



INTRODUCTION TO THE SUGAR SECTOR IN KENYA

SEPTEMBER 2012

SUMMARY

TRAINING COURSE

MAINSTREAMING ENVIRONMENT AND CLIMATE CHANGE

HANDOUT 1

Chapter 1: Scope

The Government of Kenya (GOK) and stakeholders in the sugar industry have been implementing the National Sugar Adaptation Strategy (NAS) with financial support from the European Union since 2007.

This study has the objectives to:

- Describe, identify, and assess the likely significant environmental effects of implementing the NAS;
 - Provide information to better integrate environment into decisions, implementation, and monitoring;
 - Provide strategic-level recommendations on how to minimize potential negative effects and optimize positive effects.
- The findings are meant to 'green' the ongoing activities and to influence policy development in the sugar sector.

Chapter 2: Background

Sector Programme, Geographical Scope, Sugar-Sector Issues (2006–2012), Alternatives, and Policy and Legal Framework

Pre-NAS situation

The sugarcane industry in western Kenya had previously achieved relatively high cane yields, but yields per hectare declined over the years, and significantly so after 2000. Issues ranging from weak regulation, insufficient outgrower involvement, poor pricing, ineffective licensing and dispute regulation, and delayed payments were partially addressed via the Sugarcane Act (2001). But, other issues proved persistent, such as the issues affecting growers (e.g., poor husbandry, organisation, and financing), poor cane yields and cane quality, and factory operations (e.g., poor infrastructure, especially the road network, obsolete technology, high taxation, and illegal sugar imports). The unresolved issues were manifested in Kenya's sugar price, which was 3.1 to 3.5 times the world market price per tonne in 2005.

Sector Programme Objectives

The NAS has the following major objectives:

1. Improve sugarcane production and productivity;
2. Privatization and financial restructuring of public mills;
3. Rehabilitate, modernize, and expand sugar factories;
4. Diversify products and add value;
5. Promote trade and marketing;
6. Protect the environmental and social components.

Geographical Scope

The geographical focus of the NAS comprises the various traditional sugar belt zones, including Kakamega, Nyando, and South Nyanza in western Kenya, and the new sugar belt zones in the Tana Delta and Kwale region on the Coast.

Sugar sector issues: *An analysis of farm-level issues and sugar-mill issues*

Through discussions with sugarcane farmers, extension workers, researchers, and staff from sugar mills, field observations, factory visits, and literature review, the team analysed the overall situation at the existing sugar mills and at the farmers' sugarcane fields.

The conclusions of this situation analysis include the following:

- Overall, sugarcane production per ha did not significantly improve in the 2005 to 2012 period. Of note, until now (2012), the sugar companies have not been able to address the most significant problems related to the low yields and high costs of sugar (which include, among others, high transport costs and sub-optimal agricultural practices);
- Sugarcane farmers and millers need to develop new, different (more equitable) arrangements for growing and supplying cane to the mills;
- There is still a need to focus research on the most field-relevant needs of the millers and of the sugarcane farmers;
- Although due diligence reports have been completed on the public mills, it is unclear when the privatization process will actually happen;
- As of 2012, little was achieved in terms of rehabilitating, modernizing, and expanding existing operations. However, in the 2006–2012 period, there has been an increase in the number of sugar factories (e.g., Butali);
- The policy-level stakeholders are interested in irrigating sugarcane, but farmers are not familiar with irrigating sugarcane;
- The cane industry is diversifying, moving into cogeneration, alcohol production, and other activities (e.g., bottling water);
- The COMESA safeguards have been extended (one last time) to 2014, but these extensions have done little to make the sugar sector more competitive;
- One general conclusion is that a good number of the sugar-sector issues (including the environmental and social management issues) have a strong 'institutional' component, and the institutional issues have to be more fully understood and managed to achieve a modern, competitive, low-cost, efficient, and *environment-friendly* sugar industry.

Alternatives Based on an analysis of the sugar-sector issues in Kenya, the four alternatives developed are:	
<i>Alternative 1:</i>	Expand the sugar industry in a horizontal manner (using a larger area, but with the existing cane production per hectare) (i.e., the zero-alternative or the business-as-usual alternative)
<i>Alternative 2:</i>	Fully implement the NAS
<i>Alternative 3:</i>	Cane production under irrigation (and smallholders): A: Cane production under irrigation in Kakamega B: Cane production under irrigation in Nyando C: Cane production under irrigation in Southern Nyanza
<i>Alternative 4:</i>	Large-scale, irrigated, nucleus-estate for sugar production.
Institutional, Policy, and Legal Framework (for the sugar sector and for environmental management) An overview of the <i>Institutional, Policy, and Legal Framework of the Sugar Sector</i> is provided in Chapter 2.7. Table 8 lists the entities and Ministries, related Parastatals, and related policies and legal instruments that have bearing on the sugar sector (e.g., GOK and the Ministries responsible for Agriculture, Water and Irrigation, Environment and Mineral Resources, Lands, Regional Development, Energy, Forestry, Planning, Transport, Health, and Tourism).	
Chapter 3: Approach and Methodology and Assumptions, Uncertainties, and Constraints	
Approach and methodology The overall approach and methodology for this study was a stakeholder approach (comprising interviews, focus-group-discussions, and participatory workshops using tailor-made tools), supplemented with literature review, factory visits, and field observations in all sugar belt zones. The scoping period was conducted between in May 2012. About 100 institutional stakeholders were identified during the scoping period. The detailed study was conducted June-July, 2012. Stakeholders and workshop participants provided inputs to the consistency analysis, compatibility analysis, qualitative impact analysis, and mitigation and optimizing measures. The National Workshop on the <i>Draft Report</i> was held in Kisumu July 24 th , 2012. The participants provided input to the evaluation of alternatives, using the qualitative scenarios developed for each alternative and a Multi-criteria Analysis procedure.	
Assumptions, uncertainties, and constraints Assumption: Kenya's sugar sector will face significant competition from imported sugar in the near future; Uncertainty: It is uncertain whether the sugar industry in western Kenya will be able to cope with the increasing population pressure, increasing land fragmentation, and competing land uses; Constraints (in western Kenya): <ul style="list-style-type: none"> It is difficult for farmers to produce low-cost sugarcane partly because of the high price of inputs (e.g., land preparation and fertilizers); It is difficult to decrease the high cost of transporting the cane to the sugar mills because there are 1,000s of km of farm roads to maintain and little budget to do so; The extension system is currently ineffective and inadequate to meet the needs of 300,000 sugarcane farmers; Constraints regarding this study: <ul style="list-style-type: none"> Very little quantitative data was available; the study relied on qualitative and descriptive assessments, and stakeholder inputs; The study entailed a large number of workshops in a short amount of time, posing a number of logistical challenges. 	
Chapter 4: Baseline Study	
Key issues identified during scoping period Ten key issues were identified during the scoping period: <ol style="list-style-type: none"> Protecting habitats (especially wetlands and forested areas); Protecting soil (from erosion and pollution); Optimizing land use (and avoiding land use change); Protecting watersheds (including water supply and water quality); Adapting to climate change and variability; Protecting health; Enhancing livelihoods (including food security, poverty alleviation, and income); Improving productivity (of sugarcane through good husbandry, better road infrastructure, value addition etc.); Supporting economic development (e.g., irrigation and other sectors); Strengthening capacity (for planning, research, extension services, Outgrowers' Organisations, legal enforcement, and monitoring and evaluation). The ten issues reflect the concerns of the policy-and-legal framework <u>and</u> the concerns of the scoping-period stakeholders.	
Baseline and Trends (Opportunities and Constraints) Biological: <ol style="list-style-type: none"> Habitat: There are some important national parks, reserves, and wetlands near some of the sugarcane areas (e.g., 	

Kakamega Forest National Park, Tana River Delta, and Yala Swamp). Kenya's natural areas and forests are generally under threat, and it is critically important to safeguard the water towers (e.g. the Mau Complex). Lake Victoria is showing signs of eutrophication. There are important bird areas, threatened ecosystems, endangered species, and problems with invasive species within the geographical focus of the study.

Given the above baseline, constraints can be listed as follows: Sugarcane farms are not to encroach and/or pollute:

- Protected areas;
- Important forested areas, especially the 'water towers' (Mau Forest Complex; Kakamega forest);
- Important wetlands (the Tana River Delta, Yala Swamp, Lake Victoria);
- Important bird areas.

Any additional development within the Tana Delta will need to strictly apply environmental safeguards. To safeguard biodiversity, the sugarcane sector should not contribute to the eutrophication and siltation of Lake Victoria and other important rivers because this threatens biodiversity in general and promotes the growth of invasive species, such as hyacinth.

Physical:

2. **Protecting soil (and the issue of land degradation):** There are soil erosion, soil fertility, and deforestation issues in the sugar belt areas. With increasing population pressure, an increase in unsustainable land use and land degradation can be expected.
3. **Land use:** Some farmers are already converting their land from sugarcane to other crops, or diversifying their farming activities to better ensure food security. Due to land competition, some farmers have moved into sensitive habitats (e.g., wetlands, steep slopes, or riverine habitats).
4. **Protecting watersheds:** Water resources increasingly need to be carefully managed to avoid negative impacts on food production, economic development, and water quality. Population growth alone will continue to reduce per capita water availability. Local water deficits are projected in some sub-drainage areas.
5. **Adapting to climate change:** Rainfall is highly variable throughout the seasons, between years, and between locations. This is expected to be exacerbated by climate change and variability, resulting in more frequent and more severe episodes of drought and floods. Irrigation may help mitigate climate change, but to date, this has not been fully developed due to the high cost of the infrastructure. With respect to smallholders, land fragmentation due to inheritance practices make irrigation even more difficult **and** expensive.

Given the above baseline, constraints can be listed as follows:

- Due to the population increase (2.9% per year), the pressure on the limited agricultural lands in the high- and medium-potential lands is expected to increase further, leading to unsustainable land use and land degradation;
- The frequency of local water deficits can be expected to increase, as will the number of water-use conflicts between upstream and downstream users;
- Climate change and variability will increase the number of flooding and drought events; developing and implementing mechanisms to help sugarcane farmers to mitigate and adapt to climate change is a priority;
- Sugar-mill effluents are insufficiently treated. Most sugar mills have old machinery and/or insufficient capacity to treat their effluents and have not modernized as expected;
- Air emissions from the factory chimneys do not comply with acceptable limits.

Socio-cultural:

6. **Health:** Governance issues (e.g., transparency of deductions) and gender equity could be improved. Malaria and HIV/AIDS are prevalent in the sugarcane growing areas.
7. **Food Security, livelihoods, and poverty:** Food security is a challenge, especially given the small farm sizes. Some farm families try to cope by intercropping and doing mixed farming. The poverty rate in the sugarcane growing areas is generally high. Although some farmers do well with sugarcane, others do not and complain about the deductions that sugar mills take from the final payments on delivery of the sugarcane crop.

Given the above baseline, constraints can be listed as follows:

- In western Kenya, the number of densely populated areas has risen sharply over the past decade, leading to increasing competition between the various land uses;
- Women do a lot of the sugarcane farming, but rarely attend training sessions;
- With climate change, malaria is spreading into the highlands;
- Nyanza province has the highest HIV/AIDS prevalence rate in the country (14%);
- Access to clean potable water is an issue for many rural people;
- Agricultural guidelines say that farmers should maintain 1/3 of their land for subsistence crops, but the guidance can be ignored;
- Tackling poverty will entail raising the income of sugarcane farmers; it is urgent to review the 'contracts' made between the farmers and the millers to review the deductions made and revise where needed the cost-and-benefits sharing agreement.

Socio-Economic:

8. Productivity: There are a number of constraints to sugarcane farming in the western part of Kenya, including: erratic rainfall; seed quality; knowledge and implementation of best practices to grow sugarcane; weed control; fertilizer use and application; and transport (all of the latter need to be improved to achieve a competitive sugar industry). Regarding 'value addition', most sugar mills are enthusiastic about cogeneration and ethanol production, and there is a need to pay attention to any conflict that may arise between producing energy for sale, environmental management, and the sugar business.

Given the above baseline, the constraints can be listed as follows:

- It is urgent that a practical solution be found to the cultural practice of sub-dividing land, to avoid the collapse (or severe reduction) of the sugar industry in western Kenya;
- More demonstration plots are needed to show farmers the benefits of new varieties and good husbandry;
- A more effective and innovative extension-service-delivery-model to cater to the large number of sugarcane farmers is needed;
- Mills need to provide top-quality extension services at low cost;
- Mills need to be more strongly involved in the transport of the sugarcane;
- The Sugar Act 2001 needs to be amended to revise the profit-sharing arrangement between the miller and farmer;
- Farmers need to ensure that inputs are received on time and provided for at the lowest costs (e.g., through farmers' groups);
- Farmers find it difficult to get credit in a timely way (which prevents them from implementing good husbandry e.g., buying fertilizers or weeding in a timely way);

One point of concern regarding diversification and value addition is that the need to generate electricity to sell to the grid through cogeneration can lead to some poor environmental and poor agricultural practices (e.g., cutting down trees to feed the boilers and premature harvesting of sugarcane). This negates the environmental improvements of a CDM project.

9. Economic Development: There is no experience with irrigating sugarcane in the western part of the country. This will need attention if implemented, because farmers associate irrigation with growing other crops, such as rice. Introducing irrigation for sugarcane will require a lot of awareness raising and capacity development.

Chapter 5: Impact identification and evaluation

Consistency Analysis (internal compatibility of each NAS objective against the other NAS objectives)

The key findings of the internal consistency analysis of the NAS objectives are that:

- The NAS did not provide a specific objective to address farm-level issues, specifically, that the relationship between the mills and the farmers has to improve (i.e., more benefits to the farmer) before good husbandry, good environmental management, and higher yields can be expected and achieved.
- Given that the NAS has been under implementation since 2007, the consistency analysis also highlighted that it is time to more clearly define some of the NAS objectives or to update some objectives.
- The consistency analysis highlights that the NAS objectives (1. Improvement of sugarcane production and productivity; 2. Privatization and financial restructuring of public mills; 3. Rehabilitation, modernization, and expansion of sugar factories; 4. Product diversification and value addition; 5. Trade and marketing) **could** be made more consistent with NAS Objective 6. *Environmental and social protection* by fully applying and enforcing environmental (which includes social) protection measures. For example, sugar mill effluents need to better comply with environmental standards. Of note, **fully implementing Objective #6 requires much institutional strengthening.**
- The highest potential for internal conflict is between Objective 3b (*Expand sugar factories*) and Objective 6 on environmental and social protection (including a risk of having a negative impact on food security).

Compatibility Analysis of the NAS with 22 other policy-and-legal framework items

Twenty-two framework items were analyzed in detail to assess the compatibility of the external policy-and-legal framework with the NAS objectives. Key findings related to the compatibility of the NAS objectives with other policy-and-legal framework objectives include:

- Without stakeholder compliance to environmental and social protection regulations, the NAS could have significant negative impacts on the environment, especially through intensification of agriculture (and the use of agrochemicals), expansion into new areas (e.g., sensitive areas), and any additional infrastructure, such as roads;
- There has been no focus to date on the safe use, storage, management and disposal of agrochemicals, and this should be addressed now, in tandem with the intensification of sugarcane production;
- With regards to privatization, the compliance of the private sector with environmental and social management safeguards cannot be assumed, given that some private mills are currently not even complying with effluent standards. The compliance of private mills with mitigation measures will have to be monitored closely, and private sector efforts to incorporate cleaner production, Clean Development Mechanisms, ISO certification, and corporate social responsibility, will need to be further encouraged;
- Specific monitoring is needed to verify the expected positive impacts of the NAS on the social environment and social goals related to poverty alleviation, improvement of livelihoods, and food security;
- The compatibility analysis also highlights some concerns regarding:
 - A statement in the *Constitution*: 'if ... access... to a clean environment is violated, a person may apply to a court for

<p><i>redress</i>. This statement may need an interpretation by the Supreme Court to avoid spurious lawsuits.</p> <ul style="list-style-type: none"> ○ A statement in the <i>Agricultural policy</i>, regarding the 'pricing of water'. It was felt that the cost of water for agriculture should not be prohibitive. ▪ There are many areas of potential incompatibility with the water policy, given the many water users (including domestic use and use by wildlife), a high water demand in general, some water shortages at times, and climate change and variability. There will be a need to ration water at times, regulate water consumption, and allocate water in an equitable way, especially given climate change and variability; ▪ Expanding the hectares of land under sugarcane will also need to be monitored against the land policy, which aims to move towards efficient, sustainable, and equitable land use.
<p>Qualitative Impact Analysis of the NAS Objectives on the Key Environmental Components</p> <ul style="list-style-type: none"> ▪ The Team and the Mombasa, Kakamega, and Kisumu workshop participants analyzed the impacts of the NAS objectives and activities on the 10 issues. The analysis showed that the following NAS objectives and sub-objectives could have significant positive and/or negative impacts on habitats, soils, land use, water catchment, and water supply: <ul style="list-style-type: none"> ○ Improve infrastructure in the sugarcane producing areas, including rehabilitate roads; ○ Improve cane yields (especially through intensification); ○ Privatize and financially restructure public mills; ○ Promote trade and marketing. ▪ Usually an issue is whether the activities would be conducted in compliance with good environmental practice and standards (e.g., would the road design avoid sensitive habitats? Will the privatized sugar mills release effluents that comply with environmental standards?) As stated in the above-mentioned assessments, the uncertainty associated with implementing good environmental behavior has a large institutional capacity component related to enforcement and monitoring, especially by the National Environment Management Authority (NEMA) and KSB. It is noted in general that without enforcement and monitoring, environmental and social safeguards may not be implemented.
<p>Chapter 6: Analysis of Alternatives</p>
<p>Qualitative Scenarios</p> <p>The 4 alternatives were analysed using two methods: 1. Qualitative scenarios and 2. A multi-criteria analysis procedure.</p> <p>The Qualitative Scenarios</p> <p>Scenario 1 (horizontal expansion) highlighted that once the COMESA safeguards expire, the sugar industry in western Kenya will be forced to sell sugar at a competitive price. Millers will have to minimize their costs, including having to lower the cane price given to farmers. The sugar industry in western Kenya will either collapse or find a way to increase the cane production per ha and to make sugarcane growing attractive to farmers. The sugar industry will probably have to mechanize some of its field operations to survive. If this option is too expensive in western Kenya, the sugar industry will have to be rationalised and, in the future, sugarcane will only be grown where it is most profitable to do so (e.g., the Coast).</p> <p>Under Scenario 2, the NAS is fully implemented, with these results:</p> <ul style="list-style-type: none"> ▪ Higher cane yields per ha are achieved and more sugar is produced at factories through vertical, rather than horizontal expansion; ▪ The Government-owned companies are in private hands; ▪ The mills are rehabilitated and modernized; ▪ The factories have developed a number of accompanying industries, based on sugarcane by-products (e.g., cogeneration, ethanol, and water bottling); ▪ The local sales and export products are more diversified and profitable; ▪ The above is achieved, while safeguarding the environmental and social components. <p>But due to land scarcity and increasing population pressure, food crop cultivation (e.g., maize, rice, and vegetables) will tend to move into sensitive environmental areas (e.g., wetlands, riverbanks, forested areas, or steep slopes). River basin studies conducted on the Nzoia and Sondu Rivers have indicated that further encroachment of agriculture into forested or uncultivated land will result in significant increases in erosion. The trend of dividing land into smaller and smaller units (i.e., land fragmentation) and the associated negative impact on sugarcane productivity and efficiency may lead to 'block farming' (as suggested by the sugar industry) or group farming (where farming families choose to consolidate their farms, as reported in some locations in Nyando).</p> <p>Scenario 3 examines cane production under irrigation (with smallholders in western Kenya). It concludes that introducing (formal) irrigation in an undulating landscape, such as western Kenya, to a large number of scattered, individual farmers is problematic. A more realistic option is to irrigate the nucleus estate of sugar companies (where feasible), as a way to increase cane production in a vertical manner (i.e., intensification), reduce the cost price of cane delivered to the factory, achieve an ex-factory sugar price that can compete with the COMESA market players, and adapt to climate change and variability.</p> <p>Scenario 4 looks at irrigating a large-scale nucleus estate with vertical intensification. All operations can be efficiently organized on a large nucleus estate. The Coast is the likely location of such a complex. In the case of a large nucleus estate on the Tana Delta, it would necessarily have to apply a lot of environmental and social safeguards, given that the coastal area has low rainfall, and there are many water users, and a potential for water conflicts between upstream and downstream water users.</p>

Multi-criteria Analysis of the Alternatives

Subsequent to analyzing the alternatives by developing qualitative scenarios, the team and the stakeholders attending the July 24 national draft workshop analyzed and compared the alternatives using a multi-criteria analysis (MCA) framework

The MCA showed that:

- Alternative 1 (horizontal expansion/business-as-usual) has the worst performance when evaluated against the environmental objectives.
- The NAS, with the assumption that it is accompanied by environmental and social safeguards, can contribute significantly to sustainable sugarcane development. The detailed analysis highlighted that the NAS had some low scores under a few objectives, e.g., related to adaptation to climate change, protecting health, strengthening outgrowers, and strengthening the legal mandate and monitoring and evaluation. This highlights the need to strengthen the NAS in those areas in the next amendment.
- With respect to Alternative 3 and 4 (both focused on irrigation), the MCA exercise highlighted that incorporating irrigation into sugarcane development requires further assessment and a lot more demonstration. It is generally more feasible to apply (formal) irrigation on the nucleus estate of sugar mills or within large-scale projects.
- The MCA also highlighted that to date, there is little actual experience with irrigating sugarcane and stakeholders currently do not associate 'irrigation' with 'sugarcane farming'.

Chapter 7: Institutional Capacity Assessment for Environmental Management and to Implement the Recommendations

This study uses a capacity assessment framework that covers 3 pillars of capacity:

1. **Policy capacity**, which comprises issues related to whether an organisation has the mandate, instruments, and procedures (e.g., manuals) to do a function;
2. **Human resources capacity**, including not only having the right skilled people in adequate numbers, but also the related databases and laboratories to perform a function;
3. **Institutional capacity**, which comprises having adequate budgets, networks, and organisational structures to perform the function (e.g., alliances between national and county authorities, and multi-sectoral forums).

Seven entities are analysed using this framework: NEMA, Ministry of Agriculture (MOA), KSB, Kenya Sugar Research Foundation (KESREF), mills, Outgrowers' Organisations, and sugarcane farmers.

Overall, institutional capacity is a core issue in this study. A large part of achieving the NAS objectives is about these 6 institutional capacity sub-issues: a. Strengthening planning, capacity, and coordination; b. Expanding and disseminating research; c. Strengthening extension services; d. Strengthening Outgrowers' Organisations; e. Executing the legal requirement; and f. Strengthening monitoring and evaluation.

In general, the 7 entities have some general capacity issues under the 3 pillars. For instance, although the Sugar Act (2001) explicitly incorporates environmental and social management duties in the sugar sector, often environmental and social management is mainly **implicit in most of the roles** that it defines for the key sugar sector stakeholders. All entities have an insufficient number of staff to fulfill their environmental and social management mandates. Some environmental training will be needed; KSB central, County-level KSB, and the sugar mills will have to allocate budgets and will have to designate (and train) Environmental and Social Management Officers to monitor and evaluate related mitigation measures, to set up related monitoring systems, and to collect, process, and disseminate related data.

In addition, new organisational models are needed to deliver extension services and to organize farmers to negotiate good profit sharing arrangements.

Chapter 8: Mitigation or Optimizing Measures and Indicators	
<p>The first general recommendation emphasises that all projects requiring an Environmental Impact Assessment (EIA) must complete EIA studies (e.g., new sugar mills and irrigations works).</p> <p>Otherwise, Chapter 8 provides mitigation or optimizing measures and indicators for the 10 key issues. As well, Table 27 (Chapter 8) provides an extensive list of activities that need to be implemented for each mitigation measure.</p>	
BIOLOGICAL MITIGATION MEASURES	INDICATORS
Habitats: <i>Protect sensitive habitats; avoid wetlands, fish spawning areas, forest patches, and avoid cutting down trees when growing sugarcane.</i>	<ul style="list-style-type: none"> Encroachment into wetlands and fish spawning areas Change in forest cover Amount of re-forestation activity Existence of access for environmental services
PHYSICAL MITIGATION MEASURES	INDICATORS
Soil Erosion and Land Degradation: <ul style="list-style-type: none"> Minimize soil erosion and soil compaction Improve soil drainage Protect soil quality, minimize soil pollution, and correctly use inputs, such as fertilizer 	<ul style="list-style-type: none"> Soil erosion and compaction in the field Loading practice (manual vs. mechanical) Calendar of cane-crushing activities at the mills (Adequacy of) drainage system Change in frequency and intensity of floods (farm level and at nucleus estate) Borrow pit rehabilitation Water quality of nearby water sources, related to NPK standards Soil test results disseminated and use of soil test results in fertilizer application
Land Use: <i>Reduce land use competition (by developing a sugar-sector land use plan)</i>	<ul style="list-style-type: none"> Location of sugarcane fields and compliance to land use policy for sugarcane
Watershed (water quantity): <ul style="list-style-type: none"> Protect watersheds and conserve and store water Include 'water scarcity' and 'value of water to be consumed' (and climate change) in the sugar-sector feasibility studies 	<ul style="list-style-type: none"> River water flows (ratio of Qmax and Qmin) # of water storage initiatives Water use per unit of production The cost of water
Water Quality: <ul style="list-style-type: none"> Minimize soil erosion Minimize pollution Optimize the use of agrochemicals 	<ul style="list-style-type: none"> Water quality (NPK, TSS; TDS, chemical content) of water bodies near sugarcane growing areas Water quality of sugar mill effluents Awareness training in agrochemicals Certificates in fertilizer application Water management practices
Climate Change: <ul style="list-style-type: none"> Support appropriate water management (including irrigation systems) and water conservation in wet and dry season Control air emissions 	<ul style="list-style-type: none"> (Adequacy of) flood control during wet season Availability of water in dry season (by county) Air quality emissions from sugar mill chimney stacks
SOCIAL CULTURAL MITIGATION MEASURES	INDICATORS
Governance and Equity: <i>Develop a fair system to share the costs and benefits in the sugarcane industry</i>	<ul style="list-style-type: none"> (Fair) allocation of costs and benefits in sugar sector
Gender: <i>Increase the participation of women in the sugar sector</i>	<ul style="list-style-type: none"> % of women in sugar-sector workforce % women participating in training
Children: <i>Educate children and sugarcane farming families about accident risks</i>	<ul style="list-style-type: none"> # of accidents in sugar sector involving children
Health: <i>Protect health and increase health awareness of sugar mill workers</i>	<ul style="list-style-type: none"> # and quality of health awareness campaigns Health status/statistics of the sugarcane workers Quality of labour-force housing (Sugar cane workers') access to potable water and medical care
Food Security and Diversified Nutrition: <i>Support food security and a diverse diet</i>	<ul style="list-style-type: none"> # and quality of training in integrated farming Allocation of food crops vs. sugar crop on land parcels
Poverty, Income, and Livelihoods: <i>Promote fair pay and profit sharing within the sugar sector</i>	<ul style="list-style-type: none"> Payments and deductions in payments to sugarcane farmers
Cane Payment System: <i>Develop a fair sucrose-based payment system</i>	<ul style="list-style-type: none"> Farmers' knowledge about the new payment system Pilot studies on equitable sucrose-based payments Sucrose-based payment system adapted to each local growing situation
SOCIAL ECONOMIC MITIGATION MEASURES	INDICATORS
Infrastructure (Roads): <i>Ensure that road works are conducted to standard and that road maintenance</i>	<ul style="list-style-type: none"> Quality of road works funded by sugar sector Cost to transport sugarcane in areas receiving road works vs. the

<i>works are associated with reduced sugarcane transport costs</i>	cost of transporting cane where there are no road works
Productivity of Sugarcane Fields: <i>Expand nucleus estates (longer term) and promote good husbandry on nucleus estate and on the outgrowers' farms.</i>	<ul style="list-style-type: none"> ▪ Sugarcane yields per hectare (over time) ▪ Price of fertilizer and distribution of fertilizer
Value Addition through Diversification: <ul style="list-style-type: none"> ▪ Promote environmentally sound diversification and energy production ▪ Explore new avenues for diversification 	<ul style="list-style-type: none"> ▪ Amount of power generated and sold to the electricity grid ▪ Environmental practices associated with using bagasse for generating electricity ▪ Correct sizing of cogeneration plant and vinasse waste treatment plant ▪ # of other diversification activities
Competition and Privatization: <i>Incorporate environmental management requirements into privatization schemes and processes</i>	<ul style="list-style-type: none"> ▪ The environmental policy of privatized mills ▪ Environmental management systems (at the sugar mills) ▪ # and quality of cleaner production, CDM, CSR, ISO initiatives ▪ Economic instruments for environmental management
Competition, Privatization and Social Benefits: <i>Promote corporate social responsibility during privatization process and subsequent mill operation</i>	<ul style="list-style-type: none"> ▪ Quality of severance packages ▪ # and type of alternative-livelihood training programs ▪ Benefit sharing arrangements and social benefits from sugarcane farming ▪ Amount and type of environmental research supported by private sugar mills
Expansion: <i>Focus on the vertical expansion of the sugarcane fields, rather than on horizontal expansion (and use environmental permits when granting licenses)</i>	<ul style="list-style-type: none"> ▪ The environmental performance and production statistics from mills requesting expansion permits ▪ Compliance to mill environmental management plans ▪ Hectares of land under sugarcane (over time: stable or decreasing?) ▪ Habitat fragmentation
Sugarcane production: <i>Implement best practices in agronomy to increase production and reduce the cost of growing sugarcane</i>	<ul style="list-style-type: none"> ▪ Sugarcane yield per unit of land ▪ # and quality of training on best agricultural practices ▪ Fertilizer use (quantity and type) and cost of fertilizer
Promote General Economic Development: <i>Diversify local economy to reduce vulnerability to economic or climate shocks</i>	<ul style="list-style-type: none"> ▪ Feasibility studies on diversification of the economy; ▪ Regional statistics on income from other economic activities, e.g., agro-tourism
INSTITUTIONAL MITIGATION MEASURES	INDICATORS
Planning, Capacity, and Coordination: <i>Strengthen environment-friendly planning, capacity, and coordination</i>	<ul style="list-style-type: none"> ▪ Environmental officer in position at each major sugar mill ▪ Environmental Unit with dedicated Environmental Officer at KSB ▪ County-level environmental desk officers
Sugar-sector Research: <i>Expand and disseminate research and focus on field-relevant environmental management research</i>	<ul style="list-style-type: none"> ▪ # and quality of environmental management research activities ▪ Dissemination of research results
Extension Services: <i>Revise the extension model, strengthen extension services in general, and the extension services for environmental and social management</i>	<ul style="list-style-type: none"> ▪ Revised extension model ▪ Expansion of extension services (# and quality of training sessions, # and quality of extension workers) ▪ # and quality of extension services covering environmental management topics ▪ Evaluations of the provided extension services
Outgrowers' Organisations: <i>Strengthen some of the promising outgrowers' organisations and develop some new organisational models</i>	<ul style="list-style-type: none"> ▪ Capacity of Outgrowers' Organisations to fulfill institutional roles ▪ New organisational models for Outgrowers' Organisations
Farmers: <i>Increase the benefits of the sugarcane producers, while maintaining environmental and social safeguards</i>	<ul style="list-style-type: none"> ▪ Farmers' income from growing sugarcane ▪ # and quality of environmental and social management training ▪ Capacity of farmers to take on new environmental and social management roles and functions ▪ Field-level environmental conditions
Legal Requirement, Compliance, and Licenses: <i>Integrate environmental criteria into the sugar mill licensing procedure and approval process</i>	<ul style="list-style-type: none"> ▪ Integration of environmental criteria into licensing procedure
Enforcement: <i>Strengthen NEMA and publicize good environmental behavior</i>	<ul style="list-style-type: none"> ▪ Capacity of NEMA to monitor sugar sector (# of NEMA county staff; # of NEMA mill audits conducted by NEMA) ▪ Environmental awards
Monitoring and Evaluation: <i>Strengthen environmental monitoring within the sugar sector</i>	<ul style="list-style-type: none"> ▪ NEMA compliance reports ▪ Internal environmental audits (from mills) ▪ (Existence of) environmental and social monitoring system ▪ Evaluations of the monitoring reports

