Mobilizing innovation:
Sugar Protocol countries adapting to new market realities[1]

Johannes Roseboom

Innovation Policy Consultancy
Bastion 26
4351 BG Veere
The Netherlands

Tel: (31) 118-594274
E-mail: j.roseboom@planet.nl

Abstract

The EU Sugar Reform has negative consequences for the sugar industries in Sugar Protocol (SP) countries as their export revenues will decline sharply. In order to adapt to new market realities the EU is offering the SP countries a significant development assistance package (€ 1.2 billion) to restructure their industries as well as various other forms of assistance. One of them is a five-year ACP sugar research programme to be funded by the European Development Fund. This programme aims to improve the overall competitiveness of the sugar industry in ACP countries (and in particular in the SP countries among them) in order to survive in a less-protected global sugar market. At the same time, the Everything-But-Arms (EBA) agreement has created new opportunities for sugar-producing EBA countries to export to the EU sugar market.

Another major driver for innovation in sugar industry is the use of sugarcane or sugarcane waste as a source of renewable energy. The latter option (using sugarcane waste for energy production) is the better bet for SP countries in the short run, but in the long run energy production may become the core business of the sugarcane industry and sugar just a by-product. It will depend, among other things, on the oil price, the efficiency with which sugarcane can be produced and transformed into energy, continued access to preferential markets for sugar, and subsidies for renewable energy.

The impact of the ACP research programme on the competitiveness of the sugar industry will only materialize a considerably number of years down the line. In the case of sugarcane breeding, for example, it may take as long as 15 years before a new variety will be released commercially. This will be too late for high-cost producers in SP countries to survive. The better solution for them is to focus on how they can catch up faster on existing technologies – by planting new sugarcane varieties, improving sugar fields and agronomic practices, and benchmarking the performance of their sugar mills in order to identify best practices.

[1] Published in *Development Economics between Markets and Institutions: Incentives for growth, food security and sustainable use of the environment*, edited by Erwin Bulte and Ruerd Ruben. Wageningen: Wageningen Academic Publishers, 2007.

1. Introduction

In recent years, analysis of the impact of the EU Sugar Reform on third countries (and in particular the Sugar Protocol countries) has been dominated by trade models. However, now that the key parameters of the EU Sugar Reform have been set and are being implemented, the policy focus has shifted to how these countries can adapt to new market realities. The *EU Action Plan on Accompanying Measures for Sugar Protocol Countries* (EC January 2005) with a total budget of approximately € 1.2 billion for eight years is playing a lead role in this process. But also various other instruments are being mobilized to facilitate the adaptation process, including an ACP Sugarcane Research and Innovation Programme to be funded by the European Development Fund (EDF). A budget of € 13 million has been set aside for this (still-to-be-approved) five-year programme.[2]

This paper aims to provide an overview of the strategic policy choices that the Sugar Protocol countries are confronted with and focus on the question how innovation, both technically and institutionally, could facilitate their adaptation strategies. First, however, an overview of the broader context will be sketched in order to better understand the drivers for innovation.

2. The Global Sugar Market and the EU Sugar Reform

Sugar is an important ingredient in people's diet the world over and sugar production (both from sugarcane and sugar beet) is widely distributed. During 2005/2006 season, total world sugar production reached nearly 150 million ton – of which 76% originated from sugarcane and 24% from sugar beet. Since the 1980s, all growth in sugar production (on average 2% per year) is coming from sugarcane, while sugar production based on sugar beet has been stagnant or contracting. Currently, 69% of the world's sugar is consumed in the country of origin whilst the balance is traded on world markets. This makes it one of the more intensively traded agricultural products in the world.

What makes sugar in particular a 'difficult' commodity is that sugar markets have a long history (often going back to colonial times) of being heavily regulated by governments the world over. Two such regulations are:

1. The *EU Sugar Regime*, which regulates the internal production, import and export of sugar of the European Union by means of fixed, national production quota, import restrictions, and an internal intervention price that is substantially higher than the world market price; and
2. The *ACP/EU Sugar Protocol*, signed by the EU and some 18 ACP countries,[3] regulates that these countries have the right to export a certain quota of sugar (i.e., approximately 1.3 million ton in total) to the EU at a guaranteed price (related to the price paid to European farmers) and on a duty-free basis. While at the time of signing the treaty (1975) the internal EU price was close to (or even below) the world market price, in most of the years after 1975 the EU sugar price exceeded the world market price quite significantly. In recent years, for example, the EU sugar price has been

[2] This paper is based on the feasibility study for this programme (Roseboom, Kooistra and Pabon [May 2007]). I would like to thank my colleagues Taco Kooistra and Claudia Pabon for their input into this study.

[3] Barbados, Belize, Congo (Republic of), Cote d'Ivoire, Fiji, Guyana, Jamaica, Kenya, Madagascar, Malawi, Mauritius, Mozambique, St. Kitts & Nevis, Swaziland, Tanzania, Trinidad, Zambia, and Zimbabwe. Surinam and Uganda originally also were Sugar Protocol countries, but stopped exporting to the EU many years ago. Their quotas have been redistributed.

roughly three times the world market price. In particular for countries that hold large Sugar Protocol (SP) quotas (such as Mauritius, Fiji, Jamaica, and Swaziland, which jointly hold 80% of the SP quota) this Treaty has been very profitable. Some SP countries, for example, import sugar for own consumption in order to fill their SP quota. In addition, further market access is given by the Agreement on Special Preferential Sugar (SPS), granting temporary import quotas for some 17 ACP countries (some 200,000 ton in 2002/03).

Despite the fact that at the pre-reform price level the EU produced more than enough sugar (19-20 million ton) to cover internal consumption (16-17 million ton), the SP meant that it had to import the agreed quota and at the same time dump a surplus of sugar (4.7 million ton) on the world market at high cost. This practice has been under criticism as unfair to developing countries for a long time. It is one of the classic examples of the No Aid but Trade Campaign. However, the two major reasons that triggered the EU Sugar Reform were:

1. A successful complaint by Australia, Brazil, and Thailand (three major sugar exporters) at the WTO that some of the EU sugar export practices are in conflict with international trade agreements. These agreements have placed explicit limits on the volume of subsidized sugar export by the EU; and.
2. The Everything-But-Arms (EBA) agreement, which gives the poorest countries in the world free access to the EU market, including the EU sugar market for which there is a special transitional regime. Sugar import quota and levies for EBA countries exporting to the EU are to be phased out by 2009. In contrast to the SP countries, no import quota restrictions will apply to the EBA countries in the future. Given the high EU sugar price, the EU sugar market feared to be swamped by sugar from EBA countries after 2009. Studies differ in terms of the magnitude of the immediate supply response by the EBA countries, but a major supply response in the long run in the case of no price adjustment is the most likely scenario upon which to base policy decisions.

In response to these emerging problems, the EU decided to reform its sugar policy drastically and reduce the internal EU price for sugar with 36% over the period 2006 to 2009. The expected outcome of this reform is that the European sugar production will contract sharply as high-cost producers will stop producing and hand in their quota. Their quota will not be redistributed to low-cost producers in other European countries. All-in-all, it is hoped that this reduction in production (in combination with an increase in import due to the EBA agreement) will be sufficient to reduce subsidized EU sugar export to acceptable levels under WTO agreements (EC June 2005).

The reduction of the internal EU price for white sugar with 36% will also affect the EU sugar import from SP countries. The quotas as such remain untouched (and unused quotas can be redistributed), but the price paid for sugar will decline significantly. Despite the sharp price reduction, the EU internal sugar price will still be double the world market price, and hence will remain an interesting export market for most SP countries. Nevertheless, the reduction in revenues requires that they adjust and streamline their sugar sectors significantly.

Oxfam, one of the more vocal players in the EU Sugar Reform debate, proposed a reduction of the EU sugar production quota with 25% rather than a reduction in the EU sugar price (Oxfam 2002). In that way the SP countries (as well as the EBA countries) could continue to benefit from a high EU sugar price. However, the EU opted to induce internal quota reductions indirectly through a major price reduction. In that way high-cost sugar producers in

Europe are expected to give up their quota first and new sugar imports from sugar-exporting EBA countries will be dampened.

While most parties involved seem to accept the price reduction as inevitable in order to rationalize the global sugar market, the EU is under criticism because of the short time period within which the price reduction will take place (i.e., four years) and the limited amount of adjustment funding made available for the SP countries. At the same time, sugar-exporting developing countries that fall under the EBA agreement may increase their export to the EU market in the coming years as import restrictions (quota and import tariff) will be gradually lifted. At the same time, however, they are also confronted with the lower EU sugar price due to the EU Sugar Reform. Hence the supply-response by these countries will be more limited than in a scenario without an EU sugar price reduction. In the latter instance, some studies predict an additional 3 million ton of sugar entering the EU by 2010, while with the EU price reduction the EU sugar import from EBA countries is estimated in the range of 0.2-0.9 million ton of sugar, depending on the assumed substitutability between European sugar and sugar from EBA countries (van Berkum et al. 2005).

While the trade models show that the countries that formally complained about the EU sugar export practices (Australia, Brazil and Thailand) hardly gain from the EU Sugar Reform, it is clear that the SP countries will be big net losers of the EU Sugar Reform. They will see their export revenues from sugar decline with some 36% (assuming no reduction in the volume of export). On an annual basis this will be a loss of some € 245 million in export revenues for the SP quota (1.3 million ton) and some € 36 million for the SPS quota (0.2 million ton). At the same time, the EBA countries will gain, but substantially less than under a scenario of no price reduction.

In the following chapters, we will have a closer look at the SP countries and their options to respond to this drastic reduction in income.

3. Some Key Characteristics of the Sugar Protocol Countries

In terms of sugarcane production, the 18 SP countries represent only a very small share (3%) of the world-wide sugarcane production (Table 1). The real big producers in the world are Brazil and India, which together are good for half of the world sugarcane production. Other important producers are China, Thailand, Pakistan, Mexico, Colombia, Australia, USA, Indonesia, Cuba, South Africa and the Philippines (all producing more than 25 million ton of sugarcane per year). Most sugarcane is transformed into sugar, but some is also used to produce alcohol and (increasingly) ethanol as well as many other products.

Table 1: Worldwide Sugarcane Production

	Sugarcane production (2001-2005 average)	
	(million ton)	(percentage)
Sugar Protocol countries (18)	39.4	3.0
Brazil	388.9	29.7
India	270.0	20.6
Other countries (98)	610.7	46.6
Total (118)	1,309.0	100.0

Source: FAO production statistics, downloaded April 2006.

The cost price of sugar varies greatly across the various sugar exporting countries (Figure 1), indicating that the reduction of the EU sugar price (from roughly three times to two times the world market price) will affect some SP countries a lot harder than others. Even at the high pre-reform price level, the sugar industries in several Caribbean countries were already making losses (Barbados, St Kitts & Nevis, and Trinidad & Tobago). For these countries adjustment to the lower price level will be difficult, if not impossible. St Kitts & Nevis and Trinidad & Tobago, for example, have decided to stop producing sugar. Barbados is in the same league, but wants to transform its industry from producing sugar to producing energy. Jamaica stands out as the country for which the dice could go either way – either the industry is being rationalized and modernized significantly and will survive or it has to close down. Explanations for the high cost of sugar production in the Caribbean are: (a) a lack of economies of scale; (b) a high cost environment (relatively expensive labour and land); (c) poor management due to government ownership; and (d) lack of capital to renew plants and improve sugar fields. The sugar industries in these countries have already been in decline for some time (as reflected by declining trends in production and yields) and the EU Sugar Reform just gives the final blow to an already weak industry.

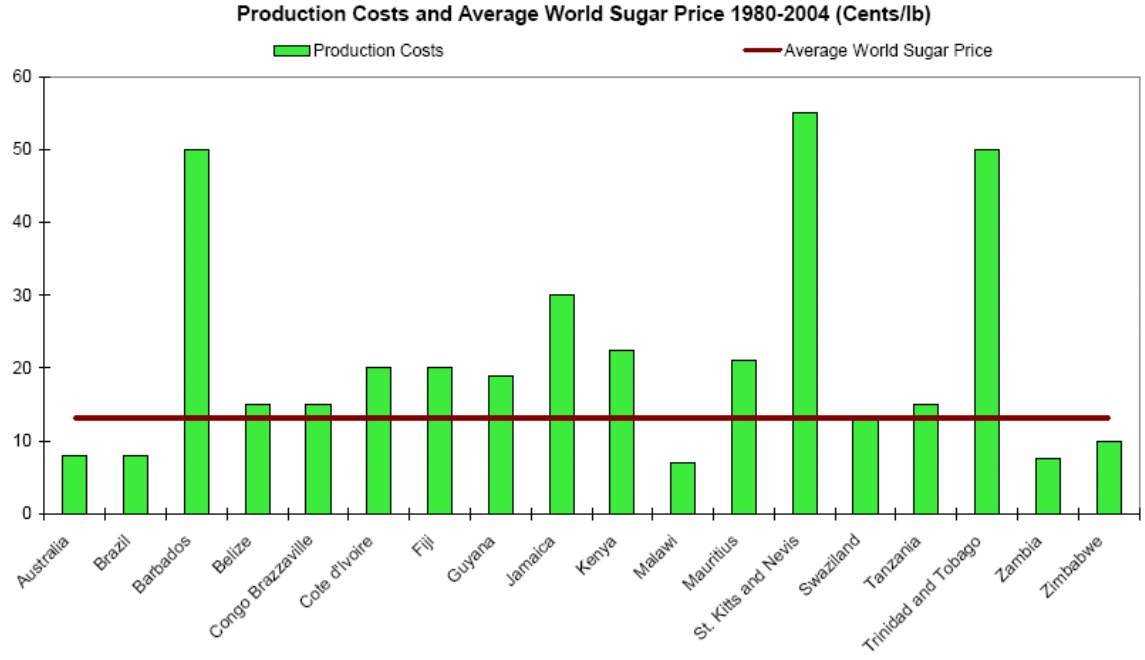

Figure 1: Sugar Cost Price Comparison
Source: Garside et al (2005)

Factors apart from the sugar cost price that matter in terms of understanding the vulnerability of SP countries as a consequence of the current EU Sugar Reform are:

1. The relative dependence of the sugar industry in SP countries on the EU market. Table 2 characterizes the SP countries on the basis of two variables, namely the sugar export as a percentage of sugar production plus import and the share of the EU in the country's sugar export. Countries with sugar industries located in the lower, right-hand corner are the ones most affected by the EU price reduction. Interestingly enough, some exporters are big importers themselves. We also identified the SP countries that fall under the EBA agreement and hence will benefit from no longer being bound by EU import quota after 2009; and

2. The relative size of the sugar industry in the overall economy (in terms of share in GDP and employment) and in terms of export earnings. In four SP countries (Fiji, Guyana, Mauritius, and Swaziland), the sugar industry represents more than 5% of GDP and in six SP countries (as above plus Belize and St Kitts & Nevis) sugar export earning exceed more than 10% of total export earnings. Hence sharp reductions in sugar earnings in these countries can easily lead to macro-economic instability. In addition, social and environmental concerns play a major role in these countries as well.

Table 2: Dependency of the Sugar Industries in Sugar Protocol Countries on Export to the European Union

		(Sugar Export) / (Sugar Production + Import)		
		0-25%	25-75%	75-100%
Share EU in country's sugar export	0-25%	*Congo, DR* *Mozambique* *Zambia*		
	25-75%	Cote d'Ivoire Zimbabwe	Belize *Malawi* St Kitts & Nevis Swaziland	Fiji Guyana
	75-100%	Kenya* *Madagascar** *Tanzania*	Jamaica* Trinidad & Tobago*	Barbados Mauritius

Note: Countries in italics also fall under the EBA agreement and hence will after 2009 no longer be constrained in their sugar export to the EU by EU import quota.
* Major sugar importers.

While the sugar price reduction by the EU is looming as a big threat to at least some of the SP countries, at the same time new opportunities are emerging for the sugarcane industry in the form of creating additional value by producing bio-ethanol and electricity out of sugarcane waste. Many of these energy generating activities have become profitable in recent years due to a high oil price as well as technological development. This opportunity is in particular attractive for SP countries that are struggling with high energy import bills. In addition, there is a rapidly growing market for bio-ethanol due to the renewable energy policies of the EU and the USA.

4. EU Policy Measures to Accommodate the EU Sugar Reform

In recognition of the socio-economic consequences of the EU Sugar Reform on SP countries, the European Commission has promised a package of accompanying measures to facilitate the adaptation of these countries to a new market situation. This package was first presented in January 2005 under the title 'Action Plan on Accompanying Measures for Sugar Protocol Countries Affected by the Reform of the EU Sugar Regime' (EC January 2005).

Considering the differences between the SP countries, in terms of the intensity of the impact of the reform as well as possible responses, the Action Plan offers a broad range of support options, to be tailored to each situation. It includes both trade measures and development assistance to help the SP countries to adapt. Favourable trade measures are expected to emerge from the current round negotiations within the WTO as well as from the bilateral negotiations of the EU with the ACP countries on Economic Partnership Agreements. Although these trade measures are important, in this paper we will focus on the second

component of the Action Plan, namely the package of development assistance that the EU has offered to the SP countries for the period 2006-2013 in order to adapt to the new market situation. The total budget envelope for this assistance runs up to approximately € 1.2 billion.

The Action Plan argues that the development assistance can be provided mainly along three different axes: (1) Enhancing the competitiveness of the sugar sector; (2) Promoting the diversification of sugar-dependent areas; and (3) Addressing broader adaptation needs, such as employment and social services, environmental impact, and macro-economic stability. A positive assessment of the viability of at least part of the sugar industry is an essential prerequisite for directing EC support towards enhancing competitiveness. If not, priority should be given to measures along the other two axes. The Action Plan discusses various possible measures along each of the three axes, but leaves the actual selection of the required measures to each of the SP countries.

To get access to the Action Plan funding, the 18 SP countries have each been requested to develop a multi-annual, comprehensive adaptation strategy in close consultation with all the stakeholders in the sugar industry. Although an important first step in shaping up the development assistance package under the Action Plan, the process took place under a cloud of political friction between the EU and the SP countries. Accepting the EU Action Plan basically meant accepting the EU Sugar Reform. By mid-2006, however, 13 of the 18 SP countries had developed and submitted to the EC a national adaptation strategy for their sugar sector. However, the quality of these national adaptation strategies differs greatly and has often been negatively affected by an atmosphere of animosity and the idea of trying to squeeze as much assistance out of the EU as possible. A problem is that many of the submitted strategies do not really prioritize the required actions (they want to do everything under the sun), nor indicate how they will be financed and implemented. The total estimated costs of the national adaptation strategies are many times higher than the available EU budget. In many instances it is unclear how the full strategy will be financed, taking into account the different possible funding sources. This basically disqualifies many of the strategies as effective planning tools. Nevertheless, the EC has accepted the national adaptation strategies as a starting point and has selected in each country key areas on which it will focus its assistance. What will happen with those parts of the strategy that do not receive EU funding is often unclear or highly insecure.

Despite the overwhelming emphasis on improving the competitiveness of the sugar sector, investment in sugar research features only in a few of the strategies in a significant way. Moreover, in selecting priority areas for EC support this opportunity of supporting competitiveness further disappears into the background and is left to the industry to take care of. This is rather unfortunate, particularly in upcoming sugar producing countries that still lack any significant sugar research capacity of their own.

The three most common themes across the national adaptation strategies put forward by the SP countries are: (1) Increased productivity at both field and factory level; (2) Diversification into ethanol and electricity production (which will require major capital investments); and (3) Social measures to support people that will loose their job due to the restructuring of the sugar industry. Interestingly enough, many SP countries (in particular EBA countries) are optimistic about their future opportunities in the sugar industry and aim to expand production. The strategies of those countries usually also include further investment in infrastructure (irrigation, roads, railways, etc.) and opening up of new land for sugar production.

Enhancing the overall productivity of the sugar industry stands out as an essential requirement for the SP countries to stay in business and continue to benefit from a substantially less attractive, but still significant preferential trade agreement with the European Union (the new EU sugar price will still be roughly double the world market sugar price). In the following two sections of this paper, we will first look at the research and innovation capacity in place in SP countries (chapter 5) and subsequently at the contours of a sugar research and innovation agenda (chapter 6).

5. Sugar Research and Innovation Capacity

Sugarcane is a plantation crop, organized and managed predominantly in large production units. Due to their size, sugar estates can afford to employ agricultural specialists to bring advanced technical expertise to the enterprise. Also the sugar mills employ the necessary technical specialists for chemical analysis and controlling the various factory processes. All-in-all, sugar companies with stakes in both sugarcane production and processing usually employ a substantial cadre of trained technical specialists. However, the research capacity of these in-company technical services (other than some adaptive trials and testing) is usually rather limited.

A common phenomenon in many sugar-producing countries (often inherited from colonial times) is for local sugar companies to organize and finance their technical services jointly. Depending on the size of the sugar industry, this joining of forces allows them to move into more advanced research activities for which they individually lack the capacity. Classic examples of industry-based and funded sugar research institutes are the South Africa Sugar Research Institute (SASRI), the Mauritius Sugar Industry Research Institute (MSIRI), the Sugar Industry Research Institute of Jamaica (SIRI), and the West Indies Central Sugarcane Breeding Station (WICSCBS). The latter is a regional entity.

Table 3 provides an overview of the sugar industry in the different SP countries, including their sugar research capacity. In about half of the SP countries the sugar industry is monopolized by just one public or private company that owns all the sugar mills. Such companies often also own major sugar plantations, but do not necessarily control all sugarcane production. Some of the production may come from independent smaller sugar plantations, but increasingly also from smallholders who operate as outgrowers for the larger plantations. Prices paid to independent sugarcane producers under such monopolistic situations are a permanent cause for conflict. In many countries institutions have been created to deal with this problem (like Sugar Boards and Authorities) and have been given the authority to set a fair sugarcane price for both producers and processors. Nevertheless, conflicts are still quite common and in particular about incomplete and delayed payment and corruption.

Sugar research and innovation is foremost an in-company activity and particularly so in countries with just one sugar company. Specialized, stand-alone sugar research institutes and technical services only occur when there are multiple local sugar companies.[4] However, the balance between intramural and extramural technical capacity can differ quite a bit from country to country. In some, like Mauritius, there is a long and strong tradition of collaboration and so the industry is depending heavily on MSIRI for technical input, while in

[4] The exception, Fiji, has only recently created a sugar research institute after complaints by sugar growers that the Fiji Sugar Corporation was not doing enough.

other countries, like Mozambique, the technical collaboration between the sugar companies has been relatively weak (or non-existent) and far less research and technical services are undertaken jointly.

Table 3: Overview of the Sugar Industry and Sugar Research Capacity in the Sugar Protocol Countries

Country	Sugar companies	Sugar research
Barbados	The sugar industry is owned by the government, which has contracted Barbados Agricultural Management Company (BAMC) to manage it.	BAMC has an Agronomic Research and Variety Testing Unit as well as a Sugar Technology Research Unit. Barbados also houses the West Indies Central Sugarcane Breeding Station (WICSCBS), which has a regional mandate.
Belize	Belize Sugar Industries Ltd (BSI) and Petrojam Ltd. are both privately owned, but have been granted monopolies by the government.	BSI: R&D Unit
Congo, Republic of	Société Agricole de Raffinage Industriel du Sucre (SARIS-Congo) is owned by SOMDIAA, a group of food processing industries in various French-speaking African countries.	No specific information available.
Côte d'Ivoire	Industry dominated by two companies: Sucrivoire and Sucre Africain (SUCAF).	Centre National de Recherche Agronomique (CNRA): conducts contract research for the two sugar companies
Fiji	Fiji Sugar Corporation (FCS) holds a sugar monopoly and is state owned.	Sugar Research Institute of Fiji (SRIF), established in 2005 as a tripartite partnership between FCS, the Fiji Sugarcane Growers Council and the Government of Fiji. Previously the responsibility for sugar research rested with FSC.
Guyana	Guyana Sugar Corporation Inc. (GUYSUCO) holds a sugar monopoly and is state owned.	GUYSUCO: Agricultural Research Centre
Jamaica	Seven mills (Frome, Monymusk, Bernard Lodge, Appleton, Worthy Park, St. Thomas, and Trelawny) are still in operation of which at least three are expected to be closed down. All mills are state-owned. Proposed restructuring of the industry includes privatization of the mills.	Jamaica Sugar Industry Authority: Sugar Industry Research Institute (SIRI)
Kenya	Some 8 sugar factories in operation: Busia Sugar Company, Mumias Sugar Company, Muhuroni Sugar Company, Nzoia Sugar Company, Chemelil Sugar Company, South Nyanza Sugar Company, West Kenya Sugar Company, and Miwani Sugar Company. Most companies are partly owned by the government.	Kenyan Sugar Research Foundation (KESREF), established in 2000, took over all sugar research previously conducted by the Kenyan Agricultural Research Institute (KARI). This restructuring was the result of an attempt to shift the full responsibility (including financing) for sugar research back to the industry.
Madagascar	Industry dominated by two companies: Siramamy Malagasy (SIRAMA) and Sucrerie Complant de Madagascar (SUCOMA)	Centre Malgache de la Canne et du Sucre (CMCS)
Malawi	Illovo Sugar (Malawi) Ltd. (previously a government monopoly).	Illovo Sugar (Malawi) Ltd: R&D unit

Country	Sugar companies	Sugar research
Mauritius	As part of the adaptation strategy, the milling capacity has been rationalized significantly. Only four mills will stay in operation, namely: Savannah, Rose Belle, Mon Loisir, and Mon Desert Alma. The first two mills are owned by the 'Societe Usiniere de Sud' in which various shareholders participate.	Mauritius Sugar Industry Research Institute (MSIRI) and the University of Mauritius (several sugar-related departments)
Mozambique	Industry comprises four privately owned companies/mills: Maragra Mill (Illovo), Mafambisse Mill (Tongaat-Hulett), Marromue Mill (Sena Holdings Ltd), and Xinavane Mill (Tongaat-Hulett). All four mills are in foreign hands.	Centro de Promoção da Agricultura (CEPAGRI) (formerly Instituto Nacional de Açucar)
St. Kitss & Nevis	St. Kitts Sugar Manufacturing Corporation (state owned): In the process of being closed down.	St. Kitts Sugar Manufacturing Corporation: Agronomy and Research Department
Swaziland	Industry dominated by four companies: Mhlume and Simunye (Royal Swaziland Sugar Corporation), Tambankulu Estates (Tongaat-Hulett), and Ubombo (Illovo).	Swaziland Sugar Association: Technical Services.
Tanzania	Industry dominated by three companies: (i) Kagera Sugar Company Ltd. (Sugar Industries Ltd.); (ii) Killombero (Illovo); and (iii) Mtibwa Sugar Estates Ltd (Tanzania Sugar Industries).	Kibaha Sugarcane Research Institute (Ministry of Agriculture) and the National Sugar Institute. The latter focuses primarily on training, but conducts some research as well.
Trinidad & Tobago	Caroni Ltd. (state owned) has been dismantled. Caroni's sugar refining business will continue as the Sugar Manufacturing Company Ltd, processing imported raw sugar.	
Zambia	Nkambala, owned by Zambia Sugar PLC / Illovo, covers some 90% of the market. Kafue (Consolidated Farming Ltd) covers the remaining 10%.	Nkambala depends, through its mother company Illovo, on sugar research capacity in South Africa.
Zimbabwe	Industry dominated by two plants: Triangle Mill and Hippo Valley Estates. Tongaat-Hulett, which already owned Triangle Mill, has recently also taken over Hippo Valley Estates.	Depend, through Tongaat-Hulett, on sugar research capacity in South Africa.

A complicating factor in the case of Mozambique (and also in other African countries, like Malawi, Swaziland, Zambia and Zimbabwe) is that the ownership of the sugar companies is no longer exclusively national. In particular South African sugar companies nowadays own quite a number of subsidiaries throughout southern Africa and rely heavily on the technology base at home (i.e., SASRI and Sugar Milling Research Institute [SMRI]). Rather than investing in building local sugar research capacity, these companies prefer to contract out research to SASRI and SMRI. In the short run this gives them the best research results money can buy. In the long run, however, this will keep the host countries dependent on imported sugar technology. A national sugar research and innovation strategy may counterbalance such dependence and prioritize those areas where building local capacity is most needed.

Characteristic for sugar research (in contrast with most agricultural research) is that it is primarily organized and financed by the sugar industry itself. The monopolistic / oligopolistic character of the industry makes that the commodity chain is usually relatively well-organized (i.e., a few powerful players that can take the lead) and can be taxed easily to finance a public

good like sugar research (i.e., no free riders and low collection costs). This model seems to work well as long as: (a) Ownership of the industry is predominantly national (foreign companies have different loyalties -- see above); and (b) State ownership in the sugar industry is not undermined by political interference.

A handicap of sugar research being financed within the industry is that at times that revenues are low research will be affected as well. This is one of the big threats that sugar research in SP countries is running at the moment.

6. Enhancing Sugar Productivity: An Innovation Agenda

The EU Sugar Reform forces the SP countries to push through major rationalizations within a short period of time. The most dramatic ones that have been proposed is the complete close down of the sugar industry in St Kitts & Nevis and a partial close down in Trinidad & Tobago. In other countries, consolidation of milling capacity and elimination of marginal sugarcane fields are being proposed as well. For those parts of the industry that intend to stay in business, however, increased productivity (both at field and factory level) will be crucial.

In order to enhance the overall productivity of the sugarcane industry, three major innovation clusters within the industry can be identified, namely: (1) Sugarcane breeding; (2) Agricultural practices in sugarcane production; and (3) Sugarcane processing and products. We will discuss each of these clusters in detail in the following three sections.

6.1 Sugarcane breeding

Sugarcane breeding is a well established practice in the sugarcane industry and has a long and successful history. Leading sugarcane breeding centres among the SP countries are the West Indies Sugarcane Central Breeding Station (based in Barbados, but servicing the whole Caribbean), MSIRI (based in Mauritius), and indirectly SASRI (based in South Africa, but servicing many neighbouring SP countries). Most of the funding for this breeding work is coming from the local sugar industry. However, for breeding work done for third parties these centres usually charge a fee or royalties. In particular many African countries lack local sugarcane breeding programmes and hence their sugar industries rely on imported sugarcane varieties. Their own involvement is usually limited to variety testing only.

For long, sugarcane breeding has been focusing primarily on high yields and high sucrose. With the rapidly emerging interest in producing electricity out of bagasse (the waste left over after the sugarcane has been milled), high fibre content has suddenly become a desirable characteristic. While in the past low fibre was preferred, now the selection has started to move in the opposite direction.

Electricity companies are only interested in a steady, year-round supply of electricity. In order to get around this bottleneck, sugar companies are: (a) Installing generators that can work on both bagasse and other sources of energy (i.e., oil, coal, or gas); and (b) Trying to lengthen the sugarcane harvesting season. This has resulted in a demand for early-maturing, high-sucrose sugarcane varieties. In this business model, sugar production is still the lead activity. By adopting a business model in which energy production is leading and sugar a by-product, like in the case of Barbados, breeders are looking for sugarcane varieties that can be harvested year-round and are less concerned about the sucrose content.

In addition to these characteristics required for electricity production, breeding programmes continue to emphasize disease resistance (such as to ratoon stunting disease, yellow spot and yellow leaf syndrome) and improved agronomic characteristics such as rapid covering of the inter-row, erectness, tolerance to drought and freezes, and optimal nutrient uptake (Glaz 2003).

Genetically modified (GM) sugarcane varieties are currently under development in various countries, but most importantly in Australia and Brazil. They both have announced the commercial introduction of GM sugarcane by 2011. However, for SP countries exporting to the EU market, sugar from GM sugarcane may encounter problems of acceptance by European and other consumers. Hence some caution of introducing GM sugarcane (and of investing in the development of them) in these countries is warranted. GM sugarcane can expect less resistance when it is used exclusively for non-food applications like the production of bio-ethanol. Among the SP countries, only Mauritius has invested in a sugarcane biotechnology programme to date.

A common problem in many sugar-producing countries is the relatively slow uptake of new sugarcane varieties by sugarcane growers. While the standard recommendation is to replant sugarcane fields every 6-8 years, many sugarcane growers (and in particular the smaller ones) ratoon their sugarcane for a far longer period, sometimes for up to 20-30 years. Because replanting is costly, a slowdown in the spread of new varieties is usually a sign that growers are pessimistic about the sugar market prospects.

Greater investment in sugarcane breeding will not lead to immediate successes in sugarcane fields. Developing a new variety takes time (13-15 years) and the uptake of improved varieties tends to be slow due to high replanting costs. An intervention on the latter may help sugarcane planters to increase their yields per hectare and reduce their costs per ton sugarcane produced in the short run. In other words, they should reduce the backlog there is in adopting improved sugarcane varieties. This is a one-time, short-term advance that can be made. Speeding up the sugarcane breeding programmes in general is the longer-term solution – this requires more funding as well as the adoption of better breeding techniques (e.g., molecular markers).

6.2 Agricultural practices in sugarcane production

Principle areas of attention with regard to agricultural practices in sugarcane production are:

- *Crop rotation*. In most countries sugarcane is grown as a mono-crop without any crop rotation. Research, however, has shown that long-term cultivation of sugarcane can lead to changes in soil pH, loss of organic matter, and adverse changes in soil biota. Crop rotation can reverse these developments and help increase productivity levels (Glaz 2003). Moreover, crop rotation and multi-cropping in sugarcane areas may lead to a more ecologically sound use of the land and diminish the dependency of farmers on a single crop for their income.
- *Crop protection*. The use of chemical pesticides and insecticides in sugarcane production is quite common, although application levels seem to be relatively moderate compared to some other crops. Nevertheless, the total costs of this chemical protection are quite considerable in monetary terms as well as in terms of health risks and environmental damage. Hence there is a permanent drive to develop cheaper alternatives that have less negative externalities. In countries like Australia, India and

South Africa the use of bio-pesticides and biological control is a major research topic.

- *Water management*. Sugarcane is a relatively hardy tropical or sub-tropical crop, which has been adapted to grow both in high rainfall areas and in desert conditions. In the latter situation it is entirely dependent on irrigation. Often the volume of water available determines the area that can be planted with sugarcane. Hence improving the irrigation efficiency is high on the research and innovation agenda in many sugarcane growing areas. Too much water can also constitute a problem (both in irrigated and rain-fed production) and hence the importance of adequate drainage.
- *Soil management*. Important aspects of soil management in sugarcane production are maintaining soil fertility, avoiding soil compaction and reducing the incidence of soil erosion. The latter is in particular a problem in hilly areas and does not only affect the soil quality of the sugarcane fields, but also creates huge negative externalities downstream as rivers and lakes get filled up with sediment.
- *Nutrient management*. Nitrogen and phosphorus are crucial nutrients for an adequate development of sugarcane, while at the same time they can cause environmental pollution when not adequately managed. Reported improved management practices are the re-use of trash, the application of micro-organisms, and the optimization of nutrient application by utilization of spectroscopy tools for assessing nutrient status in the cane in real time and adapting the management practices accordingly (Glaz 2003).
- *Mechanization*. The introduction of mechanized harvesting is usually steered by cost-benefit considerations. In countries where labour is relatively cheap and capital expensive, harvesting is still done predominantly by hand. Topographic characteristics also influence the choice for a human cutter instead of machinery. Most of the machines used by sugarcane producers have been developed by the private agricultural machinery industry. The role of sugarcane research has usually been limited to looking at how best machinery can be used in the field and what type of adjustments are needed (e.g., the optimal width between sugarcane rows). Innovation in this domain is taking place especially in Brazil and Australia (Ridge 2003). New developments focus on refinement of cane transport equipment, harvesting machinery, trash management to optimize nutrient application, and of cutting for replanting.
- *Burning of sugarcane*. Burning of sugarcane prior to harvesting is still a common practice in many countries. Increasingly, however, this practice is under attack (and some countries have introduced legislation that forbid this practice) because the smoke it causes is a health hazard and causes environmental pollution. In addition, there is evidence that burning often negatively affects the quality of the sugarcane. Currently research is taking place to further optimize the use of the trash either for energy cogeneration or in the field as a natural fertilizer.
- *Optimization Models and Geographic Information Systems*. Better understanding of sugarcane growth has been brought upon by the use of models. APSIM-Sugarcane and CANEGROW are models successfully used for estimating yields and making irrigation decisions not only in Australia and South Africa, were they were developed but also in other countries like Mauritius. Successful application of GIS tools has been reported in Argentina, Cuba and Thailand (Glaz 2003).

So far, we have discussed agricultural practices in sugarcane production without considering the characteristics of the farming households involved. Traditionally, sugarcane has been very much a plantation crop, grown on large estates. Increasingly, however, smallholder sugarcane growers (between 0.5 and 10 ha) are entering the scene. In particular in new sugarcane growing areas, smallholder settlements are quite popular. However, the yields per hectare of smallholder sugar growers tend to be substantially lower (10-20%) than that of neighbouring

sugar estates. The exact reasons for this difference are not clear, nor the interventions needed in order to eliminate this gap. Lack of adequate technology transfer mechanisms is one of the factors that may come into play.

6.3 Sugarcane processing and by-products

Sugar cost price differences are not only determined by the efficiency of sugarcane production, but also by that of sugarcane processing. Factory efficiency is determined by both the quality of the plant infrastructure as well as by its management. Although modern plants are usually a lot more efficient than older ones, the quality of the management of the plant (process and quality control, logistics, administration, etc.) still can make a major difference in the efficiency of the plant. For example, the quality of raw sugar from many SP countries tends to be relatively poor, resulting in price penalties in the EU market. This may not be such a problem when you receive a high, protected sugar price, but at a substantial lower price such penalties are felt a lot more. Better quality control (including paying farmers for the quality of their sugarcane rather than sheer volume) may reduce such penalties considerably.

Energy saving and co-generation of electricity at the plant may also result in major cost savings. However, such interventions often require important modifications to the existing facilities. Sugar mills are also increasingly under scrutiny for how they manage their water use and waste streams due to tightening environmental standards (Blackwell 2002).

The most important recent development regarding sugarcane processing efficiency has been the better utilization of waste products. Sugarcane residues are produced either as post-harvest residues or as the result of its processing into final products. Harvesting the sugarcane will leave as by-product the trash, i.e. tops, dry and green leaves, which are usually burned in the fields directly after harvesting. Processing into sugar will yield residues, such as bagasse (solid resulting after juice extraction), cachaza (material remaining after cleaning the juice which is a mix of juice, coagulated proteins and minerals), molasses (thick syrup obtained in the preparation sugar by repeated crystallization) and water (Pabon Pereira, et al 2006).

Bagasse, for example, is rich in energy and produced in large quantities. Rather than burning it very inefficiently in order to get rid of the waste, the aim now is to recover as much energy as possible and sell the surplus in the form of electricity to the national grid. This requires investment in better boilers as well as in generators. National electricity companies are usually only interested in a steady, year-round supply of electricity. The answer to this challenge has been the introduction of generators that can work on both bagasse and other sources of energy (gas, coal, biomass, etc.). Still, in quite a number of countries national electricity companies seem to be hesitant of adopting the idea of buying electricity from sugar companies or only offer a very low price (e.g., South Africa). The technology is there, but many institutional and managerial hurdles still need to be taken. Nevertheless, in most national adaptation strategies co-generation of electricity is included as one of the more important measures to be pursued.

Another major waste product of sugar production is molasses, which is rich in sugar and can be used in many different ways, such as the production of ethanol, glycerol, fructose syrups, solvents, organic acids, amino-acids, and vitamins. It is nowadays often also directly used as animal feed and fertilizer. Bio-ethanol can be produced from molasses or straight out of sugar juice, but the latter is only an interesting economic proposition when sugarcane can be produced very cheaply and has no alternative than to be sold at the low world market price

(e.g., Brazil and Australia). Bagasse can also be used to produce bio-ethanol, but the conversion process is more demanding and still in development.

For sugar industries having access to markets that pay sugar prices that are substantially higher than the world market price, producing sugar as the primary product rather than bio-ethanol is the more attractive proposition at present. However, this may change when the oil price continues to rise and hence pushing the price of bio-ethanol up. Most national adaptation strategies, however, propose entering the bio-ethanol market by producing bio-ethanol on the basis of molasses. This requires investment in bio-ethanol plants. Whether or not this is an attractive economic proposition all depends on the oil price and local government policies regarding renewable energy and taxation as well as on the production costs associated with the sugarcane production itself since biomass costs play a large role in the economics of the bio-ethanol industry.

While in most national adaptation strategies the production of electricity and bio-ethanol are conceptualized as important by-products of the sugar industry, the national adaptation strategy of Barbados clearly adopts a different business model for the sugar industry. In this model, the production of electricity constitutes the primary source of income, while ethanol and sugar production come at second plan.[5] Although there are doubts regarding the feasibility of this business model at present (in particular because of the high cost environment of Barbados), it may give us a hint of how the sugarcane industry may transform itself into a renewable energy industry in the long run. It all depends on what the oil price will do and what type of alternative (and thus competing) renewable sources of energy may emerge.

7. Conclusions

Competition is the main driver for innovation to take place in any industry, including the sugar industry. In addition, two other major factors are driving innovation in the sugar industry in SP countries at the moment, namely:

- Policy-driven changes in market opportunities: The *EU Sugar Reform* and the *EBA Agreement*, both being phased in at the moment, are affecting the opportunities of the SP countries on the EU sugar market. The EU price reduction will expose SP countries to stiffer competition (although still relatively protected). However, not all SP countries will be affected equally. The impact depends on the SP quota held (which is based on historical rights), the overall competitiveness of the local sugar industry, and on whether the country falls under the EBA agreement or not. While in some SP countries sugar production will contract, in others (in particular those with EBA status and a competitive advantage) it will expand. Mobilizing the necessary capital for such expansion will constitute an important bottleneck.

- High oil prices and a strongly increased interest in renewable energy have placed the spotlights on sugarcane as the most efficient crop to produce bio-energy from at the moment. Economically, the most interesting opportunity at the moment for SP countries is to use sugarcane waste to co-generate electricity and bio-ethanol. It is a business model in which energy production is a by-product from sugar production. The pace at

[5] The projected revenues after the reforms of the sugar industry in Mauritius are 75% sugar, 15% electricity, 7% ethanol, and 3% carbon credits. In the case of Barbados, the projected, post-reform revenues are 50% electricity, 25% ethanol and 25% sugar.

which this business model will be adopted depends on the availability of capital and technical know-how in the sugar industry in SP countries. A possible next step is to make energy production the core business of the sugarcane industry and sugar a mere by-product. However, this is still a hotly debated scenario in terms of environmental soundness (some argue that more energy goes into the production of sugarcane than we get out of it and substituting one type of pollution for another) and moral acceptability (energy production competing with food production).

Although on-going and planned sugarcane research activities promise interesting improvements in the future efficiency of the sugar industry, most of them will come on board too late to save all the high-cost sugar producers in SP countries from bankruptcy. Short-run solutions have to be found more in the sphere of catching up on adopting existing technologies. Subsidies to improve sugarcane fields, to speed up the adoption of new sugarcane varieties, and to promote better agricultural practices most likely will result in more immediate improvements in sugarcane yields.

Also at the factory level immediate gains can be made by catching up on existing technologies and managerial practices. As experience in South Africa has shown, benchmarking of sugar mills and sugar industry operations is a useful tool of identifying those areas that can be improved easily and quickly. The International Sugar Organization (ISO) as well as private consultancy firms offer international benchmarking services.

References

Berkum, S. van, P. Roza, and F. van Tongeren. *Impacts of the EU Sugar Reforms on Developing Countries*. The Hague: LEI, June 2005

Blackwell, J. "Recent developments in sugarcane processing." *International Sugar Journal* Vol. 104, No. 1237 (2002): 28-42.

European Commission (EC). *Action Plan on Accompanying Measures for Sugar Protocol Countries Affected by the Reform of the EU Sugar Regime*. Commission Staff Working Paper. Brussels: CEC, January 2005.

European Commission (EC). *The European Sugar Sector: Its importance and its future*. Brussels: EC, June 2005.

Garside, B., T. Hills, J.C. Marques, C. Seeger, and V. Thiel. *Who Gains from Sugar Quotas?* London: Overseas Development Institute (ODI) and London School of Economics and Political Science, 2005.

Glaz, B. "Integrated crop management for sustainable crop production: Recent advances." *International Sugar Journal* Vol. 105, No. 1252 (2003): 175-186.

Langhans, B. "Status and future trends in process instrumentation and control." *International Sugar Journal* Vol. 105, No. 1252 (2003): 168-171

Oxfam. *The Great EU Sugar Scam: How Europe's sugar regime is devastating livelihoods in the developing world*. Oxfam Briefing Paper No. 27. London: Oxfam, 2002.

Pabon Pereira, C.P., J.B. van Lier, W.T.M. Sanders, M.A. Slingerland & R. Rabbinge. "The Role of Anaerobic Digestion in Sugercane Chains in Colombia." In *Proceedings VIIIth Latin American Workshop and Symposium on Anaerobic Digestion*, Punta del Este, Uruguay, 2-5 October 2005 (2006)

Ridge, R. "Trends in sugarcane mechanization." *International Sugar Journal* Vol. 105, No. 1252 (2003): 150-154.

Roseboom,, J. , T. Kooistra, and C. Pabon. *Support to Research in the ACP Sugarcane Sector*. Brussels: Transtec, May 2007.