Molasses 10% higher (Mol = Rs 4,224/ton)				Molasses 10% lower (Mol = 3,456/ton)			
	NPV on Gross Profit		NPV on Net Profit		NPV on Gross Profit		NPV on Net Profit		NPV on Gross Profit		NPV on Net Profit	
	Cane Only	All Revenue	Cane Only	All Revenue	Cane Only	All Revenue	Cane Only	All Revenue	Cane Only	All Revenue	Cane Only	All Revenue
Estates - mostly manual												
Established variety												
Dryland	($2,313)	$254	($6,904)	($4,337)	($2,166)	$402	($6,757)	($4,189)	($2,461)	$107	($7,052)	($4,484)
Irrigated	($1,664)	$1,802	($7,658)	($4,191)	($1,465)	$2,001	($7,459)	($3,992)	($1,863)	$1,603	($7,856)	($4,390)
Improved variety												
Dryland	($1,672)	$1,208	($6,264)	($3,383)	($1,510)	$1,371	($6,101)	($3,221)	($1,835)	$1,046	($6,426)	($3,545)
Irrigated	($799)	$3,090	($6,792)	($2,903)	($580)	$3,309	($6,574)	($2,684)	($1,018)	$2,871	($7,011)	($3,122)
Estates - highly mechanized												
Established variety												
Dryland	$1,159	$3,804	($5,587)	($2,943)	$1,311	$3,956	($5,435)	($2,791)	$1,008	$3,652	($5,739)	($3,094)
Irrigated	$2,803	$6,373	($5,346)	($1,776)	$3,007	$6,578	($5,141)	($1,571)	$2,598	$6,168	($5,551)	($1,981)
Improved variety												
Dryland	$2,090	$5,058	($4,656)	($1,689)	$2,257	$5,225	($4,489)	($1,522)	$1,924	$4,891	($4,823)	($1,856)
Irrigated	$4,060	$8,066	($4,089)	($83)	$4,285	$8,291	($3,864)	$142	$3,834	$7,840	($4,315)	($309)
Planters - mostly manual												
Established variety												
Dryland	($2,330)	$2,571	($9,010)	($4,108)	($2,213)	$2,689	($8,904)	($4,002)	($2,448)	$2,454	($9,115)	($4,214)
Irrigated	($2,173)	$3,876	($9,160)	($3,111)	($2,014)	$4,035	($9,017)	($2,968)	($2,332)	$3,717	($9,303)	($3,254)
Improved variety												
Dryland	($1,651)	$3,682	($8,435)	($3,102)	($1,522)	$3,811	($8,319)	($2,986)	($1,781)	$3,552	($8,552)	($3,219)
Irrigated	($1,483)	$5,024	($8,611)	($2,105)	($1,308)	$5,199	($8,454)	($1,947)	($1,657)	$4,849	($8,768)	($2,262)
Planters - moderately mechanized												
Established variety												
Dryland	($433)	$4,585	($7,694)	($2,676)	($312)	$4,706	($7,585)	($2,567)	($554)	$4,464	($7,803)	($2,785)
Irrigated	$195	$6,359	($7,384)	($1,220)	$358	$6,522	($7,237)	($1,072)	$31	$6,195	($7,531)	($1,367)
Improved variety												
Dryland	$326	$5,772	($7,044)	($1,597)	$459	$5,906	($6,924)	($1,477)	$192	$5,639	($7,163)	($1,717)
Irrigated	$1,723	$8,357	($6,001)	$632	$1,903	$8,537	($5,839)	$794	$1,544	$8,177	($6,163)	$471

Source: Authors' calculations from the competitiveness model using 12% discount rate.

4.6 Input Prices

4.6.1 Cost of Labor

139. Labor costs (basic wages, and statutory contributions to the National Pension Fund and to the Sugar Industry Pension Fund) are higher in the sugar sector compared with other economic sectors in Mauritius. The situation is the result of a history of voluntary retirement packages negotiated as part of EU market reforms. The simulations were based on a maximum potential reduction in overall labor costs (wages, benefits, etc.) of 40% across all types of labor (farms, mills, refineries, IPPs), with a minimum of no labor cost reduction (increases in labor costs were not considered). Savings from reducing labor costs could be up to Rs136 million.

140. Wages in the sugar industry appear to be 22.89% higher than wages in other areas of manufacturing (see Table 31 below). On one hand, it is highly possible that data from Statistics Mauritius understate true wage differences to a large degree by looking only at monthly wages without the cost of statutory contributions. On the other hand, wage differentials do appear to be much lower at the farm level than in manufacturing. It is important to note that small planters with fewer than 10 full-time employees are not bound by the same legal obligations under the labor law, but face problems of their own with labor scarcity and high cost of engaging part-time workers for specific tasks.

141. Table 31 summarizes data from Statistics Mauritius which suggests that wages in the agriculture (farming) part of the sugar sector are 5.81% higher compared with other wages in agriculture forestry and fishing.

Table 31. Average monthly earnings by industrial group 2016–2018 (Rs)

Industrial group	March 2016	March 2017	March 2018	Average
Agriculture, forestry and fishing	*20,124*	*21,091*	*21,399*	*20,871*
Sugarcane	*20,766*	*22,928*	*22,779*	*22,158*
Increment for cane (Rs)	642	1,837	1,380	
Increment for cane (%)	3.09%	8.01%	6.06%	**5.81%**
Manufacturing	*17,511*	*17,826*	*18,508*	*17,948*
Sugar	*22,884*	*24,097*	*22,847*	*23,276*
Increment for sugar (Rs)	5,373	6,271	4,339	
Increment for sugar (%)	23.48%	26.02%	18.99%	**22.89%**

Source: Statistics Mauritius, Digest of Labor Statistics 2018.

142. The approach taken for the simulation of labor costs at the farm level was to model a range of possible wage reductions in all types of labor from five to 40%. Labor savings would result in lower sugarcane production costs and Table 32 shows how each level of labor reduction would impact the per ton costs of sugarcane as a fundamental competitiveness measure. Because other costs are included, the total savings in per ton costs are less than the specific change in labor. In the base analysis, labor accounts for 43% to 45% of corporate costs in mostly manual variations and 4% of total costs with full mechanization. For planters, labor accounts for 36% to 41% of total costs in the manual models and 14% to 17% in the semi-mechanized models.

Table 32. Per ton costs of cane production different levels of labor savings (US$/ton cane)

	Mostly manual/Manual				Mechanized/Semi-mechanized			
	Established Variety		Improved Variety		Established Variety		Improved Variety	
	Rain	Irrig	Rain	Irrig	Rain	Irrig	Rain	Irrig
CORPORATE ESTATES								
Base analysis	**42.07**	**39.80**	**39.70**	**37.63**	**39.37**	**36.05**	**36.68**	**33.65**
5% lower labor	40.98	38.80	38.65	36.66	39.11	35.83	36.44	33.46
10% lower labor	39.89	37.80	37.59	35.69	38.84	35.61	36.20	33.26
20% lower labor	37.71	35.80	35.49	33.76	38.31	35.18	35.71	32.87
40% lower labor	33.34	31.80	31.28	29.88	37.25	34.32	34.75	32.09
SMALL PLANTERS								
Base analysis	**53.13**	**47.03**	**49.83**	**44.49**	**48.89**	**42.78**	**45.70**	**38.88**
5% lower labor	52.20	46.10	48.93	43.58	48.59	42.43	45.39	38.61
10% lower labor	51.27	45.17	48.03	42.67	48.28	42.07	45.09	38.34
20% lower labor	49.40	43.30	46.24	40.86	47.67	41.37	44.48	37.81
40% lower labor	45.67	39.58	42.65	37.24	46.45	39.96	43.27	36.74

Source: Authors' calculations from the competitiveness model.

143. The change in farm-level wage rates naturally provides greater savings in production costs to manual variations than to mechanized ones. In fact, from about a 20% savings in labor cost, and especially with 40% savings, manual production would become cheaper for corporate estates and small planters than mechanized production. However, even if labor costs were somehow reduced by 20% to 40% through renegotiated contracts, finding enough people willing to work at these low rates would be another problem.

144. Table 33 summarizes the NPV results with 10% and 40% reductions in labor costs. As shown, even with a 40% reduction in labor costs, the net NPVs on cane revenue without supplements remain negative, indicating that even very deep reductions in labor costs are still not enough to restore the viability of sugarcane.

Table 33. NPV results at different levels of labor savings

	Base analysis				Labor 10% lower				Labor 40% lower			
	NPV on Gross Profit		NPV on Net Profit		NPV on Gross Profit		NPV on Net Profit		NPV on Gross Profit		NPV on Net Profit	
	Cane Only	All Revenue	Cane Only	All Revenue	Cane Only	All Revenue	Cane Only	All Revenue	Cane Only	All Revenue	Cane Only	All Revenue
Estates - mostly manual												
Established variety												
Dryland	($2,313)	$254	($6,904)	($4,337)	($1,506)	$1,062	($5,949)	($3,381)	$915	$3,483	($3,082)	($514)
Irrigated	($1,664)	$1,802	($7,658)	($4,191)	($643)	$2,824	($6,488)	($3,021)	$2,422	$5,888	($2,978)	$488
Improved variety												
Dryland	($1,672)	$1,208	($6,264)	($3,383)	($810)	$2,071	($5,252)	($2,371)	$1,778	$4,659	($2,219)	$662
Irrigated	($799)	$3,090	($6,792)	($2,903)	$297	$4,187	($5,548)	($1,658)	$3,587	$7,476	($1,813)	$2,076
Estates - highly mechanized												
Established variety												
Dryland	$1,159	$3,804	($5,587)	($2,943)	$1,237	$3,882	($5,361)	($2,717)	$1,470	$4,114	($4,683)	($2,038)
Irrigated	$2,803	$6,373	($5,346)	($1,776)	$2,900	$6,470	($5,101)	($1,530)	$3,192	$6,762	($4,363)	($793)
Improved variety												
Dryland	$2,090	$5,058	($4,656)	($1,689)	$2,168	$5,135	($4,430)	($1,463)	$2,401	$5,368	($3,752)	($785)
Irrigated	$4,060	$8,066	($4,089)	($83)	$4,157	$8,163	($3,844)	$162	$4,449	$8,455	($3,106)	$900
Planters - mostly manual												
Established variety												
Dryland	($2,330)	$2,571	($9,010)	($4,108)	($1,629)	$3,272	($8,309)	($3,407)	$474	$5,375	($6,205)	($1,304)
Irrigated	($2,173)	$3,876	($9,160)	($3,111)	($1,272)	$4,777	($8,259)	($2,210)	$1,432	$7,481	($5,555)	$494
Improved variety												
Dryland	($1,651)	$3,682	($8,435)	($3,102)	($923)	$4,410	($7,707)	($2,374)	$1,263	$6,596	($5,521)	($188)
Irrigated	($1,483)	$5,024	($8,611)	($2,105)	($521)	$5,985	($7,650)	($1,144)	$2,362	$8,868	($4,767)	$1,740
Planters - moderately mechanized												
Established variety												
Dryland	($433)	$4,585	($7,694)	($2,676)	($168)	$4,849	($7,430)	($2,412)	$624	$5,642	($6,637)	($1,619)
Irrigated	$195	$6,359	($7,384)	($1,220)	$562	$6,726	($7,017)	($852)	$1,663	$7,828	($5,915)	$249
Improved variety												
Dryland	$326	$5,772	($7,044)	($1,597)	$602	$6,049	($6,767)	($1,320)	$1,433	$6,880	($5,936)	($489)
Irrigated	$1,723	$8,357	($6,001)	$632	$2,044	$8,678	($5,680)	$953	$3,007	$9,640	($4,718)	$1,916

Source: Authors' calculations from the competitiveness model using 12% discount rate.

145. Table 34 looks at the potential impact of combining a hypothetical 10% reduction in the cost of labor with improved pricing of bagasse. Although this reduction would not appear to be enough to transform the viability of cane by itself, if combined with pricing of bagasse in reference to HFO plus a 15% green premium –as the industry has advocated—, a more positive picture would emerge, at least for corporate estates. These positive NPV results largely depend on excluding IPPs from sharing in bagasse revenue, but at least many of the NPVs in the third column (net NPV on cane revenue excluding supplements) would go from red to black for the corporate estates. However, this finding does not necessarily imply that wage rates can or even should be reduced by 10%, since this is a policy decision to be agreed among stakeholders.

146. Unfortunately, the situation is less positive for small planters. All variations (except for the most advanced system analyzed) continue to return a negative NPV even with a 10% reduction in labor costs, HFO pricing of bagasse with a 15% green premium, and elimination of bagasse payments to IPPs.

Table 34. NPV results from 10% labor savings and pricing of bagasse in reference to HFO with and without green premium

	10% lower labor only				Labor 10% lower + HFO pricing of bagass with 15% green premium							
					Scenario 1 (IPPs continue to share in bagasse revenue)				Scenario 2 (no bagasse payments to IPPs)			
	NPV on Gross Profit		NPV on Net Profit		NPV on Gross Profit		NPV on Net Profit		NPV on Gross Profit		NPV on Net Profit	
	Cane Only	All Revenue	Cane Only	All Revenue	Cane Only	All Revenue	Cane Only	All Revenue	Cane Only	All Revenue	Cane Only	All Revenue
Estates - mostly manual												
Established variety												
Dryland	($1,506)	$1,062	($5,949)	($3,381)	$1,032	$3,600	($3,410)	($843)	$3,718	$6,286	($724)	$1,843
Irrigated	($643)	$2,824	($6,488)	($3,021)	$2,784	$6,250	($3,061)	$405	$6,410	$9,877	$565	$4,031
Improved variety												
Dryland	($810)	$2,071	($5,252)	($2,371)	$2,038	$4,919	($2,404)	$477	$5,052	$7,933	$609	$3,490
Irrigated	$297	$4,187	($5,548)	($1,658)	$4,142	$8,031	($1,703)	$2,186	$8,211	$12,100	$2,366	$6,255
Estates - highly mechanized												
Established variety												
Dryland	$1,237	$3,882	($5,361)	($2,717)	$3,851	$6,496	($2,747)	($102)	$6,618	$9,263	$20	$2,665
Irrigated	$2,900	$6,470	($5,101)	($1,530)	$6,430	$10,000	($1,571)	$1,999	$10,164	$13,735	$2,164	$5,734
Improved variety												
Dryland	$2,168	$5,135	($4,430)	($1,463)	$5,102	$8,069	($1,497)	$1,471	$8,206	$11,173	$1,607	$4,575
Irrigated	$4,157	$8,163	($3,844)	$162	$8,117	$12,123	$117	$4,123	$12,308	$16,314	$4,307	$8,313
Planters - mostly manual												
Established variety												
Dryland	($1,629)	$3,272	($8,309)	($3,407)	$396	$5,297	($6,486)	($1,584)	$2,539	$7,440	($4,557)	$345
Irrigated	($1,272)	$4,777	($8,259)	($2,210)	$1,463	$7,511	($5,798)	$251	$4,356	$10,404	($3,194)	$2,855
Improved variety												
Dryland	($923)	$4,410	($7,707)	($2,374)	$1,349	$6,683	($5,662)	($328)	$3,754	$9,087	($3,498)	$1,836
Irrigated	($521)	$5,985	($7,650)	($1,144)	$2,546	$9,053	($4,889)	$1,617	$5,792	$12,299	($1,968)	$4,539
Planters - moderately mechanized												
Established variety												
Dryland	($168)	$4,849	($7,430)	($2,412)	$1,918	$6,935	($5,552)	($535)	$4,125	$9,143	($3,566)	$1,452
Irrigated	$562	$6,726	($7,017)	($852)	$3,378	$9,542	($4,482)	$1,682	$6,358	$12,522	($1,800)	$4,364
Improved variety												
Dryland	$602	$6,049	($6,767)	($1,320)	$2,943	$8,390	($4,660)	$787	$5,420	$10,866	($2,431)	$3,016
Irrigated	$2,044	$8,678	($5,680)	$953	$5,204	$11,837	($2,836)	$3,797	$8,547	$15,181	$173	$6,806

Source: Authors' calculations from the competitiveness model using a 12% discount rate.

4.6.2 Technology and Operational Improvements

147. Finally, improvements in efficiencies and cost reductions due to technological change in various subsectors were modeled. Cost reductions and efficiency improvements were simulated for (i) export-related operations and logistics costs incurred by MSS; (ii) costs of support institutions (MCIA/MSS); (iii) the loading zone system for millers; and (iv) refining, milling, and electricity cogeneration operations.

148. From all the improvements in efficiencies and cost savings, the potential operational cost reduction related to the export logistics reported by MSS (simulated to be of a reduction of a maximum of 20%) seem to produce the largest impact, with a potential boost to sector-level profits of up to Rs200 million. These costs relate to freight, export charges, storage and costs for importing NOS. Technological improvements at the IPP and milling level (of an estimated maximum of 5%) produce savings of Rs79 and Rs60 million, respectively. Technological change at the milling level can produce cost savings of approximately Rs21 million. Savings due to institutional cost reductions are less than Rs5million.

5. Conclusions

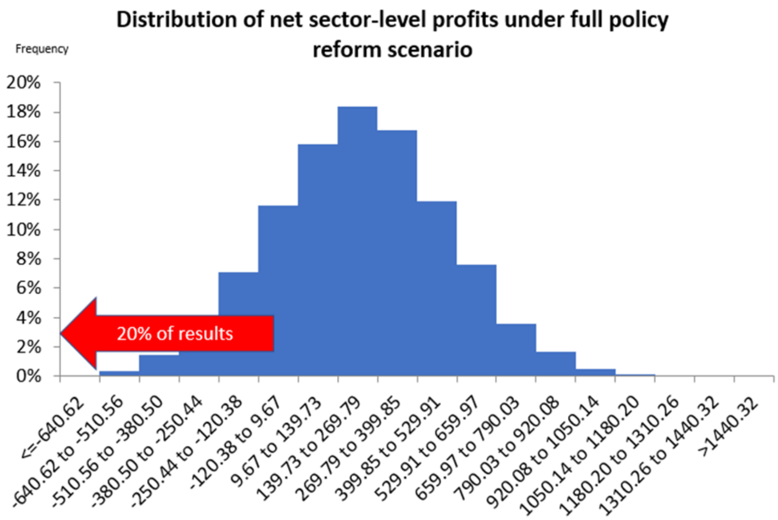
5.1 Summary of Conclusions from Simulations

149. This competitiveness analysis does not present single policy options in terms of scenarios where the sector becomes viable, even when modeling under expected changes in sugar prices and exchange rate. The need to undertake several policy changes in order to make the sector viable makes it critical to learn from past reforms. Previous reform attempts have not succeeded because they were unilaterally pushed by one subsector of the industry and met with opposition from workers and small farmers. The last significant reform in the sector in Mauritius was the Multi Annual Adaptation Strategy (MAAS), developed for a 10-year period (2006–2015) with a long list of policy changes and objectives (see Annex 4). Part of these reforms were implemented, but due to incompleteness (combined with other internal and external factors), the sector continued its declining trajectory, even accelerating the drop in sugarcane volume produced.

5.1.1 Sector Level

150. The analysis shows that under the current production levels and structure, a simultaneous implementation of the most impactful policy changes can increase the probability of the sector turning a profit over the coming 10 years. The sector shows a profit if it is able to simultaneously: (i) increase the price paid for electricity from bagasse to the equivalent of HFO; (ii) reduce labor costs by 40%; (iii) increase the share of specialty sugars sold to 50%; (iv) increase the share of high-tech farms to 95%; and (v) save at least Rs200 million per year on sugar export costs. However, once simulations of variations in the international sugar prices and the exchange rate are introduced, these reforms produce an 80% probability of sector profits over the coming 10 years (see Figure 23). This means that, even after all these important and rather difficult changes, the sector still faces a 20% chance of producing a loss. Some of the policy reforms may have important fiscal implications. For example, reducing labor costs may require early retirement schemes (the last one costing Euros94 million), while increase the technology at farm level, may require further investment in agriculture innovation and adoption of new farm-level technologies (recent farm mechanization and replanting efforts were estimated at Rs300 million per year, but with mixed results) (LMC, 2015).

Figure 23. Distribution of net sector-level profits under full-policy reform scenario



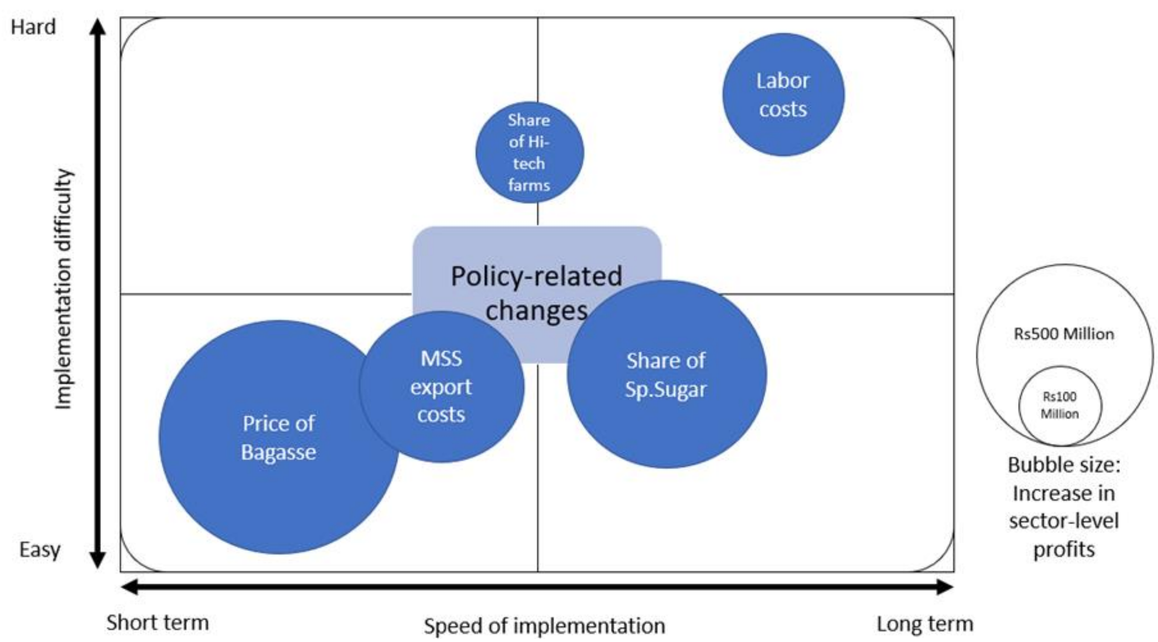
151. Alternatively, another set of simulations was completed to account for a potential downsizing of the sector—reducing sugarcane production while maintaining the share of small planters and all other variables constant. Six scenarios were simulated under different combinations of reductions in sugarcane production and milling capacity. The six scenarios contemplated different combinations of 1 to 2 mills, operating at capacity with production levels of 1 to 2.65 million tons of sugarcane. The analysis shows that two out of the four scenarios could yield sector-level profits of Rs700 to Rs888 million (without considering the implementation costs of this reduction and the possible implication in terms of additional transport costs and welfare losses). The viability of these two scenarios is based on the focus of the sugarcane sector on the production and export of specialty sugars. These scenarios were modeled without any additional policy changes like the ones mentioned in the previous paragraph. Yet, the fact that only a few sector downsizing scenarios present a positive outlook for the sector means that there needs to be a "managed" downscaling of the sector to ensure its focus on specialty sugar production, but also to ensure that there is an appropriate support for the transition of farmers and workers to other activities. The sensitivity analysis on these two scenarios shows a more than 95% confidence level of the sector making a profit over the coming ten years under different output prices and exchange rate scenarios.

3.1.1 Sector Level

152. At the sector level, the competitiveness model has allowed to identify factors and policy changes that can improve sector viability, placing them in order of their impact on the sector's bottom line. The policy-related changes that can produce the largest positive impact in the sector's bottom line (short of direct support) are: (i) increasing the share of specialty sugar sold; (ii) reducing export-related costs (operations and logistics); (iii) increasing the price of electricity from bagasse; (iv) reducing labor costs, and (v) improving the efficiency (yields and/or quality) of sugarcane production. While other variables may affect a given actor within the sector in a significant way, they do not have a single large impact in the overall sector's bottom line.

152. Figure 24 shows a map of the analyzed variables rated by sector stakeholders during participatory consultations based on implementation difficulty and timeline. The size of the bubble reflects the impact of each policy on the bottom line of the sector. Figure 24 provides an insight into the immediate changes that can be brought about to the sector (*low-hanging fruit)* vis-à-vis their expected impact. These are the easiest and fastest to implement, and most impactful variables considered: (i) a reduction in sugar export-related costs, and ii) an increase in the price of bagasse. Other impactful policies, that would nevertheless be slower and more difficult to implement, are: (i) a reduction in the share of sugarcane produced with optimized practices; (ii) an increase in the share of specialty sugars sold (as a percentage of total sugar value); and (iii) a reduction in labor costs.

Figure 24. Impact and perceived timeline and difficulty for implementation of selected sector policies (private and public)



3.1.2 Farm Level

153. The analysis set out to provide insights on the costs and profitability of sugarcane production and current challenges faced by large and small planters to elicit a more informed discussion of sector policies. While some growers may individually achieve very different results from the ones described here, the analysis aims to provide a broader picture of farm-level conditions and opportunities to restore the profitability of sugarcane in Mauritius.

154. Importantly, the analysis shows there is no single change that would restore the profitability of sugarcane production. Planters at all levels face many challenges with deep net losses. Improvements on farm management help both small and large planters, but multiple other improvements are needed before sugarcane production becomes profitable as a whole. Even payments for bagasse based on the avoided cost of HFO plus a 15% green premium is unlikely to restore the profitability of sugarcane for corporate estates unless backed by other savings in per ton costs.

155. The situation for small planters is even more challenging. Ton-for-ton, the analysis shows that small planter costs are 16% to 26% higher compared with corporate estates. As a share of revenue from own-sugar exports, farm-level costs for small planters amount for 66% to 92% of per ton proceeds generated by MSS. Annual profits for small planters depend heavily on supplemental payments, and when depreciation and overhead costs are considered, cane appears to be strongly unprofitable even with supplements and aggressive changes to pricing policies.

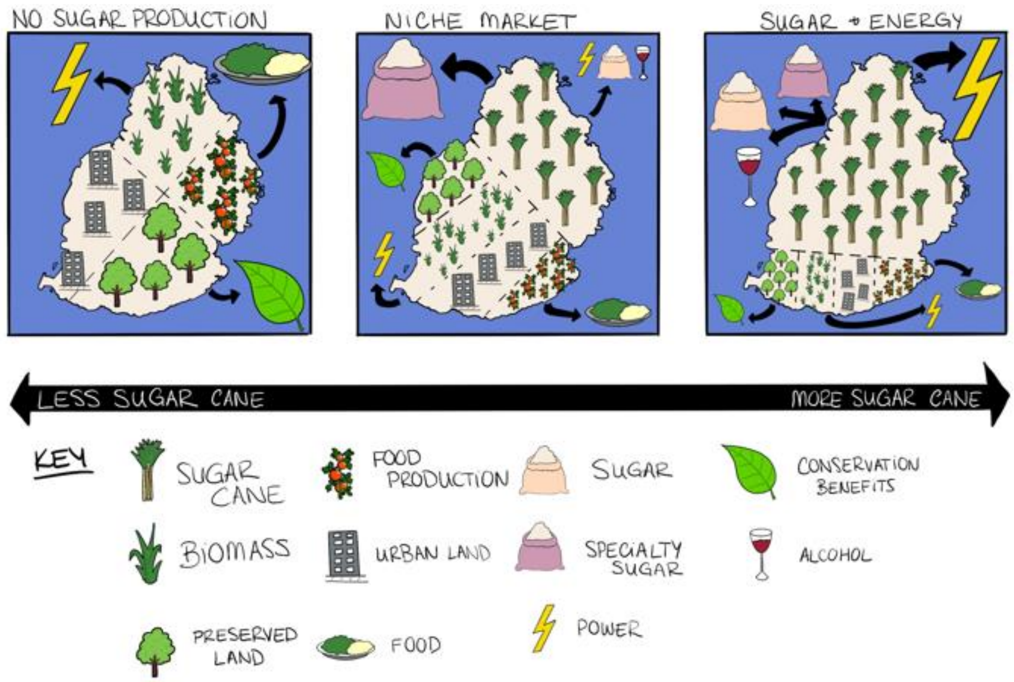
156. For large and small planters, the analysis further shows that revenue from sugar itself is unlikely to sustain sugarcane production. Even with an optimistic price outlook, sugar payments are not enough to deliver a net profit. Supplemental payments have helped offset these losses but are estimated to cost Mauritius some Rs961.8 million (US$26.7 million) annually.

157. A more realistic pricing of bagasse produces significant improvements in farm-level viability. Some modest changes may be possible to molasses prices but they are already priced with reference to international parity. Bagasse payments, however, have not been updated since the mid-1980s and bear no relation to the current value of this material as an energy source. Regular updated pricing of bagasse by indexing the value of this material to an alternative fuel source such as HFO is likely the single best opportunity to impact the profitability of sugarcane. Unlike replanting with new varieties or investing in irrigation that takes time to come to fruition, changes to bagasse pricing could deliver substantial benefits to large and small planters alike in the very short term.

3.2 Identification of Policy Areas for Consideration

158. Based on the competitiveness analysis and the sector vision exercise, there is an opportunity to introduce policy reforms and sector changes to make sugarcane production viable. If no policy action is taken in the short term, with the current level of losses, the analysis shows that the sector will continue to decline and could disappear in the next 10 to 20 years (under a pessimistic scenario). The analysis shows that the policy options to be implemented would depend on which of the two viable futures of the sector is chosen. One future is where the sector size is maintained in terms of its level of sugarcane production. This vision is supported by most stakeholders in Mauritius but will require direct taxpayer support if it is to have a high likelihood of being a viable scenario over the next decade. Another alternate future is where the sector continues to shrink to a viable size. This vision of the future of the sector is not shared by most sector stakeholders, but would require less direct taxpayer support (see Figure 25).

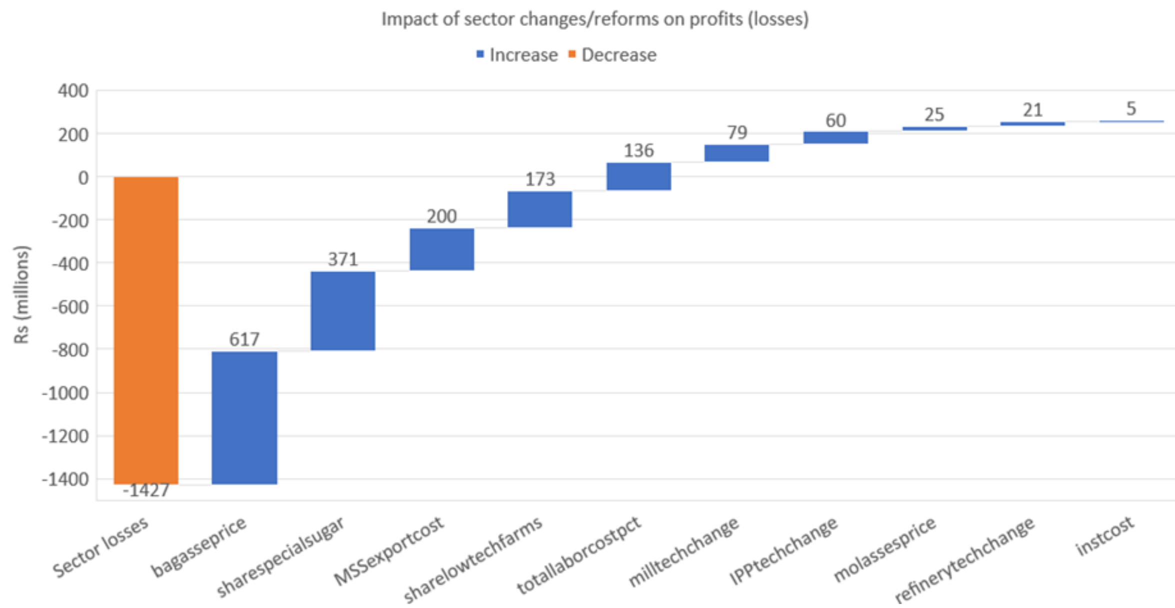
Figure 25 : Alternative sugarcane worlds for Mauritius



**Not drawn for geographic purposes

159. Although there is no single policy or sector change that would make the sector viable in its current size, the analysis suggests that the sector decline could be halted with a series of simultaneous public policy changes. Learning from past experiences of sector reform proposals, the policy options in this sector review were assessed individually, and then jointly to establish the potential impact on sector competitiveness. Under the full implementation of the most impactful policy reforms on the bottom line of the sector, the sector shows a modest degree of viability. The policy suggestions to reach this scenario are deemed *no-regret* options, as they allow maintaining sector size while enhancing its competitiveness. Even if the stakeholders of the sugarcane sector (both private and public) are committed and do successfully enact all policy reforms, volatility in the international sugar market or the exchange rate can still make it a very risky investment. Figure 26 shows the current (2019) sugarcane sector deficit of Rs1.35 billion with the expected (maximum) impact that could be envisaged if the most impactful public policies and programs were undertaken.

Figure 26. Sugarcane sector profits (losses) and potential policy changes/reforms under current production levels



160. Therefore, to halt the decline and have a high likelihood of the sector being viable over the coming decade, a set of simultaneous policy reforms and programs would need to be introduced in the relatively short term. These are the key policy reforms and sector changes that would need to be introduced in order to have a modest likelihood of sector viability: (i) increase the price paid for generating electricity from bagasse; (ii) decrease the sugar logistics and export costs; (iii) expand the revenues generated from the sale of specialty sugars; (iv) lower labor costs; (v) improve the efficiency of sugarcane farms; (v) allow the pass-through of market signals throughout the value chain; and (vii) augment the level of taxpayer support to the sector. These policy changes have different degrees of implementation difficulty and timelines, but without all these simultaneous changes, it is difficult to foresee the sector maintaining its current structure and size over the coming decade. Furthermore, given the recent experience of half-successes in implementing sector reforms in Mauritius, it would be risky to assume that the reforms would be fully implemented. Likewise, increasing the price of electricity from bagasse could be met with resistance from consumers if the surge is absorbed by electricity tariffs, making the design and sequencing of these policies particularly relevant. Nevertheless, given the consensus among most sector stakeholders on the need to maintain the current sector size, the risk may be worth taking (no-regret option).

161. If any of the above policy and sector changes is not possible, particularly the availability of direct taxpayer support, the analysis shows that the downsizing of the sector is the only viable option. This option may not be politically acceptable to most sector stakeholders, but considering such an option would be important, given that: (i) the sector continues to shrink; and (ii) there is currently no specific effort to help farmers and workers transition out of the sugarcane sector. Annex 6 presents the description of key policy actions that could be considered and the priority that should be given to each one in a sequenced implementation plan –arranged from short and medium to long term.

162. As the sector can potentially disappear over the next decade or two, immediate no-regret policy action would be required to improve its competitive position. In order to adopt a no-regret strategy, policy reforms could be introduced with the initial goal of maintaining the current size of the sector, bringing in the full force of the understanding and buy-in of sector stakeholders for adopting drastic changes to improve sector viability (short-term policy changes). This approach of immediate no-regret full policy reform implementation should be complemented with a plan to deploy direct taxpayer support focused on improving the competitiveness of the sector, and supporting farmers and workers transition to other sectors in case the sector continues to decline in spite of efforts (medium to long-term policies). This would involve switching current ad hoc public expenditures targeted to the sector into medium-term commitments of decoupled farmer support and workforce transition/re-skilling support.

163. Regardless of the set of policy reforms to implement, in order to better support the sugarcane sector through the coming years of transition, the sector's institutional setup needs to be adjusted and reviewed. Specialized public agencies focused on the sugarcane sector have not been able to provide appropriate and timely policy guidance and implementation support. Institutions supporting the sugarcane sector should focus on: (i) helping the value chain use market-based risk financing instruments (rather than relying on public expenditures and SIFB); (ii) assessing the role and support of the sugarcane sector in relation to other land uses, agriculture and energy sector objectives; and (iii) devolving functions that can be undertaken by private sector actors.

164. Finally, in order to make informed policy decisions regarding the development of the sugarcane sector, there needs to be an immediate in-depth assessment of: (i) the national and global socio-environmental impacts of the sector; and (ii) the agriculture and energy alternatives to sugarcane production. The limitations of the competitiveness analysis and vision exercise undertaken, as well as the existing literature on the sugarcane, agriculture and energy sectors of Mauritius, make policy decisions difficult in terms of options to transition away from sugarcane to other areas of agriculture or alternative economic enterprises or to further support the sector given its known (unquantifiable) externalities. The country should also think whether sugar is a commodity that they would like to continue focusing on, given its global health implications. The Government has already moved to impose a tax on sugary drinks and products starting in 2021, which bodes well for the health of the local population, and for tax revenue (which could be used to support the transition of the sugarcane sector). Further taxpayer and/or consumer support to sugarcane production may or may not be warranted depending on the estimated impact of the sector on the environment, other economic sectors, jobs, and human health. This assessment should be neither costly nor time consuming, but is important to complement the analysis undertaken so far. If the public sector is to use taxpayer resources to bridge the financial losses of the sector, the amount of resources deployed would need to be approximately Rs 1.5 to Rs2 billion, which is about a 70% increase in public expenditures in relation to 2018 figures. Furthermore, Figure 21 shows that increases in public expenditures is not the top request from stakeholders in terms of Government interventions (faire remuneration of bagasse, sector coordination and labor reform are more important that increasing the level of public expenditures to the sector.

3.1 Next steps

165. The Government of Mauritius faces a unique challenge and opportunity in helping the sugarcane sector transition to a competitive position. The competitiveness analysis shows two scenarios under which the sector could become competitive without government support: (i) maintaining the current sector size but introducing significant policy reforms and sector-level changes; or (ii) downsizing the size of the sector focusing mainly on specialty sugars. The decision between the options for the future of the sector depend, in part, on the willingness and capacity of the government to further support the sector through taxpayer resources. If no taxpayer support is envisioned going forward, sector downsizing should be considered as the preferable option. However, if taxpayer support is considered, a series of no-regret policy actions could be immediately implemented to give the sector a chance to halt its decline. An initial roadmaps for such key, no-regret policy action (increase in the remuneration from bagasse, in farm technology, and in the share of specialty sugars sold; and decrease in the sugar export logistic costs) are outlined in Annex 3.

166. Mauritius has an opportunity to take advantage of the current COVID-19 crisis and reduce its high dependence on the global economy for its sugarcane, food imports, and tourism revenues, further promoting the generation of energy from local renewable sources and of local food production. Promoting sugarcane production towards energy rather than sugar and promoting agriculture towards food products would reduce the pressure on the balance of payments and reduce the impact of future disruptions in international markets under the highly uncertain scenario the world is facing in coming years. Countries that are well integrated in global financial markets, and reliant on external food markets[44] and energy markets are expected to bear the brunt of economic shocks, unless comprehensive and timely measures are put in place to minimize socio-economic disruption (for example, during the 2008 food crisis, Mauritius struggled to meet domestic food demand). Abandoned sugarcane lands can present an opportunity for the country to help avoid a food crisis and continue to power the country on a more sustainable footing. Yet, the appetite for reform might also be curtailed by the economic crisis triggered by COVID 19, uncertainties about tourism recovery, and the implications for further public support given the reduced fiscal space, as IMF projections suggest that the economy could contract by 12% by the end of the year.

[44] According to GIEWS, the monthly food inflation rate in Mauritius increased sharply between January and April 2020, driven by the marked depreciation of the Mauritian Rupee, as did the price of locally produced vegetables, following a drop in production in 2019.

4. Bibliography

1. AFDB. African Development Bank. (2012). Swaziland—Lower Usuthu Smallholder Irrigation Project (LUSIP)—Project Completion Report (PCR). https://www.afdb.org/en/documents/document/swaziland-lower-usuthu-smallholderirrigation-project lusip-project-completion-report-pcr-26051

2. ASR BSI. (2018). BSI Launches Pre-harvest Field Cane Quality Program with Funding from the Hershey Company. http://www.sugarindustryofbelize.com/new-blog-2/2018/7/23/bsilaunches-prey harvest-field-cane-quality-program-with-funding-from-the-hersheycompany

3. BDO & Co. (2010). Final Review on the Mid Term Review (MTR) of the Multi-Annual Adaptation Strategy (MAAS).

4. Business Mauritius. (2019). *Business Mauritius Working Group on Biomass Energy Potential: A roadmap to 2025.* BM-Biomass Working Group. Port-Louis.

5. Collaborative Africa Budget Reform Initiative (CABRI). (2019). *The sugarcane value chain in Mauritius*. African Development Bank. Retrieved from https://www.cabri-sbo.org/uploads/files/Documents/CS-Mauritius-Sugar-cane-ENG.pdf

6. Davis, H. & Piggott, J. (2015). Submission on Agriculture to the Guyana Sugar Corporation Commission of Inquiry.http://agriculture.gov.gy/wpcontent/uploads/2016/01/COI-Field Report.pdf

7. Dlamini M. M. & Worth, S. (2019). Readiness of the Swaziland sugar industry towards the use of information and communication technology: perceptions of smallholder sugarcane farmers and extension officers. *South African Journal of Agricultural Extension*, n.3, 99. http://dx.doi.org/10.17159/2413

8. Eswatini Sugar Association (ESA). Annual Reports and Financials. http://www.esa.co.sz/annual-reports/

9. Ethco. (2020). Fuel Ethanol. https://www.ethanolmw.com/index.php/products/fuel-ethanol-99-5alcohol strength

10. Food and Agriculture Organization of the United Nations. (2017). 2014 *Census of Agriculture*. FAO-UN. Rome.

11. FSC— Fiji Sugar Corporation. Annual Reports. https://d586e4fd-75a4-4863-b488 df5d313b6679.filesusr.com/ugd/660c5d_5e700a6533c146afb8f382b82b5f224d.pdf

12. *Guyana Chronicles.* (2019, August 26). GuySuCo pushing "Sugar Tourism". http://guyanachronicle.com/v3/2019/08/26/guysuco-pushing-sugar-tourism/

13. Guyana Sugar Corporation. Annual Reports. https://guysuco.gy/index.php?option=com_k2&view=itemlist&layout=category&task=ctegory&id=48&Itemid=262&lang=en

14. HRDC. (2017). *Skills Studies Agriculture*. Ministry of Education and Human Resources. Port-Louis.

15. ISO- International Sugar Organisation. (2015). Organic, Fairtrade and Specialty Sugars, Mecas(15)18. https://www.isosugar.org/publications/6/iso-studies

16. ISO- International Sugar Organisation. (2014). Outlook for Cogeneration in Cane Sugar Industries, Mecas(14)17. https://www. isosugar. org/publications/6/iso-studies

17. ISO- International Sugar Organisation. (2018). Profiling the African Sugar Market and Future Trade Landscape, Mecas(18)08. https://www.isosugar.org/publications/6/iso-studies

18. ISO- International Sugar Organisation. (2019). Survey of Cane and Beet Payment System, Mecas(19)08. https://www.isosugar.org/publications/6/iso-studies

19. IUF Sugar Workers. (2012). Trade Agreements in the Sugar Industries of East and Southern Africa. Retreived from http://www.iuf.org/sugarworkers/wp-content/uploads/2012/07/Trade-Agreements.pdf

20. Joint Technical Committee (JTC) Report on Sugar. (2018). Ministry of Agroindustry and Food Security.

21. Knox, J., Díaz, J. R., Nixon, D. & Mkhwanazi, M. (2010). A preliminary assessment of climate change Impacts on sugarcane in Swaziland. *Agricultural Systems, 103* (2), 63–72. doi:10.1016/j.agsy.2009.09.002

22. LMC International. (2015). *The Economic, Social and Environmental Impact on Mauritius of Abolition of Internal Quotas of Sugar in EU Market.* Ministry of Agro Industry and Food Security. Port-Louis.

23. LMC CARDNO. (2016). Study on Current Forecast Market Developments for ACP Sugar Suppliers to the EU Market. http://www.acp.int/content/acp-sugar-producingcountrieswelcome-new-studycurrent-and forecast-market-developments-acp

24. LMC International. (2017). Implementing a Regional Sugar Market in CARICOM—an Economic Impact Assessment.

25. MAFAP- Monitoring African Food and Agricultural Policies. (2013). Analysis of incentives and Disincentives For Sugar Cane in Mozambique. **www.fao.org/mafap**

26. Market Research Future. (2018). Organic Sugar Market Research Report by Size, Share, Growth, Trend, Industry Analysis, Key Players Review and Forecast 2018–2022. *AB News Wire.* https://www.marketresearchfuture.com/reports/organic-sugar-market-4252

27. Masuku, M. B. (2011). Determinants of Sugarcane Profitability: The Case of Smallholder Cane Growers in Swaziland. *Asian Journal of Agricultural Sciences*, 3(3), 210–214.

28. Mauritius Sugarcane Industry Research Institute (MSIRI). (2019). *Contributions of R&D to the Sustainability of the Sugar Cane Industry in Mauritius.* Mauritius Cane Industry Authority. Port-Louis.

29. MCIA. (2019). *Factory Closure of the Medine Sugar Milling Co. Ltd. as from End of Crop 2018.* Mauritius Cane Industry Association.

30. MOAI (2017). *Protected Area Network Expansion Strategy 2017–2026.* Ministry of Agroindustry and Food Security, Government of Mauritius, May 2017.

MSIRI. (2007).Good management practices to improve the productivity, competitiveness and sustainability of the Mauritian Sugar Cane Industry. Réduit: Mauritius Sugar Industry Research Institute.15 p.

31. Nodalis Conseil. (2019). Bioelectricity Strategy in Mauritius Second phase.

32. Po, P. L. H. (2018). *The King Sugar is Dead, Long Live the Sugar Cane Industry.* Sugar Industry Staff Employees' Association (SISEA). Port-Louis.

33. Ramjeawon, T. (2004). *Life cycle of cane sugar on the Island of Mauritius.* The International Journal of Life Cycle Assessment. Volume 9, 254–260. July 2004.

34. Ramphull, M. & Surroop, D. (2017). Greenhouse gas emission factor for the energy sector in Mauritius. Journal of Environmental Chemical Engineering, 5(6), 5994–6000. https://doi.org/10.1016/j.jece.2017.11.027

35. Reece, L. (2018). Farmers now have access to various information on farming through PacFarmer mobile app. Fiji Village. https://www.fijivillage.com/news/Farmers-now-have-access-to-various-information-on-farming-through-PacFarmer-mobile-App-kr9s52

36. Roseboom, J. (2007). Mobilizing innovation: Sugar Protocol countries adapting to new markets realities. *Innovation Policy Consultancy.*

https://www.researchgate.net/publication/240633955_Mobilizing_innovation_Sugar_Protocol_countries_adapting_to_ new_market_realities1

37. S&D Sucden. (2019). *Sucden Sugar Market Report.*

38. Sikuka, W.; Geller, L. (2018). Zimbabwe Sugar Annual. *USDA Foreign Agriculture Service.* https://apps.fas.usda.gov/newgainapi/api/report/downloadreportbyfilename?filname=Sugar%20Annual_Pretoria_Zimbabwe_4-18-2018.pdf

39. Singh, S. (2019, December 14). Vodafone Fiji in collaboration with Sugarcane Growers Fund And Vinod Patel introduces new initiative using M-paisa system. *Fiji Village.* https://fijivillage.com/news/Vodafone-Fiji-in-collaboration-withSugarcane-Growers-Fund-and-Vinod-Patel-introduces-new-initiative-using-Mpaisa-system-kr925s/

40. SIRDI—Sugar Industry Research & Development Institute. (2016). *Strategic Development Plan* http://www.sirdi.bz/2521

41. SIRDI— Sugar Industry Research & Development Institute. (2018). Fifth Cohort of 234 farmers complete Farmer Field School. http://www.sirdi.bz/3280

42. SIRDI— Sugar Industry Research & Development Institute. (2019. Sirdi Farmer Field School Program—Training Methodology in better practices for sugarcane production. http://www.sirdi.bz/3287

43. SIRDI— Sugar Industry Research & Development Institute. (2020). Creating a sustainable sugarcane Industry in Northern Belize. http://www.sirdi.bz/projects/creatingsustainable-sugarcane-industrynorthern-Belize

44. SRIF- Sugar Research Institute of Fiji. (2014). Strategic Action Plan 2014–2020. https://srif.net.fj/resources/

45. Surroop, D. & Raghoo, P. (2017). Energy landscape in Mauritius. *Renewable and Sustainable Energy Reviews*, 73 (November 2016), 688–694. https://doi.org/10.1016/j.rser.2017.01.175

46. SWIO-RAFI. (2017). *South-West Indian Ocean Risk Assessment and Financing Initiative.* The International Bank for Reconstruction and Development/The World Bank. Washington, DC.

47. SWIO-RAFI. (2016). *Disaster Risk Profile for Mauritius.* The International Bank for Reconstruction and Development/The World Bank. Washington, DC.

48. Thomas, C. (2015). Submission to the Guyana Sugar Corporation Commission of Inquiry. http://agriculture.gov.gy/wp-content/uploads/2016/01/Guysuco-Report.pdf

49. Tongaat Hulett. (2016). Zimbabwe Overview. https://www.washingtoninformer.com/drone-on-the-farm-as-rainfall-becomes-scarce-farmers-irrigate-crops-via-unmanned-aerial-vehicles/

50. *The Washington Informer.* (2020, July 13). Drone on the Farm: As Rainfall Becomes Scarce, Farmers Irrigate Crops Via Unmanned Aerial Vehicles. https://www.washingtoninformer.com/drone-on-the-farm-as-rainfall-becomes-scarce-farmers-irrigate-crops-via-unmanned-aerial-vehicles/

51. Wolf, F., Surroop, D., Singh, A., & Leal, W. (2016). Energy access and security strategies in Small Island Developing States. *Energy Policy*, 98, 663–673. https://doi.org/10.1016/j.enpol.2016.04.020

5. Annexes

1. Competitiveness Tools User Guide

2. Sugarcane Sector Map (material and financial flows)

3. Simulation parameters and assumptions

4. Experience with the Multi-Annual Adaptation Strategy (MAAS) 2006–2015 (from LMC, 2015)

5. Result of International Benchmarking Exercise

6. Detailed Farm-Level Analysis - See Report at: https://drive.google.com/file/d/1ysde_v0csh7qMtbFj2_7m0aUfdtr4yKX/view?usp=sharing

Annex 1. Competitiveness Tools User Guide [45]

SECTOR LEVEL COMPETITIVENESS TOOL

Structure of the model

1. **The sector level competitiveness model consists of one Excel workbook with 12 interlinked worksheets.** The first five sheets lay out costs for the sugarcane sector, as reported by the actors detailed in Table 9. Tab 1, Planters_costs, is derived from the farm-level model and calculates costs per ton of cane as a function of total cane production and the 16 farm variations. Tabs 2 and 3, Milling_costs and Refining_costs, aggregate total costs reported by milling and refining companies—including labor and other operational expenses, as well as finance, depreciation, and amortization costs. Tab 4, IPP_costs, calculates the total cost of producing electricity from bagasse, based on the weighted average cost of generating 1 one kWh, as reported by the IPPs. Likewise, tab 5 breaks down the sector's commercial costs into export, institutional, and other operating expenses.

2. **The following five sheets produce simulations, revenue calculations, and bottom line assessments for the sugarcane sector based on industry-reported figures.** Tab 6 models the opportunity cost of producing electricity from bagasse instead of from coal and HFO, considering the additional import and production costs that the sector would incur were bagasse not available. Tab 7 summarizes all current costs for the industry, as listed in tabs 1 through 5, while tab 8 calculates sector revenues based on reported sales of sugar, molasses, and bagasse in per ton and monetary values. Tab 9 summarizes all costs and revenues for the industry, painting an overall picture of net losses/profits, and tab 10 suggests a list of variables— –and respective value ranges—that could be adjusted throughout the workbook to model for different scenarios.

3. **The two remaining sheets dive deeper into sub-sector financial and material flows.** Tabs 11 and 12 offer an overall picture of how the resources are distributed along the value chain in terms of costs and revenues. Tab 11, in particular, draws from industry-reported production levels, prices, and premiums, and the estimated exchange rate, to detail financial flows by product and production stage. Finally, table 12 summarizes production levels for the 2018-19-crop year for the main products in the sector: total raw sugar, specialty sugar, refined sugar, bagasse, molasses, and by-products.

4. **Key cells in the worksheets have been shaded in different colors to indicate the types of data required**. To carry specific simulations, users should focus on green cells, following the values suggested in the simulations tab. Yellow cells indicate values dictated by world indicators, such as the international price of sugar or the exchange rate, and should therefore be adjusted carefully. Similarly, pink cells mostly link back to green cells and should not be adjusted directly —–for the downstream results will update, but the link to the original

[45] The competitiveness tool and video tutorials can be accessed using this link to the MCIA – World Bank web page https://mcia.mu/world-bank/

crosscutting assumption will be broken. Thus, it is better to change the data in a green cell directly. Finally, graygrey cells are formulas that should largely be left untouched unless the user has a specific need for something else.

Color	Action
	Adjust to simulate new outcomes (at your discretion)
	Adjust carefully, based on world data
	Only change in planters_costs sheet
	Generally do not touch (let the formulas work unless you have a specific need for something else)

Color	Action
	Adjust to simulate new outcomes (at your discretion)
	Adjust carefully, based on world data
	Only change in planters_costs sheet
	Generally do not touch (let the formulas work unless you have a specific need for something else)

Uses and limitations

5. **This tool allows you to make changes to the cost structure of the sector under different production scenarios.** For example, users can adjust the share of cane harvested by small producers to capture the effect of farming variations on the overall industry outlook. Likewise, by changing costs data, users can interpret how labor cost reductions or productivity improvements impact the overall viability of the industry at the milling, refining, and energy generation stages. Finally, the tool also allows users to make changes to the commercial end of the chain, adjusting export, storage, freight, and other operating and administrative expenses at their discretion.

6. **The model also responds to changes on the revenue side, particularly as it pertains to production levels.** Users can input different production and pricing levels to model under which conditions the industry becomes most competitive —–such as adjusting the share of specialty sugars in total sugar sales or inputting a price per kWh that values the opportunity cost of production electricity from bagasse instead of fossil fuels. Across the

board, changing the level of cane production has a significant impact on both industry revenues and costs. Moreover, the tool includes blank cells to add the production and pricing of ethanol, potable alcohol, and animal feed from molasses, as that information becomes readily available to the user.

7. **The main purpose of this tool is modeling how cost and revenue changes impact the sector's overall competitiveness.** The user can achieve this by adjusting the inputs in each individual tab— –following the suggestions from the simulations tab or their own intuition—and circling back to the profits tab, which summarizes total cost values for each subsector and aggregates all sugar, bagasse, and molasses sales. The costs, revenues, and profits tabs all include graphs linked to the data that can be interpreted as graphical representations of the viability of the industry under specific conditions.

8. **As with the farm- level model, however, users should be clear about their objectives and the limitations of the model.** While the model allows changing sector level costs at the user's discretion, for example, these figures are sticky and difficult to adjust in reality. Likewise, hypothetical changes to the level of cane production will not automatically adjust the industry's processing capacity, and neither will regulatory changes accompany some of the labor cost changes that the model allows to introduce. Overall, it is important for users to decide their objectives early on and be up front about the limitations of this tool in any modeling scenario.

FARM- LEVEL COMPETITIVENESS TOOL

Structure of the model

9. **The Excel model consists of a set of 17 interlinked workbooks each with multiple pages**. There is a single "assumptions workbook" for recording crosscutting assumptions and 16 "analytical books" for each farm variation included in the base model. The base model consists of a per hectare crop budget and various summary pages with different indicators calculated from the budget. There is space to enter different costs and revenues for each year in the ratoon cycle up to the tenth ratoon. A final set of indicators from each analytical book are the copied back as links from the analytical books to the assumptions book. Various summary tables and charts are produced from these indicators on additional pages in the assumptions book.

10. **New variations can be produced. Crosscutting assumptions are easy to change in the assumptions book.** Where these assumptions are linked to the analytical book, the new assumptions will flow through to the analytical books, which in turn will update the indicators and send the new results back to the main summary page and summary tables. New crop budget variations can also be constructed by saving a copy of an existing analytical book under a new name and making changes to the crop budget page.

11. **To help users navigate the tool and know what kinds of data to enter where, a color-coding convention has been used.** In the assumptions book, tab names are color coded as follows.

- Driving assumptions (to analytical books)
- Indicator summary (from analytical books)
- PC costs and gross revenues
- Costs per ton
- Annual profit/loss
- BTPF Scenarios and Net Present Values
- Sensitivity analysis (some ideas/templates to get you started)

- Driving assumptions (to analytical books)
- Indicator summary (from analytical books)
- PC costs and gross revenues
- Costs per ton
- Annual profit/loss
- BTPF Scenarios and Net Present Values
- Sensitivity analysis (some ideas/templates to get you started)

12. **Key cells in the assumptions book and analytical books have also been shaded in different colors to indicate the types of data required.** The green cells (monetary values in rupees) and blue cells (other numeric data) are the main ones that users should change. Turquoise cells mostly link back to the green and blue cells. If a user changes the value directly in a turquoise cell, the downstream results will still update, but the link to the original crosscutting assumption will be broken. Thus, it is better to change the data in a green or blue cell so the links stay intact.

- Drop down menu (options in hidden page of each analytical workbook named "Lists")
- Monetary value (Rs)
- Other numeric value (not currency)
- Text (unit description, or other notations)
- Linked data (numbers entered/calculated someplace else, usually in the assumptions book)
- Generally do not touch (let the formulas work unless you have a specific need for something else)
- Highlighted cell to draw help find/draw attention to certain data (eg. NPV and IRR results)

	Drop down menu (options in hidden page of each analytical workbook named "Lists")
	Monetary value (Rs)
	Other numeric value (not currency)
	Text (unit description, or other notations)
	Linked data (numbers entered/calculated someplace else, usually in the assumptions book)
	Generally do not touch (let the formulas work unless you have a specific need for something else)
	Highlighted cell to draw help find/draw attention to certain data (eg. NPV and IRR results)

Driving assumptions

13. **The first several pages of the assumptions book are for driving assumptions. These allow users to change common price and yield assumption from one location.** There are pages with specific cells for users to enter the following data according to the color-coding conventions described above. In making price assumptions, standard practice in analyzing multi-year enterprises is to assume that inflation affects all prices equally so is best to work only in current terms. Similarly, for yield assumptions it is best to assume "normal" growing conditions for every year.

(i) **Output price and conversion assumptions.** For each year in the ratoon cycle, users enter payments for different sugarcane products (sugar, bagasse, molasses) and supplements. The planter's share of the final ex-syndicate price (i.e., the accrued share) is also entered on this page. Conversion factors for bagasse and molasses from cane are also entered here.

(ii) **Inputs and cane harvesting**. Certain crosscutting input prices (e.g., cost of cane sets, clearing costs, and land rent for small planters) and cane harvesting assumptions are entered on this page. Other input price assumptions are entered in each analytical book. As users work with the tool, additional crosscutting price assumptions could be entered on this with new links created to the analytical books.

(iii) **Labor adjustments.** This page allows users to adjust the labor costs by applying different percent reductions. The blue cell (C6) can be used to apply one standard adjustment factor to all categories of labor. The gray cells can be used to fine-tune the adjustments for different categories of labor.

(iv) **Yield assumptions.** There is detailed template for working out yield assumptions by age of cane for corporate estates and small planters based on different assumptions about the incremental benefits of irrigation and variety improvement. Users may follow this methodology to make modifications or enter their own year-by-year assumption directly in the spaces provided for each type of production system (see snip below). The assumptions for each variation (e.g., corporate, rainfed, established variety) are linked to the analytical book for that farm system. If a user wishes to model a new type of farm system, additional rows could be entered on this page.

IMPORTANT If ever inserting or deleting a row or column from any spreadsheet page or otherwise moving key cells around, be sure to have all books open so that the cell references update automatically. Failure to do this will cause the links in any closed books to malfunction!

(v)

CORPORATE ESTATES (TCH)

3-yr moving average for estate sector is about 80 TCH (SIS data). For base model (established variety, rainfed) assumed slightly lower average (74.3 TCH) from PC to R7.
Assumptions to calculate change in annual yield and benefits of irrigation and variety improvement are shown below.
These are base yields for manual production. With mechanization, the assumed increment shown above is added.

	PC	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	Avg (PC-R7)	Avg (PC-R10)
Rainfed													
Established variety	**94.0**	82.3	76.1	71.5	68.7	65.9	62.6	59.2	54.7	48.7	41.9	72.5	66.0
Improved variety	103.4	90.5	83.7	78.7	75.5	72.5	68.9	65.1	60.2	53.6	46.1	79.8	73.9
Irrigated													
Established variety	126.9	111.0	102.7	96.5	92.7	89.0	84.5	79.9	73.9	65.8	56.6	97.9	89.0
Improved variety	139.6	122.1	113.0	106.2	102.0	97.9	93.0	87.9	81.3	72.3	62.2	107.7	97.9

PLANTERS (TCH)

3-yr moving average for planters is about 65 TCH (SIS data). For base model (established variety, rainfed) assumed slightly lower average (62.1 TCH) from PC to R7.
Assumptions to calculate change in annual yield and benefits of irrigation and variety improvement are shown below.
These are base yields for manual production. With mechanization, the assumed increment shown above is added.

	PC	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	Avg (PC-R7)	Avg (PC-R10)
Rainfed													
Established variety	**75.0**	65.6	60.7	57.1	54.8	52.6	50.0	47.2	43.7	38.9	33.4	57.9	52.63
Improved variety	82.5	72.2	66.8	62.8	60.3	57.8	55.0	51.9	48.0	42.8	36.8	63.7	58.9
Irrigated													
Established variety	101.3	88.6	81.9	77.0	74.0	71.0	67.4	63.7	59.0	52.5	45.1	78.1	71.0
Improved variety	111.4	97.5	90.1	84.7	81.3	78.1	74.2	70.1	64.8	57.7	49.6	85.9	78.1

(vi) **BTPF worksheet.** Driving assumptions on the pricing of bagasse are entered here. There is a cell to enter the base reference price and further cells to change the allocation of bagasse proceeds between Category A and Category B planters and IPPs (see snip below). If one wishes to model elimination of bagasse payments to IPPs, set the percentage for IPPs to zero; or if one wishes to model an equal sharing of bagasse proceeds between Category A and Category B, make the percentages equal. Further parts of the BTPF worksheet use these assumptions to calculate the planter's payment in per tons accrued sugar terms. Three are templates for three scenarios on the BTPF page. The scenario named "current situation" drives the main set of indicators (i.e., the base analysis); indicators for Scenario 1 and Scenario 2 are treated as sensitivity results separate from the base analysis.

1. BTPF pricing and dertermination of total BTPF proceeds

Rs per ton bagasse used for export power = 100 Price paid by CEB into BTPF

Current base price = ***100. Proposed alt prices:*** *Coal =* ***1,165****; HFO =* ***1,582****; HFO + 15% GP =* ***1,819****.*

2. Allocation of BTPF total proceeds

IPP	50%	allocated per kWh exported
CAT-A (miller/planter)	12%	allocated on accrued sugar
CAT-B (planter)	38%	allocated on accrued sugar
Total BTPF (must = 100)	**100%**	

(vi) **kWh value of bagasse**. Part of the model calculates the kWh and value of electricity produced per hectare based on yield of bagasse. Assumptions for this part of the model are entered here.

(vii) **Capital recovery.** This page is for recording assumptions on the fixed sets of equipment used by different farm systems with a useful life spread over more than one year. Based on assumptions the replacement value, years of useful life, per ha share of use, the template calculates the annual per hectare capital recovery cost for that set of equipment. The resulting total capital recovery cost for each set of equipment is then linked to the analytical book and included as a per ha cost as appropriate.

(viii) **Derocking.** Heavy derocking also has a useful life over more than one planting cycle and is treated as a capital recovery cost. Light derocking is treated as a recurrent cost in the plant cane year. Assumptions for these costs are entered on this page.

The Analytical Books

14. **The driving assumptions described so far are sent by links to the 16 analytical books.** Each analytical book consists of four pages. The first page describes the farm variation and consists of a per hectare crop budget. This the main page users will work with. The next two pages summarize annual costs and revenues in various ways. The final page is list of key indicators that are fed back to the assumptions book using links.

IMPORTANT *Unless with very good and deliberate reason, users should not change the formulas on any of the summary pages. Other parts of the tool look to these pages for results and changing the formulas by accident could result is serious error that is difficult to trace and correct. If a user wishes to add new calculations or levels of summary, it would be best to create a new page or use blank space below the existing formulas.*

15. **The farm model page.** This is the main analytical page that users will work with. It includes the per hectare crop budget and consists of several parts for entering different costs and other information as follows.

(i) Part 1 (rows 5–18): Qualitative description. The first part is a qualitative description of the farm budget. This part includes several drop-down menus (indicated by the yellow shading) that allow users to describe the variation being modeled. There a turquoise cell for yield adjustment that is linked to a driving assumption on the impact of mechanization.

HINT: Menu lists in the yellow cells are on a hidden page. If a user wishes to change the menu options, right-click on the list of tabs, and select unhide. Alternatively, users may turn off data validation for that cell (Data→ Data Tools→Data Validation) and type any value they wish.

(ii) **Part 2 (rows 19–68): Calculation of per hectare gross revenues.** The second part of the farm model page consists of formulas that calculate per hectare gross revenues from price and yield assumptions entered in the assumptions book. As indicated by the turquoise shading, these assumptions are drawn from the assumptions book and arrive in the analytical book using links. If creating a new variation, users may need to update these links so that they point at the correct location in the assumptions book.

(iii) **Part 3 (rows 69–119): Summary of per hectare variable and total costs.** This part summarizes variable and total costs entered in Part 6 (see below).

(iv) **Part 4 (rows 120–143): Calculation of gross and net profits, current system.** This part calculates gross and net profits. In this section, bagasse is valued using data from the "current situation" part of the BTPF worksheet as described above. NPV and IRR calculations are also carried out here.

HINT: To calculate the price that will give NPV = 0 as shown in Table , use this section to run a "what-if analysis" (Data→Forecast→what-if analysis). You will tell Excel to set each the NPV results in rows 139 to 143 equal to zero by changing ex-syndicate price in the assumptions book (i.e., cell F13 on the price and conv assumptions page). After you run the analysis, the "target price" to give NPV = 0 will appear in the orange shaded cell (I130) just above the NPV calculations on farm model page. Record that price and continue with the analysis, either by asking Excel to run another what-if scenario or by restoring the ex-syndicate price to the original value in the assumptions book. Other such tests can be imagined, such as changes in yield or even changes in labor costs.

(v) **Part 5 (rows 144–191): Calculation of potential payments based on alternative pricing of bagasse.** This part draws on the Scenario 1 and Scenario 2 assumptions from the BTPF page to calculate alternative revenues for each set of conditions. Space is provided in hidden rows below this section to develop further alternative calculations for molasses/ethanol or other products. NPV and IRR calculations for the alternative scenarios are carried out here.

(vi) **Part 6 (rows 192–282): Specification of variable costs.** This part is used to enter unit prices and quantities of each item used by year. There are separate sections for materials, mechanical operations excluding harvest, labor excluding harvest, irrigation, mechanical harvesting, manual harvesting, and cane transport. Harvesting and transport costs are driven by per ton cost assumptions and quantities are given by the assumed tons of cane per hectare. Cells where unit prices that are drawn from the assumptions book are indicated in turquoise; there are also turquoise cells for labor adjustment. It is important to group costs according to these categories so that charts and tables for the structure of cost update correctly.

(vii) Part 7 (rows 283–307): Specification of fixed costs. This part is used to enter fixed overhead and capital recovery cost assumptions. Per hectare capital recovery costs are derived in the assumptions book. The values in turquoise are the ones derived for different sets of equipment as part of the base analysis. Change the quantities according to the correct set of equipment for the system being modeled.

(viii) Part 8 (rows 308 to the end): Calculation of per hectare variable costs. This is mechanical part of the worksheet and is not for data entry. It multiplies the unit prices and annual quantities entered in parts 6 and 7 to work out the annual cost of each item in currency terms.

NOTE: An early version of the model posted by MCIA had mislabeled parts 7 and 8 as "Part 6." This was a presentational error only with no impact on the calculations. The mistake has since been changed.

16. **The last page of each analytical book is a list of key indicators.** The indicators in Col F are pasted as links to the "Indicator Summary" page in the assumptions book. Provided the assumptions book and analytical books are open, any change to a driving assumption or detailed cost assumption will impact the indicators and be updated automatically in both places. If a user wishes to create an additional farm variation, new links from the list of indicators to the indicator summary page in the analytical book should be created.

Summary tables and charts (assumptions book_)

17. **There are several pages in the assumptions book with links to the "indicator summary" page that are used to produce different tables and charts.** Where links exist, changes to a driving assumption or detailed cost assumption will cause the summary tables and charts to update according to the new values. To help users navigate their way through the pages, the pages are grouped by theme and tab color as described above.
Sensitivity Analysis

18. **Pages with a pink tab are designated for sensitivity analysis.** There is typically a row or set of rows and columns with "base data" from the original analysis adjacent to "live data" that update whenever a change is made to a driving assumption or detailed cost assumption. The base data have been pasted as values and do not change. Comparing the base values with the new live values from using a different assumption (or assumptions) can help to understand the impact that change would have on costs and/or profitability.

19. **When preparing a sensitivity test, it often good practice to change one parameter at a time.** This allows the impact of each specific change to be assessed. Tests

that involve changes to multiple parameters, of course, can also be prepared. Once each test is complete, values can be restored to the original base terms.

Creating New Farm-Level Variations

20. **Users may wish to change the base assumptions or develop completely new farm variations than covered by the current base analysis.** To do this, users can make a copy of closest available analytical book and save the file with a new name. Next is to change the model description in Part 1 on the farm model page (i.e., by working with the yellow drop-down menus to describe the new variation). New yield and input assumptions will then have to be entered. This can be done by directing the turquoise cells on the farm model page to look to a new location in the assumptions book and/or by entering new values in the new farm model page directly. It is advisable to take advantage of links and use the same price assumptions as all other books so the results across the variations are as comparable as possible and will update automatically when changes to driving assumptions are made. Once the new model is complete, copy the list of indicators on the last page of the new analytical book (i.e., all data in Col F) and paste these indicators as links in a new column on the "indicator summary" page of the assumptions book. New summary tables comparing the results for all systems are made from there.

21. **An alternative approach without saving additional books is to make a copy of the base model that you save to a new folder.** When the new model is saved this way, links within the new copy should stay self-contained (i.e., changes in one copy of the assumptions book will filter through to the analytical books saved in the same folder but not to the other set of books saved in a different folder). Before making dramatic changes that are difficult to undo, users should verify that the links are, in fact, self-contained and do not crossover to the other version of the model.

22. **This second approach can be especially useful for users that wish to model the effects of a shorter ratoon cycle.** It is easy to delete crop yields and costs in the out years but difficult to put these data back. By saving a separate copy of the model, large changes can be made without jeopardizing the original base assumptions. Other uses for this approach can be imagined. The current model is structured around variations for large corporate estates and small planters, but a separate copy of the model could be created to model any other set of 16 variations (i.e., corporate estates compared with medium size planters, or arid areas with high rainfall, etc.).

Some Final Advice

23. **When developing new variations users should be clear about their objectives and be upfront about the model limitations.** The tool can accommodate a great many detailed assumptions on prices, yield, and input variations. Additional variations and fine-tuning can lead to greater accuracy but may also make the data difficult to interpret, especially if differences between one variation and another are minor.

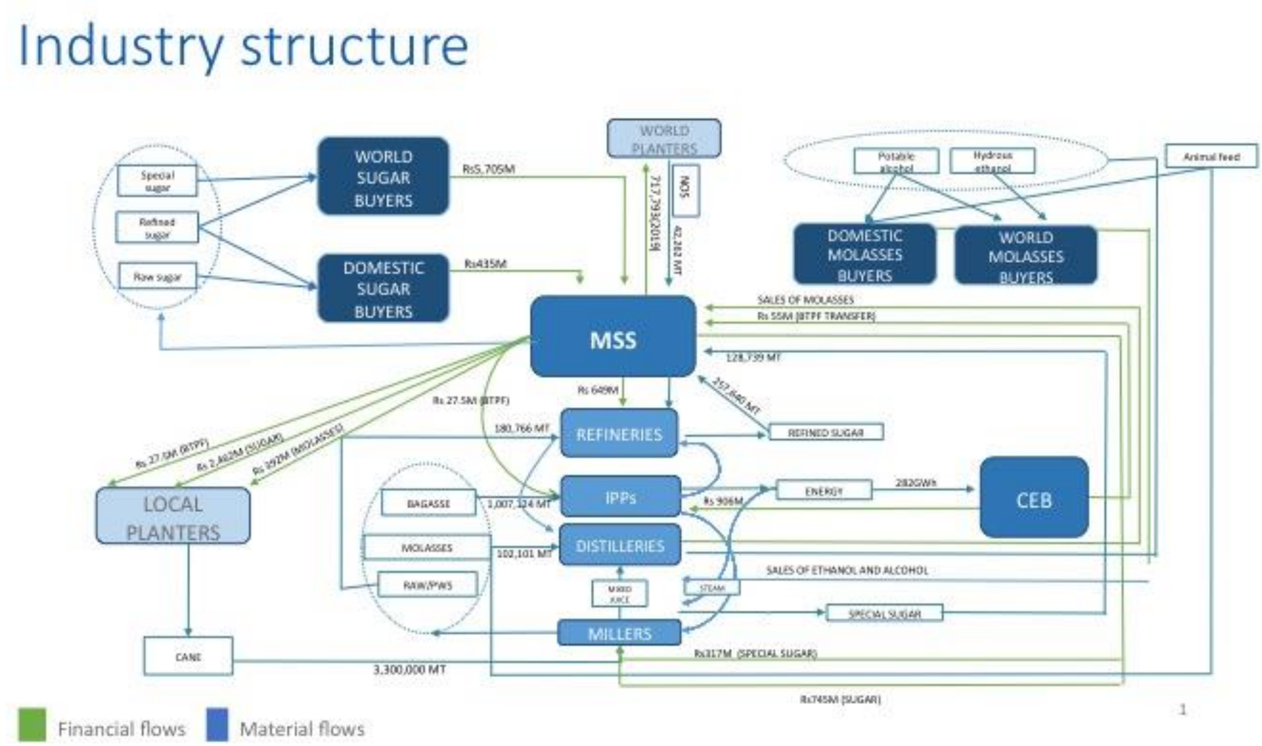
24. **Another possible use for the tool is to create new rows in the analytical book for annual cash flow calculations.** The approach for the current sector analysis was to analyze a broad spectrum of management possibilities. This helped to understand the major difference and tradeoffs production systems Mauritius currently faces. Other users may wish to use the tool for detailed investment planning. In this case new rows could be added to the analytical books fir annual cash flow indicators such as opening and closing balances, annual financing needs, interest payments, etc.

25. **In working with the tool, it is also important to recognize that some variables matter more than others.** The quality of data is important, yet some variables have only a minor impact on final outcomes and matter less to the financial indicators. Depending on the objectives, most users would do well to focus on big-picture tradeoffs than to strive for perfect accuracy as one does with business accounts.

26. **It is best to work with all books open.** This will ensure that links remain intact and that linked data update automatically in real time. "Paste special" can be used to paste cell values and links. If copying formulas with links from one book to another and you need the link to point to the new book, use "show formulas" in the data menu and copy the formulas as text to Notepad. You can then copy the formulas to the new book. Also, saving interlinked books to OneDrive may become problematic and is better to save all 17 books (or how many ever you create) to a local folder on your computer instead.

27. **Good luck and have fun exploring.** If you have questions, my email address is jkeyser@worldbank.org.

Annex 2. Sugarcane Sector Map (material and financial flows)



Annex 3. Simulation parameters and assumptions

	handlename	Current (2019)	Min	Max	Distribution	Comments / Assumptions
Share of low- tech farms (% of total production)	*sharelowtechfarms*	19%	2%	19%	skewed left	Assumed that low- tec ction (mainly by small pl se as a % of total going fo ntinue to decrease with they reach 2% of total p
Labor costs (% of labor costs)	*totallaborcostpct*	100%	40%	120%	normal	Assumed that industry-wide labor costs could further increase by 20%, but could be reduced by a max of 40% from current levels.
Tech change/Milling costs (%)	*milltechchange*	100%	80%	100%	skewed left	Assumed that costcosts will not increase, but could be reduced in terms of efficiencies of a max of 20%
Tech change/Refining costs (%)	*refinerytechchange*	100%	90%	100%	skewed right	Assumed that costcosts will not increase, but could be reduced in terms of efficiencies of a max of 2%
Tech change/IPP costs (%)	*IPPtechchange*	100%	80%	100%	normal	Assumed a max improvement in IPP electricity production efficiency of 20%
Export costs (operations MSS)	*MSSexportcost*	1,581,078,000	1,264,862,400	1,581,078,000	normal	Assumed that costs can decrease by 20% on gains in export/logistics efficiencies
Institutional costs MSS/MCIA (Rs)	*instcost*	132,945,000	106,356,000	132,945,000	normal	Assumed that costs can decrease by 20% depending on gains in institutional efficiencies

Price of electricity from bagasse paid to IPP (Rs/Kwh)	*bagasseprice*	2.70	2.38	4.87	skewed right	Assumed that the price can go up to Rs3.76 based on the price of coal (and up toupto 4.87 for HFO opsopps cost). Also assumed that the price can drop to 2.38 as per ongoing negotiations with CEB.
EU price of refined sugar (€/(EUR/ton)	*refinesugarprice*	392	353	470	normal	Assumed that price of refined sugar can drop by a max of 10% and increase by a max of 20% (in relation to 2019 prices).)
EU price of specialty sugar (€/(EUR/ton)	*specialsugarprice*	661	595	727	normal	Assumed that price of specialty sugar can drop by a max of 10% and increase by a max of 20% (in relation to 2019 prices).)
Share of specialty sugar sold (as % of total sugars)	*sharespecialsugar*	30%	30%	50%	skewed left	Assumed that the share will not decrease, but only increase in the future, up toupto a max of 40%
Price of molasses (Rs/MT)	*molassesprice*	3,840	3,500	5,000	normal	Assumed that price of molasses can drop by a max of 10% and increase by a max of 20% (in relation to 2019 prices).)
Exchange rate (Rs/USD)	*xrate*	40	36	48	normal	Appreciation of 10% and depreciation of 20%

Annex 4. Experience with the Multi-Annual Adaptation Strategy (MAAS) 2006–2015 (from LMC, 2015).

The MAAS had certain positive aspects:

1. Securing grants under the EU Accompanying Measures of approximately €250 million.
2. Access to concessionary finance for modernization programs under the ACP/EU Joint Council of Minister Decision of May 2006
3. 100% of exports are in value-added sugars (no raw sugar)
4. Closer relationship with export markets
5. A long-term partnership agreement (LTPA) that increased revenues for the country, allowing the transition away from raw sugar into specialty sugar for direct consumption.
6. Allowance of up to 15% of NOS in the value of sugar exports to the EU
7. Voluntary retirement program for 6800 employees
8. 50% cost reduction in supporting institutions
9. Fairtrade initiative launched
10. Liberalizing the domestic market for sugar
11. Improvements in cane quality (purity thresholds)

Some negative aspects:

12. No policy was put in place for the blending of ethanol and mogas
13. Cost of production was reduced, but labor costs remained high and continued to increase and to be rigid
14. Failed efforts to reach voluntary negotiated cane cultivation agreements between planters and the corporate sector
15. Many environmentally friendly measures were not implemented

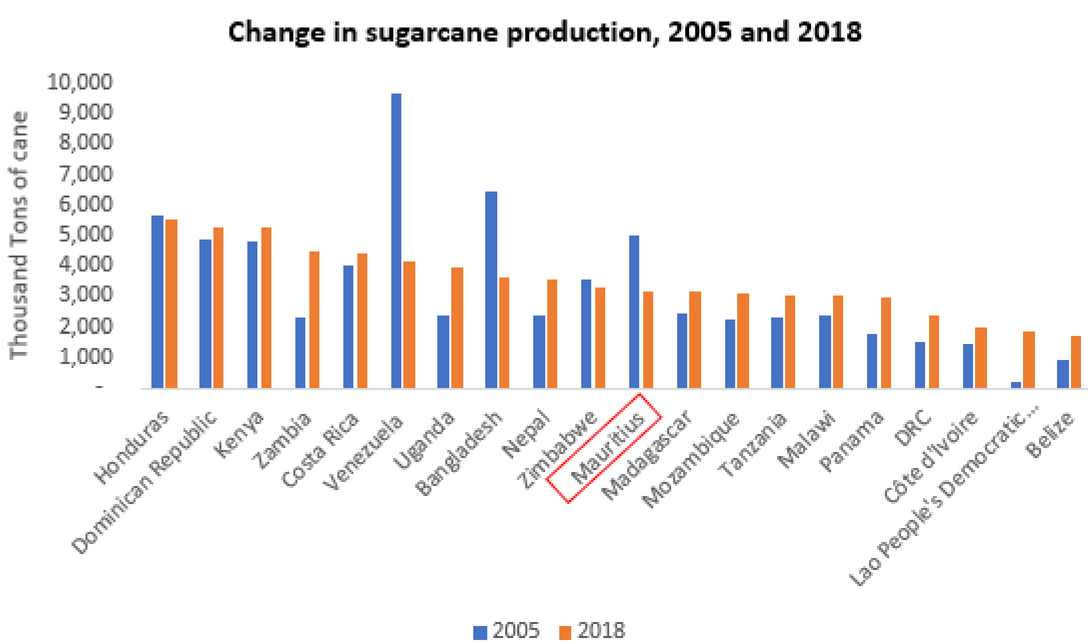
Annex 5. International benchmarking

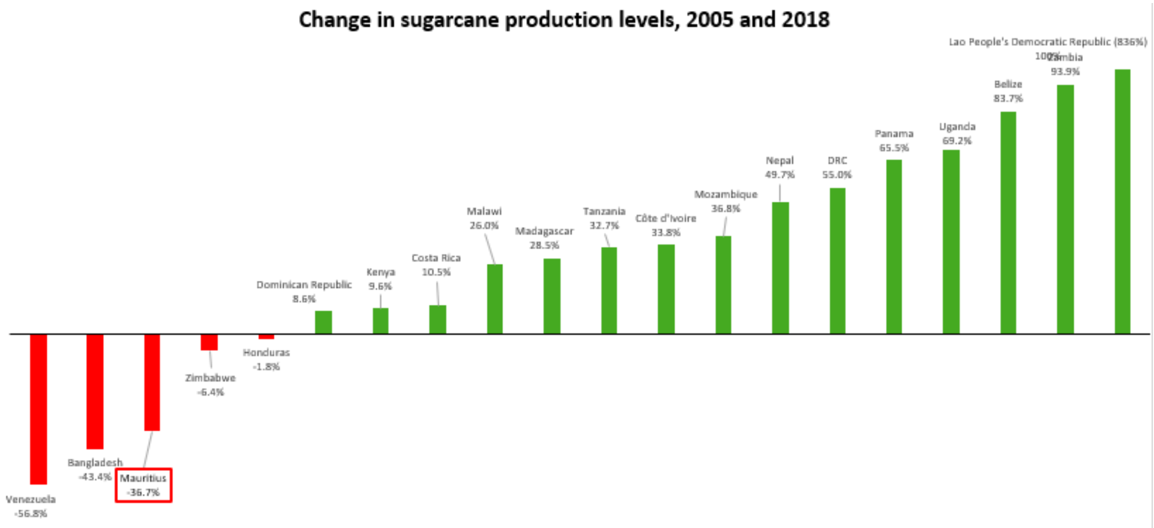
Sugarcane is the world's largest crop by production quantity, and sugar is produced in over 100 countries. Compared to India and Brazil—where sugar production stands around 37 million tons and 74 million tons respectively—Mauritius is obviously a small player. This analysis, therefore, considers countries with similarities to Mauritius in terms of geographic location, markets, and output levels. Since Mauritius ranks 39th in terms of 2018 sugar output, countries ranked 29th through 49th are considered—excluding EU producers. In that order, these are Honduras, Dominican Republic, Kenya, Zambia, Costa Rica, Venezuela, Uganda, Bangladesh, Nepal, Zimbabwe, Mauritius, Madagascar, Mozambique, Tanzania, Malawi, Panama, Democratic Republic of the Congo, Côte d'Ivoire, Laos, and Belize.

Output Levels

Most countries in the reference group experienced growing levels of cane production from 2005 to 2018 (see Figure1) despite the overall decline in the global sugar price. Zambia, for example, saw a 93.9% increase in output, while several East African countries also show a positive trajectory. Mauritius is one of the few countries with a significant decrease in production levels, along with Venezuela and Bangladesh—and to a lesser extent Zimbabwe and Honduras.

Figure 1: Change in sugarcane production levels from 2005 to 2018



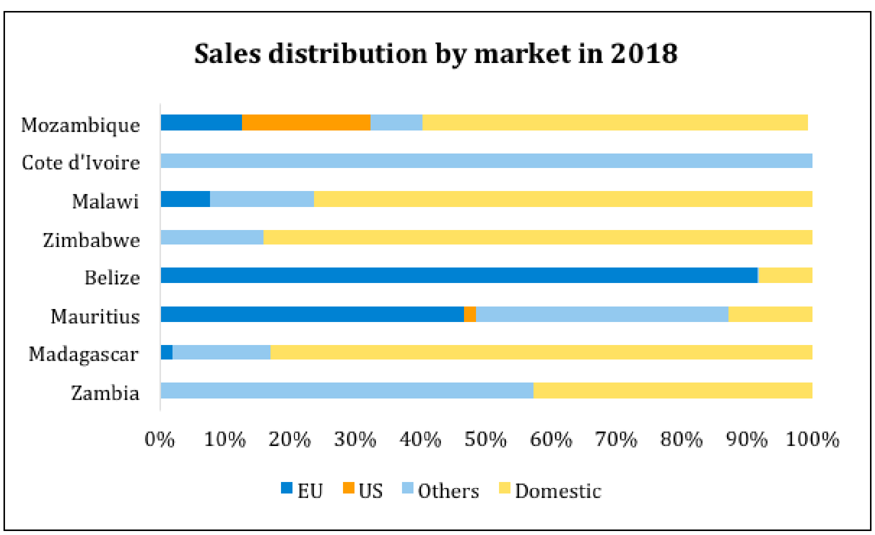


Source: FAOSTAT

Market structure

Like Mauritius, most of these reference countries belong to the ACP Group and were significantly impacted by the changing EU policies of the recent decades. As a result, while the EU was the main sugar exports destination for Cote d'Ivoire, Malawi, Zimbabwe, Madagascar, and Zambia up to 2015, by 2018 they had all reoriented their sales to other markets, as shown by figure 5. It is interesting to note also that only Belize surpasses Mauritius in terms of sugar export orientation towards the EU. All other reference countries have shifted away from the EU.

Figure 2: sales distribution by market in 2018



Source: FAOSTAT

It is important to note that some of these reference countries have a significantly entirely different output market strategy than Mauritius, exporting sugar mainly to the United States and absorbing a significant portion of production domestically. This is the case of Panama, Dominican Republic, Costa Rica, and Honduras. Similarly, Kenya and Tanzania (which are also part of COMESA free trade zone like Mauritius), but also Nepal, Bangladesh, and Venezuela mainly sell their sugar production domestically.

Revenue Streams

Mauritius is one of the most diversified countries in the reference group, producing specialty and Fairtrade sugars, electricity from bagasse, and ethanol. The only product it does not supply in relation to some reference countries, is organic sugar (produced by Zambia and Costa Rica). In the mid-1990s, Mauritius started a small operation of certified organic sugar, but it was later halted and deemed uneconomical (ISO, 2015). Similarly, in the Dominican Republic, El Ingenio Santa Rosa mill began production of Cruz Verde organic sugar in 2000 but ceased operations in 2008.

Deep Dives in Selected Comparator Countries

From the initial group of 20 reference countries, this analysis considers Mauritius, Belize, Fiji, Guyana, Zimbabwe, Eswatini, and Mozambique due to their similar production levels, output markets, in particular their exposure to the EU market. While conditions vary from country to country, this section analyzes and compares public policies and programs to highlight potential drivers of success and failures relevant for Mauritius.

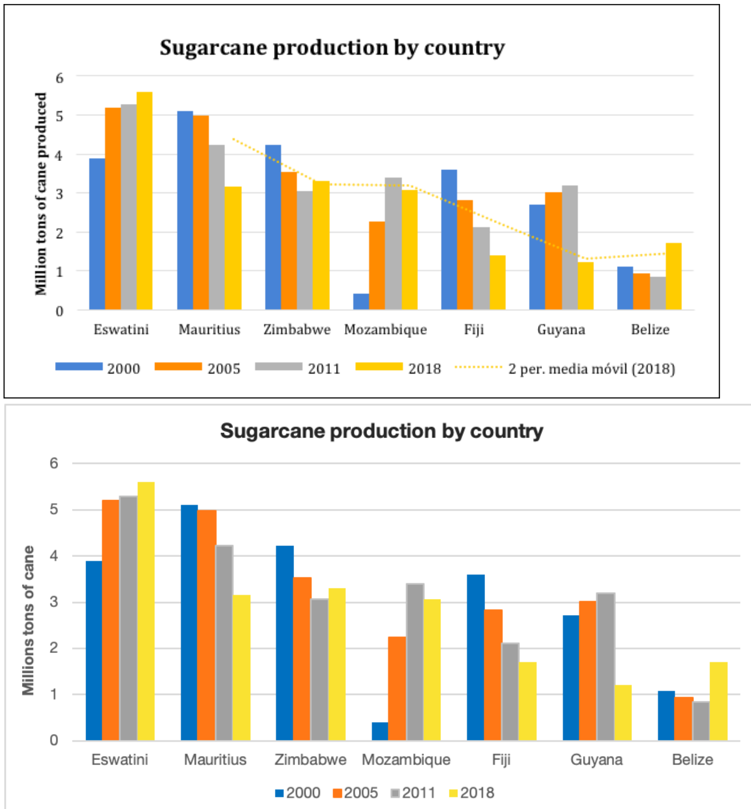
Production Trends

Sugarcane production has seen a downward trend in Fiji, Guyana, and Zimbabwe between 2000 and 2018, while the area harvested is also in decline (Figures 3 and 4). This is due, in part, to the following conditions:

- Fiji is experiencing labor shortages, natural disasters, and poor factory operations.
- Guyana is experiencing labor shortages, poor labor relations, and high costs of production.
- Zimbabwe is recovering from economic turmoil and a drought that affected much of Southern Africa.

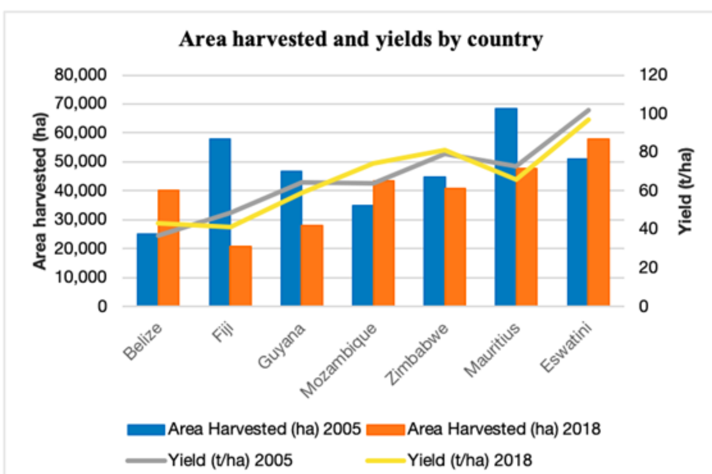
Eswatini, Mozambique, and Belize, on the other hand, have seen production increase, mostly driven by an extension in the total area under sugarcane—rather than higher yields. In addition, investments in farmer training and skill development are improving efficiency in all three nations, and Eswatini and Mozambique both have good access to water and irrigation.

Figure 3: sugarcane production by country (millions of tons)



Source: FAOSTAT

Figure 4: area harvested and yields by country

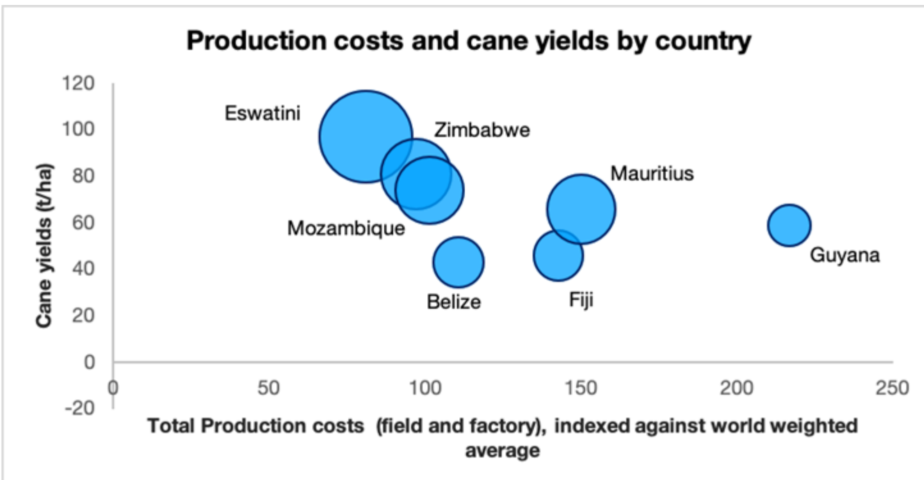


Source: FAOSTAT

Production costs

The effects of the EU reform varied from country to country, in part as a function of their production costs. Low-cost producers met the challenge by improving sugarcane yields, increasing supply, and expanding processing capacity, further lowering production costs and improving efficiency. Among this group, Eswatini, Mozambique, and Zimbabwe stand out, along with Belize to a lesser extent. High cost producers, however, struggled to cut costs, facing political and agro-climatic backlash. As Figure5 shows, Mauritius, Fiji, and Guyana can be included in this category—though lowering costs remains a concern for all producers wishing to stay competitive in the global market.

Figure 5: Total Sugarcane Production Costs and Sugarcane yields



Source: LMC International and FAOSTAT

Farm-level costs

Farm-level costs—including land preparation, planting, fertilization, cultivation, irrigation, harvesting, loading and haulage—also vary across countries. Eswatini, Zimbabwe, and Mozambique have lower field costs than Belize, Fiji, Mauritius, and Guyana, due to more favorable climate conditions and productive and efficient field operations from investments in irrigation infrastructure, land preparation and crop management. Belize suffers from inefficient cane loading and transportation costs, while Fijian fields have high levels of weed infestations, low fertilization, and high harvesting and transportation costs. On the higher end of the spectrum, Mauritius struggles with land preparation and harvesting due to limited economy of scale due to land size, limited access to mechanized harvest and irrigation due to topography and quality of the cultivated land, high labor costs, and labor shortages (LMC, 2016).

Factory Costs

In terms of processing costs, Eswatini, Belize, Mozambique, and Zimbabwe have relatively low factory costs compared to Mauritius, Guyana, and Fiji, as a result of the modernization and expansion of mills financed by government and foreign direct investments. While Mauritius underwent a centralization reform in the 2000s, financial difficulties forced the closure of additional mills—putting a strain on the remaining facilities. Similarly, factories in Guyana and Fiji incur very high costs due to the declining technical performance of mills.

Sugar Export Markets

- Belize, Guyana, Fiji, and Mauritius have largely export-oriented industries and share a higher level of exposure to the EU market. This can be partly explained by the relatively small size of their domestic markets, compared to Zimbabwe and Mozambique, and their limited access to regional or alternate markets. Each country in the reference group relies on the following markets:
- Belize exports around 90% of its output in the form of raw sugar for refining to the EU, shipping it through the UK.
- Eswatini exports about 95% of its sugar production, and over 50% of sales flow to SACU (ESA, 2018).
- Fiji exports bulk raw sugar mainly to the EU market but is pushing for sales in the domestic and Pacific Island Countries.
- Guyana exports most of its output to the EU but also sells sugar to the US and domestically (LMC, 2017). The completion of the Enmore packaging plant has allowed Guyana to target the Caribbean Community and Common Market (CARICOM) and reduce its exposure to the EU (LMC Cardno, 2016).
- Mozambique sells around 60% of its production domestically (LMC Cardno, 2016). While sugar imports pose a challenge, domestic producers benefit from a new pricing policy that imposes a tariff of 7.5% on the c.i.f. price of imports and a variable duty that stabilizes the price of imported sugar.
- Zimbabwe also sells most of its sugar domestically. In recent years, however, the inflow of cheap, smuggled sugar has increased the country's exportable surplus and resulted in more sugar being sold to the EU (LMC Cardno, 2016). To protect local producers, Zimbabwe implemented a 10% duty and a US$100 tax on sugar imports from all countries outside SADC and COMESA. [46]

Revenue Streams

Mauritius is a well-established producer of specialty sugars, though it has recently lost market share to countries selling raw sugar for direct consumption marketed as special

[46] At SADC level, SACU has a derogation under Annex VII of the SADC Trade Agreement to limit import into SACU (from all non-SACU SADC countries) at some 45,000 tons pa (hence MFN tariff applies above this limit). However, Malawi, Zambia and Zimbabwe do not mention the need for import licenses which are not issued. Likewise Mozambique imposes a reference price whereby imported sugar cannot compete with locally produced sugars. In COMESA, where more members are deficit producers, the tariff is often zero (hence no MOP for other members). Kenya, which protects its industry, has applied for safeguard at COMESA level to limit COMESA imports to its level of annual deficit.

sugar. Eswatini and Belize, for example, sell around 40,000 tons and 5,000 tons of VHP raw sugar to the EU, respectively. The latter also produces and exports specialty sugars to the UK and Canada. Fiji, on the other hand, only exports raw sugar for refining, while Guyana produces brown sugar for domestic and export markets.

Belize, Fiji, Mauritius Eswatini, Mozambique, and Guyana are Fairtrade certified sugar producers. The first three, however, are major world suppliers, with 28% of Fairtrade production coming from Fiji, 27% from Belize, and 9% from Mauritius. In 2009, the UK became the main market for Fairtrade sugar when Tate & Lyle converted 100% of its retail branded sugar to Fairtrade (ISO 2015). Yet, in 2015, the company stopped paying a premium for Fiji's Fairtrade sugar due to changes in the EU sugar market leading to a significant drop in the Fairtrade sugar sold. In Belize—which supplies most of the UK's Fairtrade sugar—, Fairtrade standards ensure that the Farmers' Association represents its 5,400 members, and that premiums are locally invested in agriculture, education, and healthcare.

In terms of electricity cogeneration, all countries in the reference group except from Mozambique have facilities that produce energy from bagasse. The status of each individual country in this regard is listed below:

- Fiji diversified into the sale of electricity in 2015, when it invested in a10MW cogeneration facility at the Labasa Sugar Mill, which provides power to the mill and sells the surplus electricity to the Fiji Electricity Authority (FSC, 2015).
- **Eswatini**'s Ubombo mill embarked on a factory expansion and cogeneration project in 2011, now producing enough energy to power its operations and export surplus power to the Eswatini National Grid (Illovo, 2011).
- **Belizean** mills supply 15% of the country's electricity. This is expected to increase by a further 10%, as Belize aims to achieve an 85% share of renewables in its energy mix by 2027 (LMC, 2017).
- **Guyana** aims to become fully reliant on renewable energy by 2025. In 2015, sugar mills exported 35 GWh of electricity to the grid (GuySuCo, 2015).
- **Zimbabwe**'s Hippo Valley and Triangle Sugar Mills generate enough electricity to power their operations during peak production periods. In an arrangement with the Zimbabwe Power Company, the mills agreed to supply electricity to the grid during peak production periods and consume electricity during off-peak periods.
- Mozambique does not cogenerate energy currently but has the potential to produce up to 831 MW of electricity from bagasse (Ministry of Foreign Affairs, 2018).

Relevant benchmarking trends for Mauritius

To remain competitive in a challenging sugar world market, sugarcane producers have implemented public policies and programs to increase productivity, lower production costs, and boost sales. Most reference countries measure improvements as a function of yields, cane quality (TC/TS), production levels, and production costs, yet have employed different strategies to reach their targets. These public policy and program strategies can be grouped into five overarching themes: 1 cane growing performance (replanting, variety development, and increasing the sugarcane cultivated area), 2 training and development, 3 reduction in production costs, 4 research and development, and 5 water management.

The EU Accompanying Measures Sugar Protocol (AMSP) was a series of measures implemented between 2007 and 2013 designed to help industries increase competitiveness and mitigate losses facing the end of the EU preferential regime. While benefiting from the AMSP, Mauritius, Belize, Fiji, Guyana, Eswatini, Mozambique, and Zimbabwe rolled-out national plans to support sector growth. This section analyzes these public policies and programs to identify successes and failures relevant for Mauritius.

While comparisons can be insightful, it is important to note that each country faces a different set of challenges and conditions that determine their policy choices. For instance, Fiji and Guyana are more vulnerable to cyclones, whereas Eastern and Southern African countries are more at risk of droughts. However, natural disasters and varying weather conditions threaten the sugarcane sector in all these countries, which makes it insightful to study how each of them have approached these challenges.

Sugarcane Production Performance

Most countries have implemented public policies and programs aimed at improving sugarcane yields and quality, and sugar production outputs. Below is an overview of the policy goals set forth by Belize, Guyana, Fiji, Eswatini, Mozambique, Zimbabwe.

Belize suffers from very low yields with an average of 40–50 tons per hectare. While cane is grown in soils with a much higher yield potential, poor field drainage, suboptimal field practices, and very low replanting rates negatively impact output. To improve performance, cane quality, and yields, Belize has focused on capacity building to improve best farming practices.

In 2015, expecting a sharp decline in sugar prices and ongoing low returns from the EU market, Belize formulated a Strategic Development Plan (SDP) aimed at aligning the incentives of its main stakeholders towards improving efficiency. The SDP hoped to improve sugarcane productivity and quality at farm level by structured replanting, improved farming practices, more efficient harvesting and delivery practices, and greater efficiencies at the mill and factory-to-ship logistics. Some targets included:

- Increasing cane yields to 74 tons/ha by 2020 through the implementation of a credit system enabling farmers to replant 3,000 ha/year and rejuvenate farms within ten years.
- Reducing costs of sugar production from an average of US$20 to US$22 cents per pound (lb) to US$15 cents/lb through greater efficiency and increased volume.
- Increasing sugar output from 130,000 to 140,000 tons to 200,000 to 250,000.

In 2018, cane yields were still far from the target, at around 42 tons/ha, while sugar production remained at 155,000 tons.

The government of **Fiji**, which is a main shareholder of the Fiji Sugar Corporation, implemented the Strategic Action Plan (SAP) for 2010–2015—later updated for 2014–2020. The SAP laid out projects and steps intended to increase the sugarcane sector's competitiveness and reach key targets, emphasizing technology transfer, the improvement and introduction of new cane varieties, crop protection, and capacity building. The key goals of the SAP were

- Increasing cane yields to 70 tons/ha or more by 2020. To achieve this, the government rolled out the Sugar Cane Planting Grant to assist cane farmers to replant fields and introduced a government subsidy on fertilizers to improve grower's fertilizer ratios.
- Reaching a TC/TS ratio of 9.5 by 2020.
- Reducing costs by improving the delivery times of sugarcane through railway system maintenance and the targeted upkeeping of milling facilities.
- Protect the environment.

By 2018, yields had slightly improved but remained at 46 tons/ha and, whilst fertilizer utilization had increased, severely dry conditions played a major part in the reduction of yields (FSC, 2016). The TC/TS ratio stayed slightly off-target at an average of 9.7 since 2012. Yet, extreme weather conditions—including cyclones and droughts—adversely impacted land preparation and replanting, leading to significant variations in the TC/TS ratio and cane quality in the 2017 and 2019 crops (FSC, 2019). Moreover, all four sugar mills in Fiji are over 100 years old, which makes them unreliable and prone to breakdowns and stoppages (LMC, 2016).

In 2019, $23.51 million was allocated to the upgrade of Fiji's milling facilities (The Fiji Times, 2019), and the Fiji Sugar Corporation announced an increase in the area under sugarcane cultivation as part of its new strategic plan for 2018 to 2022 (FSC, 2017).

Guyana's sugarcane sector is experiencing major losses and suffering from inefficient field and factory operations. Poor land preparation and late season planting have led to low yields, averaging 55 tons/ha since 2015 compared to 73 tons/ha in the early 2000s. As a result, the

Guyana Sugar Corporation (GuySuCo) developed several Industry Strategic Plans -in 2009, 2013, and 2014—to address deteriorating sugarcane sector performance (Thomas, 2015). The latest version, Guyana's Agricultural Sector Strategy 2013–2030, has the following goals:

- Increasing sugar output to 450,000 tonnes by 2020.
- Reaching a TC/TS between 10 and 12.
- Increasing sugar yields to 7 tons of sugar per hectare (TS/H) S/H
- Harvesting 60% of the crop mechanically.
- Replanting of older and less productive varieties of cane like DB 66113 and D7761.

Since, however, Guyana has closed several sugar factories and transitioned others into diversified activities. In December 2016, the Wales factory shut down and the estate began transitioning into rice cultivation -in partnership with the Guyana Rice Development Board (GRDB)—livestock production, apiculture, and seed paddy production, among other activities (GuySuCo, 2016). In turn, village, planting, and harvest employees were re-employed by the Uitvlugt estate during 2016 and 2017.

In 2019, GuySuCo set forth the new Sustainable Business Model and Strategic Plan for 2019–2021, with the goals of creating and delivering more value from products and services. These plans announced investments to increase production and productivity in sugarcane plantations and guidelines to start producing value-added sugars—including PWS and electricity. Currently, GuySuCo is also promoting the sugarcane sector as part of the country's Cultural and Heritage Tourism, in line with the UNESCO-led World Heritage and Sustainable Tourism Program (Guyana Chronicles, 2019).

The South African company Tongaat Hulett operates two mills in **Mozambique**, another two mills in **Zimbabwe**, and the Tambakulu Estates in **Eswatini**. Over the years, the company has implemented several programs to boost yields and improve sugar content and extraction, with promising results. Some of these initiatives are detailed below,

- **Controlled traffic farming systems** (CTFS): GPS technology to minimize the year-on-year crop and soil damage inflicted during harvest and ratoon management operations.
- **Planting period optimization**: CTFS facilitates precision tillage operations which allow for cheaper and more effective replanting to be conducted from February to May (for irrigated estates). This calendar allows to optimize yields and maintain a stable supply of cane to the mills.
- **Drainage**: the company is encouraging the adoption of breakthrough surface a**nd subsurface drainage technologies.**

- **Irrigation**: the company developed a self-assessment tool to assist estates to benchmark themselves against global best irrigation practices, matched optimally to the prevailing soil characteristics.
- **Intra-field management**: the company encourages its growers to apply a set of operational standards to optimize the timing, sequence and quantity of agricultural inputs on an intra-field level—precision agriculture (WKS, 2018).

Innovation: Education

A common strategy employed by the sugarcane sector to increase capacity and efficiency relies on training farmers and staff, since knowledge and technology transfers are important to improve performance. This goal is shared by stakeholders and sugar research institutes, who fulfill an important role in sharing their findings with farmers and proving their benefits to increase adoption rates.

Sugar companies often own major plantations, but do not control all sugarcane production. Some of the production may come from independent smaller sugar plantations, or from smallholders who operate as out-growers for the larger plantations (Roseboom,2007).

Given that **Belize** Sugar Industry (BSI/ASR) receives 90% of its cane from farmers producing on plots ranging from 2 ha to 4 ha, the group focuses on providing training opportunities for small planters. In 2015, the Inter-American Development Bank (IADB) entered a technical cooperation agreement with the Sugar Industry Control Board (SICB) for the implementation of the project Creating a Sustainable Sugarcane Industry in Northern Belize, led by the Sugar Industry Research and Development Institute (SIRDI). This initiative intended to increase the farm-level capacity of Northern Belize to become globally competitive, granting technical assistance for farmers to adopt best practices to improve cane quality (SIRDI, 2020).

As part of this project, SIRDI rolled out Farmer Field Schools and Harvest Group discussions designed to encourage best practices through modules covering themes ranging from incorporating women and youth in the sugarcane sector and environmentally friendly practices, to harvesting techniques (SIRDI, 2020). According to SIRDI (2018), these programs have been well received and highly participative, as participants have noticed the changes on the field as a result of their attendance. In 2018, a fifth cohort of 234 farmers completed Farmer Field School (SIRDI, 2018).

SIRDI also developed the Sugar Industry Management Information System (SIMIS), which allows farmers to input their acreage data and plan for harvest (SIRDI, 2020). In addition to allowing for better decision-making, SIMIS was designed to systematize the collection of sugarcane sector data for improved management and efficiency—such as field location, variety, date planted, crop class, and production estimate. After training 19 harvesting group leaders, field captains and leaders in SIMIS, stakeholders agree that the system has greatly benefited the overall sugarcane sector (LMC, 2016).

Overall, the joint SICB/IADB/SIRDI/ project contributed to an increase of annual production from 123,000 to 144,086 tons of sugar, while the average yield of participating farmers increased from 19 to 25 tons/ha from 2015 to 2017—a 32% spike. The quality of cane, measured as the TC / TS rate, also improved from 9.82 to 8.95 (SIRDI, 2020).

The **Eswatini** Sugar Association (ESA) adopted a 10-year Extension Strategy in 2015 to improve smallholder yields by training growers on best farming management practices (ESA, 2015). The strategy meant to ensure the sustainability of sugarcane growing by providing technology transfer and advisory services to planters through a service level agreement (SLA) entered with the mills. The SLA included the provision of technical advice to boost productivity based on research findings, and support to improve the profitability and sustainability of smallholder growers. In 2015, the sugarcane sector conducted thirteen training workshops on business management (ESA, 2016).

Innovation: technology transfer (extension)

The **Fiji** sugarcane sector has also prioritized training and development, focusing on field training. Given that much of the work done by the Sugar Research Institute of Fiji (SRIF) is unknown to growers—including research on weed control, fertilizers, and crop protection—the SAP emphasized the need to strengthen relations across stakeholders to better communicate research and innovations (SRIF, 2014). Using demonstration plots and organizing visits from groups of planters, SRIF illustrates best practices while establishing a direct communication channel with the planters.

Fiji has also targeted leadership, management, and technical training as an area of focus. In 2014, the sugarcane sector began identifying skills gap and organizing training sessions sponsored by the EU and facilitated by the Australian Pacific Technical College, Vasantdada Sugar Institute of India (VSI), Fiji National University, and the University of the South Pacific (FSC, 207). In 2017, ten Technical Officers selected from across the three mills completed the Advance Certificate in Sugar Engineering and Sugar Technology Training with VSI India. Several students from this cohort were later promoted to senior roles, while others actively support and contribute with innovative ideas to maximize efficiency at the mill (FSC, 2018).

In **Guyana**, GuySuCo has also implemented training programs, including cadetships and partnerships with the Guyana School of Agriculture. However, these sessions do not allow staff members to reach the technical competency and level of expertise needed to handle some of the serious issues in the sugarcane sector. As a result, there is high turnover among managerial and supervisory employees, due to migration and low morale (GuySuCo, 2016; Davis & Piggott, 2015). This could explain the lack of consistency with regard to the maintenance of estates, machine use and operations.

In **Mozambique**, AMSP-funded training was delivered to both farmers and mill workers, covering a wide range of skills. Mills have been closely involved in the smallholder development process, providing much needed farming and project management experience (LMC Cardno, 2016). Additionally, funds were provided to assist mills on workforce development efforts and to allow the substitution of expatriate labor with domestic workers. However, there are concerns that not enough staff members participated in the schemes to ensure that the skills taught trickle down (LMC Cardno, 2016).

Eswatini is using mobile phones to transfer knowledge and production information from extension officers to farmers. There is evidence and support around the use of Information and Communication Technology (ICT)—especially mobile phones—as a source of technology for accessing information within the sugarcane sector (Dlamini & Worth, 2019)

The use of mobile phones as a means of communication and digital payments is also growing in **Fiji.** A partnership between the UN Pacific Financial Inclusion Program, USP, Vodafone and several farmer cooperatives has led to the creation of PacFarmer, a mobile app that gives farmers free access to information on government support schemes, and farming activities (Reece, 2018). In 2019, Vodafone Fiji, in collaboration with the Sugarcane Growers Fund (SGF), introduced a new initiative using the M-Paisa system, by which farmers can receive loans from SGF on their mobile phones (Singh, 2019).

Innovation: Research and Development

Research and development (R&D) plays a crucial role in the sugarcane sector, as the ability to improve husbandry and production techniques are key to its competitiveness. A common phenomenon in many sugar-producing countries is for local sugar companies to organize and finance their technical services jointly, which allows them to move into more advanced research activities than they would be able to afford on their own (see Table 1 for an overview of mills and research institutions by country). The Mauritius Sugar Industry Research Institute (MSIRI) is an example of sugarcane sector-funded sugar research institute, along with the West Indies Central Sugarcane Breeding Station (WICSCBS), which serves the Caribbean (Roseboom, 2007). In 1980, Mauritius also created the Regional Sugarcane Training Centre for Africa (RSTCA), a joint venture between UNDP and MSRIR that subsequently became the Robert Antoine Sugar Industry Training Centre and then the Regional Training Centre. This Centre is located within MSIRI and has trained agronomists and technologists from Mauritius and some 40 other countries.

In some countries, like **Mauritius**, there is a long and strong tradition of collaboration between sugar research institutes and the local sugar companies. In other countries, like **Mozambique,** the technical collaboration between stakeholders is relatively weak. In the case of Mozambique—and in other African countries like Swaziland and Zimbabwe—sugar companies are owned and operated by South African corporations (Illovo and Tongaat Hulett) that own several subsidiaries and rely heavily on their technology base at home, rather than investing in building local research capacity (Roseboom, 2007).

Table 1: Overview of mills and research institutions by country

Country	Mills	Companies	Research Institutions
Mauritius	• Omnicane, • Terra, • Alteo	Omnicane, Terra, and Alteo Groups	Mauritius Sugar Industry Research Institute (MSIRI)
Belize	• Belize Sugar Industries (BSI) • Santander	ASR Group and Santander Sugar Group	Sugar Industry Research & Development Institute (SIRDI)
Eswatini	• Mhlume • Ubombo	Royal Eswatini Sugar (RES) Corporation, and Ilovo	Eswatini Sugar Association (ESA)
Fiji	• Lautoka, • Ba • Labasa.	Fiji Sugar Corporation (FSC)	Sugar Research Institute of Fiji (SRIF)
Guyana	• lbion, • Uitvlugt • Blairmont	Guyana Sugar Corporation (GuySuCo)	GuySuCo
Mozambique	• Maragra Mill • Mafambisse Mill • Marromue Mill • Xinavane Mill	Illovo, Tongaat-Hulett, and Sena Holdings Ltd	Agriculture Promotion Centre (CEPAGRI) (closed in 2016).
Zimbabwe	• Hippo Valley Estates Ltd • Triangle Sugar Estates Ltd	Tongaat-Hulett	Zimbabwe Sugar Association Experiment Station (ZSAES)

Source: Roseboom, 2007

Reduction in Production Costs

Major world producers like Brazil and India are low-cost producers. As a result, to compete in the world market, sugar-producing countries need to improve efficiency and cut down costs.

a. Farm-Level Support

Belize has one of the lowest costs among Caribbean producers, at US$20 to US$22 cents/lb. of cane—70 to 75% of which are attributable to loading and transport (LMC, 2016). Currently, farmers' associations and BSI enter an agreement that determines supply quotas based on the planters' area. Under the current Delivery by Appointment system, each supplier receives a delivery slot within 24 hours, which leads to inefficiencies in the delivery and production of cane—forcing growers to cut cane prematurely to comply with their assigned time slots. This dynamic affects cane quality and yields, as well as transportation costs.

Around 61% of AMSP funds were destined to efforts to improve physical access, communication, and transportation through the rehabilitation of the Sugar Belt road network. At a general level, there is recognition that better roads have allowed greater mobility. Cane growers also note that improved roads have reduced the wear and tear of trucks, shortened journey times, and lowered fuel costs. Yet, there is concern that insufficient road maintenance will lead to the deterioration of these roads, losing the benefits of the AMSP over time (LMC, 2016).

On a separate front, in 2011, the Cane Quality Improvement Program (CQIP) was implemented to enhance the quantity and quality of sugar production through the implementation of better practices in the harvesting and delivery of cane (ASR BSI, 2015). The introduction of a relative quality-based cane payment system has helped the cane purity improve, motivating farmers to organize themselves to mature and provide cleaner cane through improvements in their burning, cutting, loading and transporting practices (ASR BSI, 2015).

In **Eswatini**, harvesting and agrochemicals costs represent a significantly large portion of planters' costs, affecting smallholder growers the most. To counter this burden, growers are encouraged to procure goods in groups and services in bulk. As such, farms tend to join forces and form companies to benefit from economies of scale. Yet, under current tax law, these groups must pay a business tax of 27.5%, plus an extra 10% on dividends (LMC, 2016). This is widely viewed as unsustainable, reducing the extent to which better procurement practices can mitigate farm-level costs.

In **Mozambique**, as a complement to the smallholder development scheme, the EU funded the establishment of farmers' associations. These groups have helped providing economies of scale and increasing throughput, reducing some of the financial strains in the milling sector (LMC, 2016). However, the sugarcane sector still faces critical disparities, as the two mills located in the north are operating well below full capacity, while the two facilities in the south are performing well and benefiting from the region's good infrastructure—which includes the railway system and a port—, connectivity, and low transportation costs (MAFAP, 2013).

Guyana suffers from high input costs and field labor disruptions, including strikes and prolonged disputes. Management is usually slow in settling altercations, and mechanizing operations is becoming increasingly important for sugarcane production to remain viable (Thomas, 2015). Yet, it is also essential that cost reduction does not come at the expense of agricultural standards. In 2012, with the objective of reducing costs, fertilizer-N use was reduced by 25% and cheaper sources were used to compensate. The following year, as a result, cane and sugar yields were the lowest since 1992 and the policy had to be reversed (Davis & Piggott, 2015).

b. Sugarcane Replanting

Sugarcane replanting can follow different paths. In Zimbabwe, Mauritius and the Caribbean, AMSP funds were used to help rehabilitate existing cane areas. In Belize and Guyana, this included the establishment of funds to help farmers replant their cane. In Mozambique and Eswatini, on the other hand, increasing the area under cane has been a key strategy to boost production. For all countries, research and sugarcane variety development is a key area of focus, though a common problem is the relatively slow uptake of new varieties by growers due to the high costs of replanting.

In 2012, **Belize** introduced a revolving credit scheme for replanting cane fields as part of its Multi-Annual Assistance Strategy—supported in part by AMSP funds. The goal of the program was to raising cane yields, as newly or recently planted fields are more productive. Given the high costs of replanting, the scheme was designed to provide farmers with access to funds at below commercial interest rates to finance investment costs. However, due to their high level of indebtedness, many growers were denied the loans, limiting the impact of the scheme (LMC, 2016).

In 2017, BSI launched the Pre-harvest Field Cane Quality Program in partnership with the Sugar Cane Production Committee. This three-year project offered technical assistance and training to growers on how to select the sweetest and most mature canes for harvesting. Six groups from all planters' associations signed up to participate in the first round of preharvest cane quality testing for crop season 2017–2018 (ASR BSI, 2018).

In **Guyana**, estates completed 4,792.3 ha of planting in 2016, against a budget of 7.349 hectares, while farmers planted 285.4 ha against a budget of 950.0 ha (GuySuCo, 2016). Farmers were reluctant to undertake tillage and replanting, and to take up additional lands due to the high investment costs, and the continuing low price paid for sugar (GuySuCo, 2016). The shortfall in planting on the estates occurred despite an extension of the planting season by four to six weeks in the respective crops. The deficit was a result of the limited amount of land tilled and available for planting, and a shortage of labor (GuySuCo, 2016).

Eswatini has been able to recover yields from 88.2 tons/ha in 2016 to 93.6 tons/ha in 2018 due to replanting efforts. To support the recovery of yields, particularly following droughts, ESA worked with growers to identify and replant old fields most affected by the draughts, installed drainage systems where needed, and evaluated the state of irrigation systems and their efficiencies (ESA, 2017). In addition, a partnership with the South African and Mauritian industries for a variety testing program continues to bear significantly positive results.

Similar to Mauritius, the sugarcane sector in **Fiji** is suffering from an acute shortage of sugarcane. In 2013, the country announced a US$8.4 million financial assistance package to support a cane-planting program to bring 28,000 hectares back into cane production. In 2014, 4,768 hectares of fallow land was brought back into production and 348 hectares of uneconomical ratoons were plowed out and replanted (FSC, 2014). Through the previously mentioned farm demonstration activities, SRIF also promotes the uptake of new varieties. In

2016, however, category 5 Cyclone Winston severely impacted crops and the replanting initiatives (FSC, 2016).

In **Zimbabwe**, Tongaat Hulett embarked on a private farmer rehabilitation program named Successful Rural Sugarcane Farming Community Project (SusCo) in 2012. SusCo aimed to increase the sugarcane production area from 11,200 hectares to 15,880 hectares in three years (Tongaat Hulett, 2016). Around 80% of Zimbabwe's sugarcane is produced by two large estates, while private farmers—including large scale and newly resettled growers—produce the remaining 20%. Overall. While the total area rehabilitated fell below expectations, the small-scale growers that did benefit received valuable support.

In **Mozambique**, the focus of the AMSP-funded National Adaptation Strategy was to increase sugarcane production and productivity by promoting the role of small and medium farmers. As a result of the program's emphasis on cane expansion under out-grower schemes, the country has experienced a dramatic boost in production from an increase in the area under cane cultivation, rather than heightened productivity (LMC, 2016).

c. Land Expansion

It is estimated that the AMSP supported the development of around 4,473 ha of smallholder cane land in **Eswatini**—equivalent to around 7.5% of the total area under cane. Since 2015, investments made by the sugarcane sector, the government, and the EU have interplayed to have a multiplier effect. To develop the Lower Usuthu Smallholder Irrigation Project (LUSIP I), for example, the government invested around €1.5 billion in dam construction, while the Ubombo mill invested €1.3 billion to expand its capacity to accommodate the additional cane, and AMSP funds were used to develop smallholder projects to increase cane supply (AFDB, 2012; LMC, 2016).

As a result, the expansion of cane area has increased the throughput of three sugar mills, improving the competitiveness of the sugarcane sector, and lowering unit costs. Yet, some stakeholders believed that too much focus was placed on expanding smallholder schemes, while those in operation were not supported, and that the lands were too far from mills (LMC Cardno, 2016). Distance to the mill was found to negatively influence production performance, reinforcing the need to limit the production of sugarcane to areas closer to the mills to reduce costs (Masuku, 2011).

d. Factory Operations

Guyana has undergone a major downsizing of the sugarcane sector to counter declining production, debt, and rising costs. From 1975 to 2016, the number of mills declined from eleven to six, and, in 2017, the government announced plans to close three of the remaining facilities. Despite major rightsizing efforts, GuySuCo remains largely indebted and unable to invest in operations. Facing run-down field infrastructure, lack of adequate machinery, and inadequate investment in the factories, a Sugar Task Force was established in 2017 to repair the three remaining estates and determine how costs could be rationalized and reduced (GuySuCo, 2018).

Water Management

One of the greatest vulnerabilities sugarcane producers face is the impact of weather volatility upon crop yields. Droughts result in failed cane germination, increased pests and increased diseases. As a result, countries like Eswatini and Zimbabwe meet water needs with irrigation systems.

In **Eswatini**, droughts have impacted production and destroyed around 3,000 hectares of land and sugarcane growers require between 1,500 and 1,700 mm of water supply every year (ESA, 2018). In 2018, four dams supplied 53% of the rain shortfall: the Magua Dam, the Sand River Dam, the Mnjoli Dam, and Lubovane Dam. In its Strategic Roadmap, the government committed to increase water storage capabilities in the form of medium-sized dams in strategic areas in the country, directly benefiting the sugarcane sector's water security (Takouleu, 2020).

In **Zimbabwe**, drought conditions and limited irrigation have negatively impacted yields and the supply of sugar since 2014 (LMC, 2016). Yet, the recently commissioned TugwiMukosi dam provides a major improvement for water security in the country (Sikuka & Geller, 2018). In previous years, moreover, some farmers have started using drones to irrigate their crops—avoiding piping and sprinklers by having drones transport water from a nearby dam directly to the crops (The Washington Informer, 2020).

Belize, Guyana and **Fiji**, on the other hand, rely mainly on rain to grow sugarcane and have been affected by droughts and natural disasters in the past. As climate change increases rainfall uncertainty and extreme weather conditions, farmland irrigation becomes pressing (Knox et al., 2010).

Annex 6—Policy options and programs for supporting the transition of the sugarcane sector of Mauritius

Public Policy/Program	Description	Public budget implications	Sequencing priority	Stakeholder implications
Increasing the share of high-tech sugarcane farms	An important simulation is what would happen to the sugarcane sector if the share of sugarcane produced in more efficient (high-tech) farms (more than 10 ha, or more than 60 MT of sugar produced) as a percentage of total sugarcane further increased from the current level of 81%. Results show that increasing the share of production from these farms improves the viability of the sugar sector, given the difference in yields due to mechanization, cane variety and access to irrigation. This scenario could lead to an increased level of overall sector level profits (up to Rs173 million) by reducing overall farming costs per MT of sugarcane produced.	**Moderate** (Realignment of current farm-level supports to smallholder towards improved adoption of technology, R&D, and farm consolidation)	**Short term (**Lowering farming costs and incentivizing consolidation is essential to stopping land abandonment and the further decline of the sector)	Farmers in marginal areas, under manual production may be affected and would need to leave or consolidate land to transition to high tech farming. This could further reduce the number of small farmers from 12'000 by approximately half.
Increase the share of specialty sugars exported	Although Mauritius can do little to influence world markets, strategies are available to capture more value from the sugar the country sells. Among these strategies is the potential to increase the sales of specialty sugars. Recently (2018/2019), 30% of sugar exported (in a per MT basis) have been	**Low** (involvement of trade negotiations to open new and existing markets for sugar exports)	**Short term** (As the sector modernizes and lowers its farming costs, it is	The milling operation that is not focused on specialty sugar would

	specialty sugars. If current total sugar production levels are maintained and additional marketing efforts are made, this share may increase if additional marketing efforts are made (including the possibility of involving sugar refineries in the direct sales/exports of those sugars). The three millers have thus been working to increase the share of special sugar in the total export basket from around 150,000 tons to 180,000 in the next few years. According to MSS, based on differentials between special and ordinary sugar, the final MSS price can increase by up to Rs615/ton (equal to Rs480/ton in accrued sugar equivalent). Fair Trade certification and other programs have also been suggested as ways to achieve premium prices on at least some of the total sugar production. Institutional savings may also be possible. However, estimates from data gathered show that this share would not go beyond 50% at current production levels, as the global market would not be able to absorb more than the increased level of specialty sugar coming from Mauritius. The simulation shows that increasing the percentage of specialty sugars in relation to the total sugar exported could increase sector-level profits by Rs371 million.		important to find new sources of revenue)	need to close or realign with the production of specialty sugars
Increasing the price paid by CEB for electricity from Bagasse	The weighted average price paid by CEB for the past three years to all IPPs for electricity produced from bagasse is Rs2.7/kWh. However, the price paid for electricity from HFO is up to Rs4.64/kWh (as per data supplied by CEB). Therefore, the team simulated increases in the price paid by CEB to IPPs for bagasse to equal the opportunity cost of using HFO (the opportunity cost of coal would be Rs3.76/kWh). Given that international experience shows that without Government support, the sugarcane sector will likely disappear given its lack of competitiveness, HFO was	**Low** (Involvement to indicate CEB to increase its costs of productions and eventually tariffs)	**Short term** (Finding new sources of revenue is essential to maintaining the sector afloat)	CEB and/or consumers of electricity would need to absorb the additional cost. In case the cost is passed along to consumers,

	used as an appropriate opportunity cost[47]. However, if the contract between the 3 IPPs and CEB is expected to be renewed beyond their term (even if there is no more bagasse being produced), then coal would be a more appropriate opportunity cost. The results using HFO as an opportunity cost show that there would be an increase in sector-level profits of approximately Rs545 million. This simulation excludes any additional payments for bagasse.			tariffs would increase by 4% on average if using the opportunity cost of bagasse in relation to HFO.
Reduction in the sugar export logistics costs	From all the improvements in efficiencies and cost savings, the potential operational cost reduction related to the export logistics reported by MSS (simulated to be of a reduction of a maximum of 20%) seem to produce the largest impact, with a potential boost to sector-level profits of up to Rs200 million. The costs relate to freight, export charges, storage and costs for importing NOS.	**Low** (MCIA and MSS would need to reassess and renegotiate storage and other logistics arrangements)	**Short term** (While the feasibility of this change needs further exploring, it is a *low hanging fruit* in terms of lowering sector level costs)	No significant implication to sector stakeholders
Reducing labor costs	Labor costs (basic wages, statutory contributions to the National Pension Fund and to the Sugar Industry Pension Fund) are higher in the sugar sector compared with other economic sectors in Mauritius. The simulations were based on a maximum potential reduction in overall labor costs (wages, benefits, etc.) of 40% across all types of labor (farms, mills, refineries, IPPs), with a minimum of no labor cost reduction (increases in labor costs were not	**High** (The measure of reducing labor costs by the industry may need to be accompanied by additional compensation packages and workforce retraining programs.	**Medium term** (Reducing labor costs could lower costs at the milling level—second highest in the sector—and allow a controlled	Reduction in salaries, benefits, and/or early retirement for the 4000 workers of the

[47] It is important to note that the opportunity cost is not exactly to HFO, but to the mix of fuels used by CEB to produce electricity (which is mainly HFO). However, given that CEB expects to invest in LNG plant in the case where bagasse is no longer available, this could potentially be cheaper than HFO, although investment costs are not clear and have not been provided by CEB to date. If these costs are made available, this investment in LNG should be a more appropriate opportunity cost given CEB's plan to replace a potential reduction in electricity generated from bagasse.

	considered). Given that there is approximately 4000 permanent workers in the sugarcane sector and that at times there are labor shortages, an option would be for workers to take early retirement and bring in a new generation at lower costs, focusing on mechanization and automatization of processes. Savings from reducing labor costs could be up to Rs136 million.	Current voluntary early retirement scheme is approximately Rs1.5million/worker[48])	management of the sector in response to market trends)	sugar cane industry.
Increasing the price of molasses	The approach to sensitivity analysis of molasses pricing was simply to model a 10% increase and 10% decrease from the base price of molasses. The formulas for determining the molasses price are complex and not immediately transparent[49]. However, unlike bagasse, molasses prices are updated periodically and do bear a close resemblance to current world market conditions. Based on the data gathered, adjustments on the price of molasses greater than 10 percent one way or the other are difficult to foresee. Even with the introduction of ethanol-fuel blends, the price of molasses is unlikely to change significantly since the value of molasses in a blend is still determined with reference to international parity. On the one hand, fuel blends could help Mauritius save on the cost of imported	**Low** (Involvement to broker this new price structure and indexing)	**Medium term** (Increasing the price of molasses would benefit planters directly, providing incentives to increase production and discouraging land abandonment)	Consumers and buyers of molasses and its derivatives could be impacted.

[48] This is a basic calculation of 2 months pay per year of service assuming a monthly salary of Rs13,000 and 25 years of service. In addition to this benefit, workers who accept early retirement are given a piece of land (7 perches) with all amenities and infrastructure. This is how we arrived at the Rs1.5 million/worker.

[49] Molasses payments are made with reference to an international reference price quoted by the Landbouw Economics Institute (LEI) at Wageningen University in the Netherlands. Mauritius does not export molasses and instead various users of molasses pay different prices calculated with reference to the LEI price in which 40 percent of LEI is considered the "deemed fob price" for Mauritius. Under these arrangements, exporters of potable spirits and ethanol made from molasses pay 100 percent of deemed fob; manufacturers of spirits for the domestic market pay 175 percent of deemed fob (which was capped Rs 3,500 per ton from 2016–2019) plus Rs 40 per liter of absolute alcohol. The LEI price changes monthly and in 2019 ranged from €140 to 170 per ton. The most recent LEI price (July 2020) is €185/ton. Domestic animal breeders pay a fixed price of Rs2,500/ton molasses.

	fuel, but this would come at the expense of ethanol and spirit exports that are already priced with reference to parity. At the sector level, the improvement in the price paid for molasses can produce an improvement in sector-level profits of up to Rs25 million. However, at the farm level, molasses only accounts for 13% of total cane revenue at present and a change in the molasses price by 10% one way or the other would not have a significant impact on farm profitability. The analysis shows that a 10% change in molasses price is not enough to transform the viability of cane production.			
Technology improvements at processing stages	Technological improvements at the IPP level and in milling (of an estimated maximum of 5%) produce savings of Rs79 and Rs60 million respectively. Technological change at the milling level can produce cost savings of approximately Rs21 million. This depends in part on perspectives for revenues from sugar (specialty) and bagasse.	**Low** (Supporting private sector actions for ensuring an appropriate business climate to invest— – ensuring mix of other policy options)	**Medium term** (If these changes improve conversion rates from cane to sugar and bagasse, they could both lower costs and increase revenues for mills, IPPs, and planters)	**Jobs may be lost if efficiencies are generated around labor saving technologies.**
Public sector institutional reform	Potential savings due to institutional cost reductions are less than Rs5 million. However, the impact of realignment sector size, challenges and opportunities should yield more benefits for the sector and for the transition of smallholders and workers. In particular, the following would be key institutional issues to consider: - Merge MCIA's policy capacity with the Policy Unit of the Ministry of Agroindustry to have an agriculture-wide perspective	**Low** (Supporting detailed analysis for institutional transition and establishing compensation packages and retraining for staff)	**Medium term** (Creating a more dynamic, transparent and stronger institutional setting will be essential to ensuring the	Current sugarcane specific institutions may be affected as they merge with other multisectoral

	- SIFB should transition to only facilitating market-based risk financing to the sector, such as hedging and insurance (drop its ad -hoc support to the sector), gradually leaving the industry to procure such coverage on their own according to specific needs. - MSS efforts to promote sugar sales in international markets should be taken up by public sector trade facilitation functions, and specific marketing efforts devolved to individual millers/refiners/distillers - Other agencies under MCIA should be merged with those providing support to farmers and agribusinesses in the non-sugar and energy sectors, and in the case of MSIRI, also joining forces with regional research centers, like the one in Reunion.		sustainability of the sector after averting its downfall and preventing the reemergence of misaligned incentives)	institutions, and this may result in staff reductions.
Review of sector revenue sharing	Sector revenues have different sharing arrangements depending on the revenue source. While sugar and molasses sales have a direct price change passthroughpass-through to farmers, changes in the price of bagasse paid by CEB don't. On the other hand, farmers benefit from a relative high percentage (78%) of revenues secured by MSS through the sale of sugar and molasses compared to other sugar- producing countries with similar revenue sharing arrangements. Given that sector losses are focused at present at farm level and at the milling stage, a review of the revenue sharing would be needed if changes in the revenue or cost structure are to be introduced. An important proposal on the table to ensure the passthroughpass-through of market signals throughout the value chain down to the farm level would be for planters to be paid per ton of sugarcane delivered and their respective can quality. This	**Moderate** (A transition plan to ensure a medium-term revenue sharing agreement based on the payment of sugarcane to farmers will involve technical assistance and an establishment of countercyclical farmer support to complement market-based risk financing instruments)	**Medium term** (Protecting farmers' incomes and creating the right incentives for production will be essential to ensuring that short term investments at the farm level are optimized in the medium term)	Depending on the revenue sharing arrangement and whether the new percentages are compensated by increases in revenues or reduction in costs for the various stakeholders

	would allow farmers to de-link themselves from decision-making related to processing and marketing of the products produced by the industry from cane, while having the direct market signal of the price they would get paid for the cane that they would deliver. This would require an effort to: - Establish a medium- term arrangement between farmers and millers on the quality and price to be paid for cane. - Facilitate access to market-based risk financing instruments such as insurance, price hedging and prefinancing to ensure mid-term viability of investments - Develop explicit public sector countercyclical payments to allow for drops in farmer income beyond what market- based risk financing instruments could provide.			
Managed sector downsizing	- Only a 2 out of 6 sector downsizing scenarios show that a reduction in the area under production and in the number of mills would produce sector viability under a comfortable probability interval. Therefore, policy measures would need to ensure that land transitions out of sugarcane in the right areas and in the least efficient land. As an example of the importance of implementing a well-managed transition, the last mill closure caused an increase in additional transport costs of approximately RS75 million. Furthermore, the mills should be geared towards producing premium prices in order to justify the industry's relative expensive production costs. A well-managed sector downsizing could turn around the current sector losses of Rs1.4	**Moderate** (Public expenditures could involve support to farms and workers to transition out of sugarcane)	**Medium/Long term** (A careful transition plan would take time and several policy changes around labor, transport, and institutional arrangements should be tackled first)	Planters and millers may need to leave the sector, downsizing the volume of production between 20% and 50%. This could produce a loss of jobs for about 800 to 2000 workers and for 3000

	billion into approximately Rs800 million in profits. This would require a careful plan for the transition of farms and workers out of sugarcane.			to 6000 farmers.
Realigning direct public sector support towards competitiveness and socio-environmental objectives	Public expenditures (2018) to the sugarcane sector have been increasing in Mauritius due to the decline in revenues from sugar exports. The supports have been mainly through supplemental payments provided to small planters for compensating the drop in sugar prices. These types of farmer support are not conducive to improving competitiveness. In order to promote market-based production investment decisions (rather than government support-based decisions), it would be important for public expenditures to become less distortive of farm-level decisions, focusing on helping the farmer transition to a more efficient production system or to transition out of sugarcane into other viable land uses. Depending on the course of action to be taken by the public policy for the future of the sector (maintaining the size or downsizing), support could be geared towards efficiency improvements in agriculture production and/or environmental and/or social objectives (Climate /Nutrition Smart Agriculture, Natural Resources Management, etc.)	**Moderate** (Mainly public expenditure switching with a medium- term commitment for allowing for sector investment/transition and a targeted/smart support design)	**Medium/Long term** (Making the sector sustainable in the medium to long term will depend on creating the right incentives for planters and industry actors)	The implications are for taxpayers who will need to provide support through public expenditures, but potentially benefiting from environmental and social services provided by the sector.