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Sugar cane sector review

Policy Note

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Key messages

- In the past decades the Mauritian sugarcane sector has been experiencing an accelerated decline in production, even after several attempts at reforms and at market diversification.
- Given the international sugar market outlook, given its current production structure and size, the sector is not competitive.
- In order to regain competitiveness, and in the absence of further taxpayer support to the sector, two options are possible according to the models developed: (i) further downsizing the sector towards a specialization in specialty sugars; or (ii) implement a series of simultaneous reforms, including the provision of taxpayer support to bolster competitiveness.
- Given the opposition from most sector stakeholders to the idea of downsizing, four no-regret policy reforms are recommended while the sector and Government decide what path to take: (i) increase the price of electricity produced from bagasse, (ii) support the movement towards high-tech sugarcane farming; (iii) reduce the sugar export logistics costs; and (iv) increase the share of specialty sugars sold.
- COVID19 is limiting the fiscal space to support the sector, while it is also an opportunity to push for indepth reforms that may not have been politically viable during normal times.

I. Introduction and Objective

This note discusses policy options for the Government of Mauritius to support its sugarcane sector¹. The note is the last deliverable of a series of activities undertaken by the World Bank as part of the advisory service agreement with the Government of Mauritius signed in January 2020. This note has benefited from a sector competitiveness analysis² and tool³ developed by the World Bank, and a vision exercise⁴ undertaken in a highly participatory manner with sector stakeholders. PowerPoint presentations, video recordings, trainings, and Excel models have been posted in the MCIA website⁵ for stakeholders to access during the period of the vision exercise (August-November 2020) and feedback has been compiled⁶. Given

² The competitiveness analysis report can be found here:

¹ The definition used of "sugarcane sector" in this note are the stakeholders along the value chain in Mauritius, from planters, workers, and millers/refineries/power producers/distilleries, to the marketing agency (MSS), and supporting institutions such as Trade Unions, Planter and Industry Associations, the Energy Company (CEB) and Government institutions and agencies supporting the sector.

https://drive.google.com/file/d/1Vsaa1hAD9xUWH4jKeT9r2LS38FpmYhXE/view?usp=sharing ³ The tool (Excel models) developed can be found here: <u>https://mcia.mu/world-bank/</u>

⁴ The vision exercise report can be found here: <u>https://drive.google.com/file/d/1VfhnWlbIPvaAeykBBM</u> - <u>RnC6HRKFtJch/view?usp=sharing</u>

⁵ <u>https://mcia.mu/world-bank/</u>

⁶ Feedback received from sector stakeholders and responses provided by the team can be found here: <u>https://drive.google.com/file/d/1l3HLd8cBp0u8bdet310wr3svzlzJzBho/view?usp=sharing</u>

that there are different potential viable future scenarios for the sector and that the advisory service had some limitations in relation to the terms of reference (scope) of the work⁷, there is a series of no-regret policy measures recommended along with a longer list of policy alternatives presented as options for consideration. Furthermore, the policy note (along with the competitiveness analysis and tool, and vision exercise) was prepared to facilitate policy dialogue and discussion among sector stakeholders.

II. Sector Background

The motivation for immediately addressing potential policy changes in the sugarcane sector is the accelerated decline in the country's sugarcane production over the past two decades, which has led to a recent increase in public spending to support the sector. The number of hectares (ha) planted to sugarcane in Mauritius has historically been above 70,000. Since the 1990s, production started to drop at a rate of 0.8% per year, accelerating to 3.61% per year since 2002 (see Figure 4), due to the drop in international sugar prices and the rollback of the European Union (EU) sugar protocol since 2008—which effectively eliminated the preferential access of Mauritian sugar into the EU market in 2017 (see Figure 6). Since, the EU price of sugar has consistently declined and currently stands at 75% of its July 2017 level (European Commission, 2020), which mirrors the trend in other sugar markets. The international sugar price outlook is that it will remain flat over the next 10 years⁸. This 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, and double the budget allocation to the sector in 2017. Nonetheless, land used for sugarcane has declined at a rate of 2,000 haper year over the past two decades and the total number of farmers has decreased from 27,000 to 12,000 since 2004 (the drop being mostly in the small farmer segment).

The Mauritian sugarcane sector has played a key role in the development of the economy. Although sugar revenues are only 1% of the country's GDP and the employment generated by the sugarcane sector is less than 2% of the country's labor force, the sector has a large multiplier effect in the economy. The sugarcane sector has larger multiplier effect than the textile and financial sectors⁹ and it is an important source of foreign exchange, in particular in times like the present COVID-19 pandemic, when revenues from tourism are extremely limited¹⁰. The sugarcane sector has also been at the base of the structural transformation of the country's economy, with the sugar industry reinvesting profits produced by the sale of sugar into other sectors such as tourism and financial services. Therefore, sector stakeholders, and the

⁷ The scope of this work is limited to the sugarcane sector and explicitly excludes other sectors such as food production and environment. This precludes the analysis from considering socio-environmental impacts and externalities that should be gauged when recommending policy changes.

⁸ 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 (supply closer to demand) than in the past decade. The relatively small white sugar premium (the difference between white and raw sugar prices), USD 70/t during the base period (2017-2019), is projected to increase slightly in absolute terms to USD 83/t by 2029 (OECD, 2020).

⁹ 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 (JTC, 2015).

¹⁰ Tourism revenues are expected to decrease by 92% in 2020 (see: <u>https://tradingeconomics.com/mauritius/tourism-revenues</u>).

population in general, see sugarcane as part of the cultural and economic inheritance of the country. Furthermore, in recent decades, the sector has been diversifying its revenue base by investing in its capacity to process bagasse to generate electricity for the grid, allowing the country to increase its renewable energy source.

There have been efforts to slow down or reverse the decline of the sugarcane sector in Mauritius, with only partial success in the proposed reforms. The most recent efforts have been the implementation of the Multi-Annual Adaptation Strategy (MAAS 2006-15) developed to support the transition from a dependence on the EU market after the end of the EU sugar protocol. The MAAS set out a series of reforms and investments, such as (i) diversifying export markets; (ii) incentivizing the voluntary retirement of workers; (iii) liberalizing the domestic sugar market; (iv) improving sugarcane quality; and (v) increasing value added in-country. However, some strategic objectives were not met, including: (i) a policy for the use of ethanol as fuel (blending); (ii) labor costs reduction; (iii) the implementation of environmental measures; and (iv) an agreement between planters and the corporate sector on cultivation targets (see Annex 1 for a Glossary of terms).

Although no country matches the characteristics of the Mauritian sugarcane sector, comparative countries show a mix of sector growth and decline over the past two decades. Unique features of the Mauritius' sugarcane sector include: (i) its geographic isolation; (ii) its dual purpose (sugar and energy); (iii) its relative modernity; (iv) its small domestic sugar market; and (v) its dependence in the EU market. Since the EU market reforms, some countries with similar production levels, like Fiji and Bangladesh, have seen comparable rates of decline, while others, like eSwatini, Madagascar, Belize, have seen increases (see Figure 7). Although this benchmarking shows that Mauritius is not the only country facing the challenges of the changing global (and the EU) sugar market, the growth seen in sugarcane production in comparative countries can serve as an opportunity to revisit its sector development strategy. Currently, Mauritius ranks 39th out of 100 sugarcane producing countries, while producing the same level as what some individual sugar mills in other countries process in a year.

In relation to comparative countries, Mauritius has a relatively high cost of sugarcane production and an average level of farm productivity and farmer support. Comparative countries with higher sugarcane yields that compete with Mauritius in the COMESA market (such as Eswatini, Zambia, and Zimbabwe) tend to have lower total costs of production (see Figure 8). Furthermore, the level of public policy support to sugarcane producers has been increasing in Mauritius in recent years, reaching a level of 18% of total farm receipts in 2018 (see Figure 9). This level is higher than what EU farmers receive, but lower than in competitor countries like South Africa and OECD members¹¹ (South Africa's level of producer support is 48%). However, the type of producer support recently expanded by public policies and programs in

¹¹ See a detailed note on sugar support estimates following the OECD methodology: <u>https://drive.google.com/file/d/15n8KpQ_zz_Njnb9lxPWkCDjfU_HcITPu/view?usp=sharing</u>

Mauritius focuses on supplemental payments for the output generated by small farmers, distorting farmers' production decisions and the sector's competitiveness¹².

The sector's cost structure is highly concentrated at the farm level. Almost half of the overall sector costs are farm-level costs, followed by milling and export logistics (Figure 14). At the farm level, costs are significantly different between small planters¹³ and corporate estates. Small planters produce sugarcane 16% to 26% more expensive than corporate estates. 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.

Labor costs (across the sugarcane sector) are high and have been increasing significantly in Mauritius. Wages in the sugarcane sector are 23% higher than in the manufacturing sector (Digest of Labor Statistics, 2018). Labor costs have also been increasing at more than double the rate of inflation since 2010. Sugarcane workers benefit from contributions to the national Pension Fund and to the Sugar Industry Pension Fund. These benefits are a result of voluntary retirement packages (VRS) negotiated as part of the reforms introduced to transition to the new EU market access conditions, for an approximate total amount of EUR94 million¹⁴ (LMC International, 2015). Increases in labor costs in the sugarcane sector have outpaced inflation more than twofold and have not followed the trend in sector decline (JTC, 2015), despite a decrease in the number of jobs across the sugarcane sector. Employment in the sugar sector¹⁵ declined by almost 10% in only two years, from 7,378 to 6,659 between 2016 and 2018 (Digest of Labor Statistics, 2018). Agriculture and manufacturing jobs (including in the sugarcane sector) 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).

Sector revenues are highly concentrated in sugar sales. Both refined white and specialty sugars drive 82% of sector revenues, with white refined sugar accounting for 70% of total sugar sold in terms of value. Other sources of revenue include electricity produced from bagasse and the sale of molasses. Sector revenues are distributed among stakeholders through a complex system. Revenues from sugar are divided according to a revenue-sharing agreement between planters, millers and the institutions supporting the sector. This revenue-sharing agreement is more beneficial to farmers in relation to other countries, awarding farmers 78% of sugar revenues. Likewise, revenues from molasses are collected by institutions

¹² In comparison, in most sugar producing countries with a large domestic market, the support to producers (PSE) is through market price support, including USA, India, South Africa. However, The EU, Brazil and Australia are competitive industries facing international market prices, while their public policies and programs target mostly payments based on input use. The former benefits producers by boosting a price differential between domestic and international prices, and is highly market distorting.

¹³ The definition of small planters used in the competitiveness analysis is the same one used for several Government support programs: farmers that grow plots of less than 10 ha of sugarcane or produce less than 60 MT of sugar.

¹⁴ 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).

¹⁵ Including plantations of more than 10 ha and processing facilities.

and distributed exclusively to planters at a fixed per ton price. However, revenues from electricity sold to CEB go directly to power producers (IPPs)¹⁶. Farmers and IPPs receive an equal and fixed amount in compensation for the bagasse used to export electricity to the grid through a fund (BTPF) financed by CEB (see Figure 10).

Sugarcane farmers, in particular smallholders, have seen the area under production decrease steadily since 1990 and at an accelerated rate since 2002. From the sugarcane land that stops producing, approximately 61% are left fallow (abandoned), while the rest is used to produce other food products and turned into urban uses (see Figure 11). 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. 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. Meanwhile, sugarcane has been decreasing in importance in the overall agriculture sector; while it represents 80% of the area under cultivation in the country it accounts for only 14% of the agriculture GDP (See Figure 12).

Sugarcane mills have also been steadily declining. In the 19th century, the country had 259 sugar mills. By 1990 that number had gone down to 17 (sugar represented 20% of the country's GDP). Today, there are only three mills left in Mauritius, which means that, over the past three decades, a sugar mill has closed every two to three years on average (See Figure 4). Closing a mill is not a decision that the private sector can take on its own: it requires public sector authorization based on a plan for financing of excess transport costs from sugarcane farms surrounding the closing mill to the remaining mill(s), among other issues.

Sugar marketing efforts are consolidated by law under one agency, the Mauritius Sugar Syndicate (MSS), managed by the various sector stakeholders. The Mauritian sugarcane sector is highly dependent on sugar exports and is 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's sugar market, which is historically its most important export market. As Figure 2 shows, EU sugar sales have decreased significantly over the 2005–2018 period, forcing MSS to diversify its export destinations to regional markets—mainly Kenya, South Africa, and Tanzania—and other markets—including Israel, China, and Canada. The MSS-type of monopolistic marketing structure is also found in some other sugar-exporting countries. Although this marketing arrangement has benefits in allowing for economies of scale in marketing and increasing bargaining power through larger volumes, it takes away the ability of sugar mills to design individual marketing strategies to reach niche markets and fully benefit from such efforts. An analysis of MSS' administration costs for the marketing of sugar showed that

¹⁶ The same three companies control the three existing mills and IPPs (one each). Currently, the IPPs export and are compensated for 55% of the electricity from bagasse they produce and feed the rest to their milling activities.

devolving such function to the private millers may not produce aggregate cost saving (and instead increase aggregate marketing costs as some duplication of functions may occur). Nevertheless, millers may gain additional revenues by having the flexibility of pursuing their own marketing strategies.

The sugarcane sector also contributes 14% of the electricity produced in the country (2018 Energy Mix). As seen in Figure 1, the sugarcane sector has steadily contributed to energy production, although no growth has been seen in its contribution of electricity to the grid given the decline in sugarcane production. The production of electricity has increased mainly through the use of fuel and coal and the share of renewable energy from bagasse declined from 75% in 2015 to 66% in 2018. However, an important recent effort is the objective set out by the Renewable Energy Roadmap approved in 2019 by the Ministry of Energy (MEPU), to increase the share of electricity produced from renewable sources from the current 14% to 35% by 2030. This is important for both the demand for bagasse from sugarcane as well as for alternative sources of biomass—like sugarcane trash, high-fiber/high-energy canes and grasses that could be burnt.

There are multiple governmental and non-government institutions that support the sugarcane sector. The stakeholder map for the sector (see Figure 13 and Tables 1 and 2) includes solely or partially dedicated public sector institutions and agencies, as well as trade associations and unions representing workers, farmers, and processors (millers, IPPs, refineries, distilleries).

The environmental impacts of the sugarcane sector in Mauritius are important but have not been quantified. The production of bagasse is providing a renewable source of electricity. It is also claimed by sector stakeholders that sugarcane provides a valuable landscape for tourism as well as environmental protection for soil and water resources. But the sector also produces negative impacts on biodiversity, causes air pollution and releases other industrial byproducts that have yet to be quantified. 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, climate change can have implications to agriculture and food security more broadly in the country. Increased volatility of agriculture output at a global level, as a result of global warming, could result in an increased frequency and severity of tropical storms as well as higher food prices domestically.¹⁷

The social impacts of the sugarcane sector in Mauritius are important and gender inclusion is of particular concern. The sugarcane sector has an important multiplier effect on the economy, and is a stable source of jobs and income, in particular under current (COVID 19 pandemic) conditions where tourism revenues are limited. But, gender analysis and inclusion in decision-making processes in the sector are lacking: although women represent ¼ of the labor force in the sugarcane sector (Digest Labour, 2018), there is only one woman leading a sector institution (out of more than 15 governmental and non-governmental agencies and organizations). 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

¹⁷ 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.

rates reported by small planters (FSA, 2020)¹⁸. 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.

The impact of added sugars (like the types exported by Mauritius) on human health, is a global concern. Refined white and specialty sugars produced from sugarcane have no significant amount of key nutrients¹⁹, 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. Scientific evidence²⁰ shows the negative impact of added sugar consumption on human health. The Guidance²¹ of the World Health Organization (WHO) strongly recommends a reduction in the intake of added sugar at all age levels, including a halt in sugar consumption in countries with low sugar intake. Therefore, efforts to increase the amount of added sugar consumed by humans should be seen as directly detrimental to human health outcomes.

III. Competitiveness Analysis

Based on recent available estimates, the sugarcane sector incurs losses of Rs1.4 billion annually. On a subsector level, nearly all the economic losses are borne by planters, followed by millers. Under 2019 conditions, refining and power production from bagasse were the only profitable activities for the sector. Figure 16 illustrates net profits and losses by subsector. In a general sugarcane production-wide analysis, the estimates of net present value (NPV) on annual gross and net profits based on revenues from sugarcane (sugar, BTPF, and molasses) show that all management scenarios for corporate estates and small planters return a net loss. Systems with improved management generally provide better returns, but the overall picture of net losses is clear at the farm level, explaining the constant reduction in cultivated area from smallholder farmers.

In order to simultaneously assess the impact of potential future variations of key market drivers or policy changes on the sugarcane sector's bottom line (either revenue, costs or both), the competitiveness model used Monte Carlo simulations²². This involved establishing parameters for each of the simulations identified by sector stakeholders and experts that could impact the sector's competitive position. The policy variables modeled included those with some degree of influence from sector stakeholders (see Table 3 for a list of variables).

A number of policy changes were considered for the competitiveness analysis, but were not modeled due to the low impact on the sector's bottom line or because no data was available. Some of the

²¹ See: <u>https://apps.who.int/iris/bitstream/handle/10665/149782/9789241549028_eng.pdf</u>

¹⁸ 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.

¹⁹ 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.

²⁰ For a note on the evidence of the impact of added sugars on human health see: <u>https://drive.google.com/file/d/1oJM4OL1Fnm6ktOqPpGylhS36sGDSE2ns/view?usp=sharing</u>

²² 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.

additional 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 (although 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.

The results of the competitiveness analysis 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 an increase in direct public sector support (subsidies/supplemental payments). Figure 16 shows the current (2019) sector-level losses (Rs1.4 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 public 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. Furthermore, external sector 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 a larger reduction in the production of sugarcane and in the number of mills.

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. 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 (see Annex 5 for a review of sugarcane innovation in Mauritius). Recent farm mechanization and replanting efforts were estimated at Rs300 million per year, but with mixed results (LMC, 2015). Nevertheless, the potential

for introducing disruptive technologies in the sector has been demonstrated in several countries²³ (see Box 1 below).

Box 1. The potential for disruptive agriculture technologies in the agriculture sector

Disruptive technologies have the potential to help address many agriculture sector challenges. Disruptive technologies in agriculture consist of digital and technical innovations that enable farmers and agribusiness entrepreneurs to leapfrog current methods to increase their productivity, efficiency, and competitiveness, thereby facilitating access to markets, improving nutritional outcomes, and enhancing resilience to climate change. Agri-tech solutions range from mobile phone apps to solar applications, portable agriculture devices, and bio-fortified foods. Disruptive agricultural technologies (DATs) differ from other agri-technology solutions in that they empower farmers by accelerating agri-food outcomes three- to fivefold or by circumventing the conventions of the value chain to achieve the same or better results—but with a more efficient agri-food outcome. DATs, by addressing the most pressing agricultural challenges, will contribute to improving agricultural outcomes. First, DATs help farmers by reducing the costs of linking various actors in the agri-food system both within and across countries through providing, processing, and analyzing an increasing amount of data faster. Second, DATs help farmers make more precise decisions about resource management through accurate, timely, and location-specific price, weather, and agronomic data and information, which are becoming increasingly important in the context of climate change. Third, DATs can make smallholders and especially marginalized farmers more competitive by leveling the playing field. Even in poorly connected rural contexts, or with marginalized groups that have lower access to information and markets, sophisticated off-line digital agricultural technologies can provide opportunities to help poor and even illiterate farmers. In short, DATs are overturning the sector status quo, providing an innovative approach to addressing system-wide challenges (see Annex 4 for some illustrative examples).

IV. Sector Vision

Sector stakeholders in Mauritius share a consensus on the importance of maintaining the sector in its current size and structure. The various stakeholders in the country have a common view on the need to maintain the current sector size and structure, halting the decline in sugarcane production. This consensus position bodes well to push for reforms and changes towards sector viability. Although a full consensus on all policy reforms and changes to be undertaken doesn't exist, some are more supported than others, in particular policies related to increasing the revenues from bagasse and specialty sugars, and reducing export logistics costs. Furthermore, all sector stakeholders agree on the apparent positive environmental and social impacts of the sector on the country and the economy.

Sector stakeholders rated the increase in the price paid for electricity from bagasse and the reduction in sugar logistics and export costs, as the most impactful, easiest and fastest policy reforms. Figure 19 shows the top 5 policy reforms rated by stakeholders and elucidates which immediate changes can be brought about vis-à-vis their expected sector-level impact. The variables that seem easiest and fastest to implement, with the largest impact include: (i) reducing sugar export-related costs and (ii) increasing the price of bagasse. The remaining impactful changes may take more time and would be more difficult, such

²³ See full report on disruptive agriculture technologies in Africa:

https://openknowledge.worldbank.org/bitstream/handle/10986/33961/9781464815225.pdf?sequence=2&isAllow ed=y

as (i) reducing the share of sugarcane produced in high-tech farms; (ii) increasing the share of specialty sugars sold (as a percentage of total sugar value); and (iii) reducing labor costs.

Most sector stakeholders in Mauritius did not welcome the perspective of further reductions in the size of the sugarcane sector. Although international experts have signaled the probability for the sector to continue shrinking (and even disappearing), the perspective of further reductions in sugarcane production was not well received throughout the various meetings with stakeholders, who argued the incoherence of this vision with the country's history, and the true value of the sector for the economy and the environment. This reaction from sector stakeholders was made clear even after presenting the results of the competitiveness analysis showing that there are some scenarios where the sector is viable (without government support and no drastic policy changes) under further reductions in the size of farmland under sugarcane and the number of mills. The idea that the sector may need to further downsize (or "right size"), was met with strong opposition by all stakeholders. Although this strong position by stakeholders is an opportunity to ensure urgent policy reforms to support the sector, it also presents a challenge at the moment of having a productive discussion on policy options among stakeholders. Given the significant increase in public expenditures needed to support the sector in recent years, the fiscal limitations going forward (due to COVID-19), and the sector's continuous decline, a managed downward transition towards a smaller (but viable) size should be considered as an option for its sustainable development.

Stakeholders of the sugarcane sector in Mauritius are generally empathetic to the position of other sector stakeholder groups, but there are some limitations and gaps in this understanding. As part of the sector vision exercise, several empathy, potential, and stakeholder mappings were undertaken. The results showed that: (i) although workers (trade unions) were the least willing to participate in discussions and develop a joint vision for the sector, they were the only group accepting that further sector downsizing may be happening; (ii) within government institutions, there was no clear advocacy for the taxpayer nor for the consumer of electricity (potentially affected by policy measures being discussed); (iii) there is a false perception that millers are turning a profit or are not interested in the sector; and (iv) opportunities for stakeholders beyond the sugarcane sector are limited overall (non-sugarcane agriculture or energy options are largely off the table).

The sector vision exercises showed that challenges and opportunities in introducing sector changes have been largely underestimated and depend on each type of policy reform. The key policy reforms identified as the most impactful by the competitiveness analysis and by stakeholders, have different degrees of difficulties and timelines. Also, the context in which the proposed reforms are potentially being addressed varies, and stakeholder positions and relationships change depending on the policy change at hand, therefore, a careful roadmap needs to be considered. Excess optimism has been a hallmark of previous sector reports and analysis, which did not bode well for the sector's future. The MAAS (2006-2015) did not achieve its targets for reform and sector growth, the LMC report (2015) significantly underestimated the rate of decline of sugarcane production and mill closures, the JTC report (2018) also continued to promote increases in the level of production under a clearly downward trajectory, and recent reports by various consultant firms continue to base the viability of the sector on a single change (the increase in the remuneration from bagasse). Previous sector reform attempts have not succeeded

because they were opposed by some stakeholder groups within the sector, in particular workers and small farmers. For that same reason, labor reforms have proven to be politically unfeasible and costly.

The institutional analysis of the sugarcane sector undertaken in the context of the vision exercise presented a narrow treatment of the sugarcane sector in relation to other agriculture and energy institutions. The institutions supporting the sector either treat the sugarcane sector as their unique mandate or delegate sugarcane sector analysis and decisions to those specialized institutions. Institutions specialized in sugarcane include government agencies, such as SIFB and MCIA and dependent agencies (MSIRI, CAD, FSA, AMU, SSHU), and trade unions that group workers from the sugarcane sector. Ministerial-level institutions (MOAI, MOFED, MOE) mainly rely on these specialized government agencies and MSS for analytics and for the implementation of programs. Nevertheless, there are some institutions that are multisectoral, such as the Mauritius Chamber of Agriculture (MCA), some trade unions, and the Irrigation Authority (IA) that cover several sectors (beyond sugarcane).

The centralized marketing for the sale of sugar (through MSS) has advantages in terms of economies of scale in negotiating sales and reducing costs in marketing staff for each miller; but it also has disadvantages in restricting the autonomy of sugar mills to design their own marketing strategy to adapt to changing conditions. In the past, with a multiplicity of sugar mills, MSS played an important role in using the volume of the sugar being produced in the country to negotiate better contracts and to reduce the marketing cost for each mill, as these function would be pooled for the sector. However, under the current situation with only 3 mills operating, an increased focus on specialty sugar markets, and with a multiplicity of export markets (more than 50), the sector may be better of by devolving the autonomy of implementing differentiated marketing strategies to each mill. Nevertheless, the mills continue to support MSS' role and value added. A benchmarking on the administrative and operating costs of MSS in relation to other countries like Australia and eSwatini was conducted, and it is within the range of 1 to 2% of total export value.

V. Policy Options

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 what future policy makers set as the objective to be reached for the sector. 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 additional direct taxpayer support if it is to have a high likelihood of being a viable scenario over the next decade. Another alternate viable future is where the sector stakeholders, but would require a managed transition plan (in particular for smallholders and workers) and could require less direct taxpayer support. A third future is where the sector to support the transition to other alternative economic activities for farmers and workers (See Figure 5).

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. 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 20 shows the current (2019) sugarcane sector deficit of Rs1.4 billion with the expected (maximum) impact that could be envisaged if the most impactful public policies and programs were undertaken.

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) increase 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. Nevertheless, given the consensus among most sector stakeholders on the need to maintain the current sector size, the risk may be worth taking.

If any of the above policy and sector changes is not possible, particularly the availability of direct taxpayer support, the analysis shows that the rightsizing of the sector is the only viable option. Although most scenarios for sector downsizing show continued losses, two rightsizing scenarios show a good probability of profits over the next decade. Their viability is based on the focus of the sector on the production and export of specialty sugars. These two scenarios were modeled without adding any policy changes like the ones mentioned in the previous paragraph. The fact that only a few sector downsizing scenarios present a positive outlook means that there needs to be a "managed" rightsizing of the sector to ensure a focus on specialty sugar production, but also to ensure an appropriate support for the transition of farmers and workers to other activities. This option may not be politically acceptable at present, but considering such an option would be important, given that: (i) the sector continues to shrink in an unmanaged manner; and (ii) there is currently no specific effort to help small farmers and workers transition out of the sugarcane sector. Annex 2 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. The managed rightsizing of the sector would involve to key actions: (i) to support the transition of small farmers out of sugarcane production; and (ii) to support workers of the sugar industry to transition to other sector or to retire early. Box 2 below shows an initial estimate of the support needed for such transition.

Box 2. Estimated support to small sugarcane famers and workers to transition out of the sector

The rightsizing scenarios show viability for 1 mill operating at approximately 1 million tons of sugar or 2 mills operating at 2.6 million tons of sugar. This would mean a loss of jobs for about 800 to 2000 workers and an exit from sugarcane for 3000 to 6000 farmers, mostly smallholders. At an approximate Rs1.5 million per worker for early retirement, a worker transition plan could mean a cost to taxpayers (if early retirement is to be financed by public sector) of Rs1.2 to Rs3 billion. 65% of workers in the sugar sector are less than 10 years from retirement (compared to 28% of the total working population), which could mean an opportunity to transition these workers out of the labor force while helping the competitiveness of the sector.

In relation to the transition of smallholders, a decoupled payment could be implemented to allow small farmers surrounding the areas of the closing of the mill to choose to remain in the sector (and ship sugarcane to other mills) or to transition out of sugarcane. These payments could be equivalent to the current level of producer supports provided to smallholders (approximately \$1.5 billion in 2018), amounting to approximately Rs75,000/ha. For those competitive smallholders, this amount (especially if it is confirmed over a fixed set of years into the future) would be enough to push them into viability by allowing for on-farm technology improvements; while for those smallholders that have manual harvesting systems and are operating in marginal lands, this amount could serve as investment into transitioning to other economic activities. This amount seems appropriate given the annual losses of Rs 1.4 billion that the sector faces and the Rs1.5 in annual taxpayer transfers that has been observed in the past years.

As the sector can potentially disappear over the next decade or two, immediate no-regret policy actions would be required to improve its competitive position. Regardless of what future policy makers choose for the sector, there are a series of *no-regret* options that can be implemented as they allow maintaining sector size or supporting its rightsizing, while enhancing its competitiveness. These no regret policy reforms can buy policy makers time until a vision of the future of the sector is decided. 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.

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, in particular MCIA. 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. A list of institutional reforms to accompany sector changes is included in Annex 2.

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 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 imposed 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 and promote further investments by millers and farmers, the amount of resources deployed would need to be approximately Rs 1.5 to Rs2 billion per year, 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 (fair remuneration of bagasse, sector coordination and labor reform are more important for stakeholders than increasing the level of public expenditures to the sector).

VI. Conclusions and Next Steps

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) rightsizing 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 additional taxpayer resources. However, for the time being, regardless of the future envisioned going forward, a series of no-regret policy actions could be immediately implemented to give the sector a chance to halt its decline or to manage the transition to a rightsizing. An initial roadmap for such key, no-regret policy actions (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.

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 markets²⁴ 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.

About the Authors

- Diego Arias is Lead Agriculture Economist in the Agriculture and Food Global Practice
- John Keyser is Senior Economist in the Macroeconomics, Trade and Investment Global Practice
- Imara Salas is an Economist in the Agriculture and Food Global Practice
- Dinesh Surroop is an Energy Specialist in the Agriculture and Food Global Practice
- Davide Signa is an Agriculture Specialist in the Agriculture and Food Global Practice

²⁴ 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.

Maps, figures and tables

Map 1. Sugarcane-producing regions and mills



Source: MSIRI (Note: La Barraque = Omnicane)

Map 2. Mechanization levels and irrigation equipment in corporate farms



Source: MSIRI

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



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





Source: ISO, 2019

Figure 3. 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.





Source: FAOSTAT (2020)

Figure 5. Alternative sugarcane worlds for Mauritius



Figure 6. Evolution of the ex-syndicate price from 2005 to 2020



Source: MSS

Figure 7.



Change in sugarcane production levels, 2005 and 2018



Figure 8: Total Sugarcane Production Costs and Sugarcane yields (bubble size is the sugarcane production volume) - 2018



Source: LMC International and FAOSTAT





Source: Author's calculations based on OECD methodology

Figure 10. Sector-level financial and material flows



Industry structure



Figure 11. Change in the extent of land use 2001–2010 by region

Source: LMC 2015.

Figure 12: Value Added of Agricultural Sector (2018)



Source: Statistics Mauritius

Table 1. Public sector institutions related to the sugarcane sector

Name of	Mandate
institution	

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.
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 quality 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.

Name of	Mandate
institution	
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	Trade unions represent workers in different parts of the value chain. Several unions exist in
unions	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).

Table 2. Non-governmental institutions related to the sugarcane sector

Figure 13.



Mauritius Sugarcane Stakeholder Map

Figure 14. Sugarcane sector costs 2018-19.



Source: Sugarcane sector-reported figures

Figure 15. Sugarcane sector revenues 2019



Source: Sugarcane sector-reported figures





Source: sugarcane sector-reported figures



Figure 17: Employment Share in Selected Sectors (percent) 1975–2019



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)

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



Figure 19. Impact and perceived timeline and difficulty for implementation of selected sector policies (private and public)



Figure 20. Sugarcane sector profits (losses) and potential policy changes/reforms under current production levels



Impact of sector changes/reforms on profits (losses)

Figure 21 – Stakeholder Survey, November 4, 2020 (P=planters; M=millers; T=trade unions) What should the Government do to support the sector?



Acronyms

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
MOFEDMinistr	y 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
ТСН	Ton of Cane per Hectare
VRS	Voluntary Retirement Scheme

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AITIEX 1-GIUSSA	'Y
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: 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: <u>https://grays.mu/export/</u>
Green Premium	Premium paid above the normal price due to environmental services rendered.
Medine	Mauritian company focused on agriculture production among other business lines: <u>https://medine.com/</u>
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 liquor 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	Sugar not originating (produced) in Mauritius, thus imported, mainly for refining purposes.
Omnicane	Mauritian company focusing on sugarcane production and processing: 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 used by the refineries 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: 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.

Annex 1—Glossary

Public	Description	Public budget	Sequencing	Stakeholder
Policy/Program		implications	priority	implications
Increasing the share	An important simulation is what would happen to the	Moderate	Short term	Farmers in marginal
of high-tech	sugarcane sector if the share of sugarcane produced in	(Realignment of current	(Lowering farming	areas, under manual
sugarcane farms	more efficient (high-tech) farms (more than 10 ha, or	farm-level supports to	costs and	production may be
	more than 60 MT of sugar produced) as a percentage of	smallholder towards	incentivizing	affected and would
	total sugarcane further increased from the current level	improved adoption of	consolidation is	need to leave or
	of 81%. Results show that increasing the share of	technology, R&D, and	essential to	consolidate land to
	production from these farms improves the viability of the	farm consolidation)	stopping land	transition to high
	sugar sector, given the difference in yields due to		abandonment and	tech farming. This
	mechanization, cane variety and access to irrigation. This		the further decline	could further reduce
	scenario could lead to an increased level of overall sector		of the sector)	the number of small
	level profits (up to Rs173 million) by reducing overall			farmers from 12'000
	farming costs per MT of sugarcane produced. The			by approximately
	competitiveness analysis shows that investments in			half.
	mechanization, irrigation, and variety improvement			
	could reduce total farm costs by about 5-11 percent for			
	corporate estates and 7-15 percent for small planters in			
	accrued sugar terms. With all other variables held			
	constant, investments mechanization followed by variety			
	improvement and irrigation are likely to provide the			
	greatest benefit to corporate estates. For small planters,			
	investments in irrigation, mechanization, and variety			
	improvement have the greatest impact on cost savings in			
	that order. It is important to consider that the right			
	approach to farm-level improvement depends on many			
	factors that can vary greatly from farm to farm. This is			
	why is important for the public sector support to allow			
	farmers to make investment decisions based on their			
	own reality, rather than conditioning public support to			
	the choice of a particular technology or crop.			
Increase the share of	Although Mauritius can do little to influence world	Low	Short term	The milling operation
specialty sugars	markets, strategies are available to capture more value	(involvement of trade	(As the sector	that is not focused
exported	from the sugar the country sells. Among these strategies	negotiations to open new	modernizes and	on specialty sugar
	is the potential to increase the sales of specialty sugars.		lowers its farming	would need to close

Annex 2—Policy options and programs for supporting the transition of the sugarcane sector of Mauritius

	Recently (2018/2019) 30% of sugar exported (in a per	and existing markets for	costs it is	or realign with the
	MT basis) have been specialty sugars. If current total	sugar exports)	important to find	production of
	sugar production levels are maintained and additional	Sugar exports/	new sources of	specialty sugars
	marketing efforts are made, this share may increase if		revenue)	specially sugars
	additional marketing offerts are made (including the		revenue)	
	additional marketing enories are made (including the			
	possibility of involving sugar remeilers 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.			
Increasing the price	The weighted average price paid by CEB for the past	Low	Short term	CEB and/or
paid by CEB for	three years to all IPPs for electricity produced from	(Involvement to indicate	(Finding new	consumers of
electricity from	bagasse is Rs2.7/kWh. However, the price paid for	CEB to increase its costs	sources of	electricity would
Bagasse	electricity from HFO is up to Rs4.64/kWh (as per data	of productions and	revenue is	need to absorb the
	supplied by CEB). Therefore, the team simulated	eventually tariffs)	essential to	additional cost. In
	increases in the price paid by CEB to IPPs for bagasse to		maintaining the	case the cost is
	equal the opportunity cost of using HFO (the opportunity		sector afloat)	passed along to
	cost of coal would be Rs3.76/kWh). Given that			consumers, tariffs
	international experience shows that without			would increase by
	Government support, the sugarcane sector will likely			4% on average if
	disappear given its lack of competitiveness, HFO was			using the
				opportunity cost of
				bagasse in relation
				to HFO.

Reduction in the sugar export logistics costs	used as an appropriate opportunity cost ²⁵ . 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. 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 <i>low hanging</i> <i>fruit</i> 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 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	High (The measure of reducing labor costs by the industry may need to be accompanied by additional compensation packages and workforce retraining programs. Current voluntary early retirement scheme is approximately Rs1.5million/worker ²⁶)	Medium term (Reducing labor costs could lower costs at the milling level—second highest in the sector—and allow a controlled management of the sector in response to market trends)	Reduction in salaries, benefits, and/or early retirement for the 4000 workers of the sugar cane industry.

²⁵ 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.

²⁶ 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.

	generation at lower costs, focusing on mechanization			
	and automatization of processes. Savings from reducing			
	labor costs could be up to Rs136 million.			
Increasing the price	The approach to sensitivity analysis of molasses pricing	Low	Medium term	Consumers and
of molasses	was simply to model a 10% increase and 10% decrease	(Involvement to broker	(Increasing the	buyers of molasses
	from the base price of molasses. The formulas for	this new price structure	price of molasses	and its derivatives
	determining the molasses price are complex and not	and indexing)	would benefit	could be impacted.
	immediately transparent ²⁷ . However, unlike bagasse,		planters directly,	
	molasses prices are updated periodically and do bear a		providing	
	close resemblance to current world market conditions.		incentives to	
	Based on the data gathered, adjustments on the price of		increase	
	molasses greater than 10 percent one way or the other		production and	
	are difficult to foresee. Even with the introduction of		discouraging land	
	ethanol-fuel blends, the price of molasses is unlikely to		abandonment)	
	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. 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			

²⁷ 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.

	molasses price is not enough to transform the viability of			
Tashualasu	Cane production.	1		Joho may be loot if
Technology	rechnological improvements at the IPP level and in	LOW	Wealum term	Jobs may be lost if
Improvements at	milling (of an estimated maximum of 5%) produce	(Supporting private sector	(If these changes	efficiencies are
processing stages	Savings of RS79 and RS60 minion respectively.	actions for ensuring an	improve	generated around
	rechnological change at the milling level can produce	appropriate business	conversion rates	labor saving
	cost savings of approximately RS21 million. This depends	climate to invest— –	from cane to	technologies.
	In part on perspectives for revenues from sugar	ensuring mix of other	sugar and	
	(speciality) and bagasse.	policy options)	bagasse, they	
			could both lower	
			costs and increase	
			revenues for mills,	
			IPPs, and planters)	
Public sector	Potential savings due to institutional cost reductions are	Low	Medium term	Current sugarcane
institutional reform	less than Rs5 million. However, the impact of	(Supporting detailed	(Creating a more	specific institutions
	realignment sector size, challenges and opportunities	analysis for institutional	dynamic,	may be affected as
	should yield more benefits for the sector and for the	transition and	transparent and	they merge with
	transition of smallholders and workers. In particular, the	establishing	stronger	other multisectoral
	following would be key institutional issues to consider:	compensation packages	institutional	institutions, and this
	 Merge MCIA's policy capacity with the Policy 	and retraining for staff)	setting will be	may result in staff
	Unit of the Ministry of Agroindustry to have an		essential to	reductions.
	agriculture-wide perspective		ensuring the	
	 SIFB should transition to only facilitating 		sustainability of	
	market-based risk financing to the sector, such		the sector after	
	as hedging and insurance (drop its ad -hoc		averting its	
	support to the sector), gradually leaving the		downfall and	
	industry to procure such coverage on their own		preventing the	
	according to specific needs.		reemergence of	
	 MSS efforts to promote sugar sales in 		misaligned	
	international markets should be taken up by		incentives)	
	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.				
Review of sector's	Sector revenues have different sharing arrangements	Moderate	Medium term	Depending on the	
revenue sharing	depending on the revenue source. While sugar and	(A transition plan to	(Protecting	revenue sharing	
	molasses sales have a direct price change pass-through	ensure a medium-term	farmers' incomes	arrangement and	
	to farmers, changes in the price of bagasse paid by CEB	revenue sharing	and creating the	whether the new	
	don't. On the other hand, farmers benefit from a relative	agreement based on the	right incentives	percentages are	
	high percentage (78%) of revenues secured by MSS	payment of sugarcane to	for production will	compensated by	
	through the sale of sugar and molasses compared to	farmers will involve	be essential to	increases in	
	other sugar- producing countries with similar revenue technical assistance and ensuring that		ensuring that	revenues or	
	sharing arrangements. Given that sector losses are an establishment of short term		short term	reduction in costs for	
	focused at present at farm level and at the milling stage,	countercyclical farmer	investments at the	the various	
	a review of the revenue sharing would be needed if	support to complement farm level are		stakeholders	
	changes in the revenue or cost structure are to be	market-based risk	optimized in the		
	introduced. An important proposal on the table to	financing instruments) medium term)			
	ensure the pass-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 would allow farmers to				
	ac-ink themselves from decision- making related to				
	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	,. etween			
	farmers and millers on the quality and price to	llers 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	 Only a 2 out of 6 sector downsizing scenarios 	Moderate	Medium/Long	Planters and millers	
rightsizing	show that a reduction in the area under	(Public expenditures	term	may need to leave	
	production and in the number of mills would	could involve support to		the sector,	

			1 / n . C . I	
	produce sector viability under a comfortable	Tarms and workers to	(A careful	rightsizing the
	probability interval. Therefore, policy measures	transition out of	transition plan	volume of
	would need to ensure that land transitions out	sugarcane)	would take time	production between
	of sugarcane in the right areas and in the least		and several policy	20% and 50%. This
	efficient land. As an example of the importance		changes around	could produce a loss
	of implementing a well-managed transition, the		labor, transport,	of jobs for about 800
	last mill closure caused an increase in additional		and institutional	to 2000 workers and
	transport costs of approximately RS75 million.		arrangements	for 3000 to 6000
	Furthermore, the mills should be geared		should be tackled	farmers.
	towards producing premium prices in order to		first)	
	justify the industry's relative expensive			
	production costs. A well-managed sector			
	rightsizing could turn around the current sector			
	losses of Rs1.4 billion into approximately Rs800			
	million in profits. This would require a careful			
	plan for the transition of farms and workers out			
	of sugarcane.			
Realigning direct	Public expenditures (2018) to the sugarcane sector have	Moderate	Medium/Long	The implications are
public sector support	been increasing in Mauritius due to the decline in	(Mainly public	term	for taxpayers who
towards	revenues from sugar exports. The supports have been	expenditure switching	(Making the	will need to provide
competitiveness and	mainly through supplemental payments provided to	with a medium- term	sector sustainable	support through
socio-environmental	small planters for compensating the drop in sugar prices.	commitment for allowing	in the medium to	public expenditures.
objectives	These types of farmer support are not conducive to	for sector	long term will	but potentially
	improving competitiveness. In order to promote market-	investment/transition and	depend on	benefiting from
	based production investment decisions (rather than	a targeted/smart support	creating the right	environmental and
	government support-based decisions) it would be	design)	incentives for	social services
	important for public expenditures to become less		nlanters and	provided by the
	distortive of farm-level decisions focusing on helping the		industry actors)	sector
	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 rightsizing) support could be geared towards			
	efficiency improvements in agriculture production			
	and/or environmental and/or social objectives (Climate			
	/Nutrition Smart Agriculture, Natural Resources			
	/ Mathion Smart Agriculture, Natural Resources	1		1
	Management etc.)			

Annex 3—Details of implementation issues related to 4 no-regret policy options for supporting the transition of the sugarcane sector of Mauritius



Increase in the share of specialty sugars exported



Potential gain in sector level profits of Rs370 million

Based on an increase in the share (in value) of specialty sugars exported by MSS from 30% to 50%

Issues to address:

- Limited market for specialty sugars
- Significant trade efforts (trade relations and preferential market access)
- Labor shortage is a challenge

Context and stakeholder support:

- Not all millers focus on specialty sugars
- Limited success of Fairtrade sugar

- MCA/MSIRI pilot project for organic sugar to be expanded. More work on proper certification system. MSS & millers need to invest more R&D to create new products. Potential need for international experts

Stakeholder Vision [Medium priority]



Roadmap:

- Need to bring trade negotiation capacity
- High level of support but seen as somewhat complicated and lengthy to implement given the complex trade agreements and limited demand for specialty sugars

Reduction in the sugar logistics and export costs

Stakeholder Vision [Medium priority]



Potential savings in sector level costs of Rs200 million

Involves renegotiating storage contracts and fees for managing export logistics



Issues to address:

- MCIA and MSS to address savings and actions needed to reduce costs

- Warehouse provider BSSD is open to managing inefficiencies to increase capacity but it is political to start anew.



Context and stakeholder support:

- This needs political decision making as the change would not take much time

- Consider for millers to take on the cost of export and marketing.



Roadmap:

- Establish a working group between MSS, Millers, and MCIA to address costs and renegotiate contracts.
- Not seen as very important by some stakeholders, but could be a quick win to signal will towards reforming the sector

Increase the share of high-tech sugarcane farms





What is needed to increase farm-level efficiency for sugarcane production?



Roadmap:

- Review the farm level support structure and incentives in dept, learning from past and current programs.
- Revamp R&D plan to address inter-sectoral synergies and link wit regional centers for improvement of varieties.
- Develop a national replanting plan/variety
 stratogy



Potential savings in farm-level costs of Rs173 million

Involves realigning farmer incentives towards competitiveness objectives and promoting adoption of improved technologies $\label{eq:competitiveness}$

Requires further investments in R&D

Needs to facilitate land consolidation

Issues to address:

- Need to improve MCIA's effectiveness to improve farm level efficiencies

- Irrigation and mechanization programs should be reviewed to promote technology adoption rather than input subsidies.

- Inefficient farms will need to be engaged to have a transition plan out of sugarcane



Context and stakeholder support:

- Overall low importance of such issue among stakeholders.

- Myriad of farm level support programs that have not reaped the intended benefits (need for in depth retrospective)

- Opportunities of ICTs to transform the sector in line with the overall strategy of the country on the digital economy.

Annex 4 – Agricultural Challenges and relevant examples of Disruptive Agriculture Technologies (DATs)

CHALLENGE FRAMEWORK	AGRICULTURAL CHALLENGES	STANDARD AGRICULTURAL SOLUTIONS	DAT SOLUTIONS	ILLUSTRATIVE DAT EXAMPLES
Agricultural productivity	Insufficient advisory and climate-smart services	Producer organizations, extension agents, radio, TV	Agricultural extension and advisory services delivered through videos and platforms linking experts	Digital Green in Ethiopia; Precision Agriculture for Development in Kenya
	Limited access to inputs (tractors) for land preparation	Manual, animal-aided, mechanized	Digitally enabled tractor-hiring services	Hello Tractor in Nigeria
	No systematic pest and disease management	Observe and respond	Real-time alert systems	Waterwatch Cooperative in Kenya
Market links	Poor market access	Farmer cooperatives, intermediaries	Digital platforms for finding buyers and linking buyers and sellers	Tulaa in Kenya; Maano in Zambia; Farmshine in Kenya; Zowasel in Nigeria
Farmer financial inclusion	Insufficient or unfair access to credit and financial products	Moneylenders, family and friends	Platforms for input credit, e-wallets, and insurance products	Agri-wallet in Kenya
Data analytics and agricultural intelligence	No or inadequate access to data for informed decision- making	Intuition based on observation, no solution	Portable soil testers, satellite images, remote sensing	Agrocares, based in the Netherlands and operating in Kenya; UjuziKilimo in Kenya
Energy for agriculture	Poor irrigation infrastructure	Rainfed, manual, gravity- aided	Solar-powered irrigation pumps	SunCulture in Kenya

Source: World Bank.

Note: DATs = disruptive agricultural technologies.

Annex 5 – Review of Public Innovation Investments in the Sugarcane Sector of Mauritius

- Fertilization is a chief driver of increased sugarcane production in Mauritius, yet constitutes a major input cost for planters—representing up to 25 % of the total cost of production. The current R&D activities of the Agricultural Chemistry Department aim at developing fertilizer-best management practices for maximizing profitability while minimizing dependence on mineral fertilizers. Research to investigate the potential for using microbial bio-fertilizers to partly meet the nutrient needs of sugarcane is underway.
- Soil testing and plant analysis are the basis for precise fertilizer application. The analytical services provided by the Agricultural Chemistry Department enable site-specific nutrient management for sugarcane, thus ensuring both the economic and environmental sustainability of the industry. The Agricultural Chemistry Department is developing new spectral techniques, using Infrared Spectroscopy and X-Ray Fluorescence Spectroscopy, to provide high-throughput analytical services to the sugarcane farming community. This will further enhance nutrient use efficiency in sugarcane.
- The Agricultural Chemistry Department has also contributed in the development of **high value-added co-products of sugarcane** to diversify the revenue base of the industry. These include the development of low glycemic index sugar and high antioxidant sugar, as well as the production of bioplastics from sugarcane harvest residues.
- Best cultural practices are key to improving yields and reducing costs. A New Cropping Systems (NCS) for sugarcane production has been advocated for mitigating yield decline. "The NCS is based on four pillars: reduced tillage, control traffic, leguminous fallow break and green harvesting. Dual row planting at 1.90 m to match machines track widths is being adopted on some 8,000 ha while green cane harvesting is adopted on more than 95% of cultivated area. Tillage operations have thus been reduced either in depths or in the number of passes. The legume break is being introduced currently. The above practices are expected to restore yields significantly and minimize losses.
- Current studies on trash collection for biomass focus on the adverse effects of collecting 50% of the trash left after harvest. This project has been successful in assisting the industry in their decision-making process and some 16,000 tons of trash were collected in 2018, generating more than 15 GWh of electricity. Preliminary results are confirming that no agronomic risk are linked with trash collecting and therefore can be extended over bigger areas in coming years. Such studies are fundamental in ensuring that the industry embarked on sustainably new practices without jeopardizing the environment.
- MSIRI is participating in a project to develop the roadmap for the cropping systems pertaining to **organic sugarcane production**. It is expected to produce some 10,000 tons after the precertification period and organic sugar is known to be an alternative for more remunerative prices.
- In collaboration with a research center from France, MSIRI is investigating biomass production to enhance bioelectricity production. Some 5,000 to 6,000 ha where cane yields are <60 t/ha have been identified and may be converted to energy cane or other biomass species. Developing cropping systems for cost-effective production of maximum biomass from energy cane has also been addressed. It is expected that the positive outcomes will contribute to decision to convert the marginal lands into more productive use.

 Applications of Drone Technology/Remote Sensing for agronomic practices are a necessity for the industry. MSIRI is evaluating the use of drones for multispectral data collection for development of algorithms or rule sets for a better monitoring of crop production parameters. Drone spraying of herbicides and ripeners are also targeted. The applications developed will allow more precision farming –correct spatial variability in fields more easily and minimize inputs accordingly. Localized spot application of herbicides against vine weeds in fields of canopy closure will be a tangible benefit.