ASSESSMENT OF SUGARCANE OUTGROWER SCHEMES FOR BIO-FUEL PRODUCTION IN ZAMBIA AND ZIMBABWE

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ACRONYMS

ARDA	Agricultural and Rural Development Authority
CPA	Cane Purchase Agreement
ERC	Estimated Recoverable Crystal
GDP	Gross Domestic Product
GHG	Green House Gas
KASFA	Kaleya Smallholder Farmer Association
KASCOL	Kaleya Smallholder Company
WWF	World Wide Fund for Nature
ZCFA	Zimbabwe Cane Farmers Association

EXECUTIVE SUMMARY

Southern Africa has a long established sugar industry that traditionally focused on sugar production for household consumption, use in industrial applications and for export. In addition, countries such as Malawi and Zimbabwe have produced bio-ethanol for blending with petrol since the 1970s. Governments and bio-fuel investors have explored and implemented more inclusive models that emphasize on employment creation and economic empowerment in sugarcane feedstock production and downstream business based on smallholder out-grower schemes.

The success of out-grower schemes has depended on their design, management and how the value of the resultant products is shared between out-growers and sugar companies. New investments in bio-fuel plantations (especially sugarcane and jatropha) are resulting in the opening up of new land. Among other things, such developments can reduce biodiversity and displace local people. The objective of this study was therefore to review and document experiences with sugarcane based out-grower schemes at Kaleya in Zambia and at Mpapa in Zimbabwe for purposes of:

- Improving the economic performance of existing schemes; and,
- Mitigating against adverse impacts of new bio-fuel investments.

Key conclusions and recommendations from the Study were that:

First, the economic viability of sugarcane based out-grower schemes in the study countries was influenced by: security of land tenure; technical capacity of out-growers and the status of farmer organizations.

Second, and more importantly, the success of existing and future bio-fuel investments in Southern Africa will depend on the existence of an enabling policy environment in the form of a national bio-fuels policy and strategy. Such a policy should embrace four pillars namely: economic, social, environmental and institutional.

INTRODUCTION

Preamble

The use of fossil fuels is a major contributor to Green House Gas (GHG) emissions that lead to global warming and climate change. The emissions include carbon dioxide, methane and nitrous oxide and are caused by human activities such as combustion of fossil fuels, industrial processes and deforestation. It is against this background that some developed countries (as major GHG emitters) have committed themselves to measurable levels of bio-fuel use. For example, the European Union has binding targets that its member states should ensure that 10% of all road transport fuel comes from renewable energy sources by 2020. The use of bio-ethanol for transport fuel has increased tremendously in recent years. It is being used to power cars and other vehicles such as farm tractors, boats and aeroplanes. Strong incentives, coupled with other industry development initiatives have given rise to fledging ethanol industries in Europe, Asia, South America and Australia.

The increased focus on bio-fuels has opened investment opportunities for developing countries with suitable land and water resources for feedstock production. Southern Africa is a net importer of energy in the form of fossil fuels. The introduction of bio-fuels can potentially reduce the region's dependence on imported petroleum products; stabilize prices; ensure fuel security; promote rural development and investment; reduce poverty and create employment. However, without adequate governance bio-fuel expansion can also cause a number of social and environmental problems. The region has a long established sugar industry that traditionally focused on sugar production for household consumption; use in industrial applications; and for export. In addition, countries such as Malawi and Zimbabwe have produced bio-ethanol for blending with petrol at rates up to 18% since the 1970s.

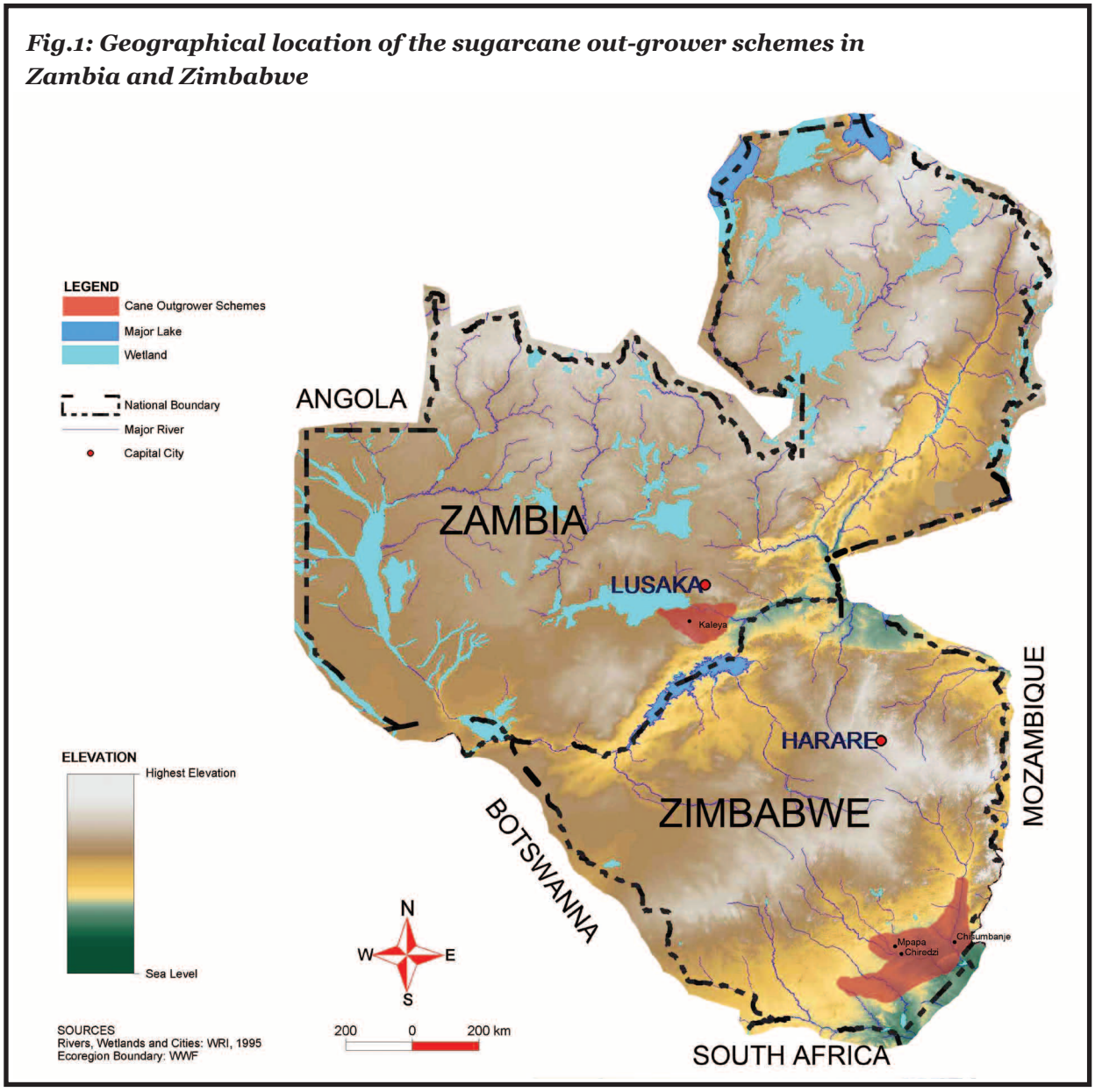
Some Southern African governments in partnership with bio-fuel investors have developed business models that focus on employment creation and economic empowerment in sugarcane feedstock production and processing through out-grower schemes. The schemes have enabled large sugar companies/estates to reduce operational costs and optimize the productive capacity of available processing plants by partnering with smallholder farmers to produce part of the feedstock. The success of the schemes has depended on the ability of out-growers to earn viable incomes. The region's experience with plantation type out-grower schemes has been largely confined to sugarcane feedstock production in countries like Malawi, Zambia and Zimbabwe. Under this arrangement, smallholder farmers enter into a formal relationship with a large sugar company. The latter provides key inputs such as planting material, fertilizer, pesticides, quality control, technical advice and a market for the feedstock.

Bio fuel car and filling station

Objective of the Study

The objective of the study was to review and document experiences with sugarcane based out-grower schemes in Zambia and Zimbabwe with emphasis on challenges and opportunities in order to improve performance and to provide lessons for new bio-fuel investments in the region. Figure 1 shows the geographical location of the study schemes.

Fig.1: Geographical location of the sugarcane out-grower schemes in Zambia and Zimbabwe



METHODOLOGY USED

The study was carried out by two national consultants. It was based on literature reviews complimented by informal discussions with key informants and formal interviews with sample sugarcane out-growers. Formal survey questionnaires were administered to ten of the 161 smallholder farmers at the Kaleya scheme in Zambia and five of the 17 famers at the Mpapa scheme in Zimbabwe. The formal survey focused on sugarcane production and marketing information and on farmer welfare. The information was complimented by related studies commissioned by the World Fund for Nature (WWF) in the region.

RESULTS

Study countries

Zambia

The sugar industry in Zambia contributes significantly to the national economy. It produces 500 000 tons of refined sugar per year and the Zambia Sugar Company accounts for 94% of the output. The domestic market absorbs 150 000 tons of sugar annually. The surplus is exported and it accounted for 2% of total national exports in 2009. However, regional sugar markets will become tighter for Zambia in future as other countries (e.g. Malawi, Mozambique, Swaziland and Zimbabwe) increase their sugar output. This will open opportunities for Zambia to lay a foundation for bio-ethanol production.

The country's sugarcane is planted on 22 000 ha mainly in Mazabuka district in the south. Major players are the Nakambala estate under the Zambia Sugar Company (15 000 ha); private farms (2 085 ha); Kaleya Smallholder Company Ltd (1 420 ha) and smallholder out-growers (2 220 ha).

Zimbabwe

The sugar industry accounted for 1.4% of Zimbabwe's Gross Domestic Product (GDP) before 2000. It has been dominated by two companies (Hippo Valley Estates and Triangle Limited) that contribute 85% of the total sugar output. The country's processing capacity is 600 000 tons of raw sugar and 260 000 tons of white refined sugar against a historically high national white sugar demand of 230 000-250 000 tons per annum during the 1990s. The surplus is exported. However, low sugar cane production in the last few years led to sugar imports. For example, 39 330 tons of sugar were imported in 2009 after only 2.4 million tons of sugarcane were produced.

A Sugarcane processing plant

Zimbabwe's two sugar mills produce molasses, a by-product of the sugar making process. The molasses is used to produce ethanol at the Triangle distillation plant which has an annual processing capacity of 40 million litres of bio-ethanol. According to Table 1, Zimbabwe's ethanol production is relatively competitive within the region. For example, the cost of producing 1 litre of ethanol in the country ranges between $0.25 and $0.40 compared to $0.50 and $0.60 in Malawi. This is partly because of Zimbabwe's experience with bio-ethanol production from molasses that dates back to the 1970's (Box 1). Annex 1 gives the bio-fuel conversion rates for sugarcane, sweet sorghum and jatrpoha.

Table 1: Cost of ethanol production in selected countries

Country	Sugar factory capacity (tc/day)	Cost (low estimate) $/litre	Cost (high estimate) $/litre
Brazil	500	0.19	0.25
Malawi (exisiting)	166	0.50	0.60
Zambia (new)	300	0.35	0.45
Zimbabwe (exisiting)	484	0.25	0.40

Source: Johnson et al (2006)

Box 1: Zimbabwe's experience with bio-fuel production

In 1965 Zimbabwe embarked on the production of sugarcane based fuel grade ethanol from molasses and blended it with petrol up to 15%. The blending programme was terminated in 1992 due to drought and the creation of export markets for potable ethanol (for beverages). Interest in bio-fuels was revived in 2005 with the establishment of an Ad-Hoc Cabinet Committee on Import Substitution in the Energy Sector. Government launched a national bio-fuel feedstock production programme and built two bio-diesel processing plants. Processing capacities of the plants are 1 million litres/year and 36 million litres/year for the Mutoko and Mt Hampden plants respectively. In 2009 the government, through the Agricultural and Rural Development Authority-ARDA (a parastatal organization) partnered, under a Built Operate and Transfer Arrangement, with a private company, Green Fuels, on a 10 year $600 million ethanol project at Chisumbanje estates. The project will produce 240 million litres of ethanol per annum from the direct fermentation of sugarcane juice from new sugarcane plantations.

Sugarcane is planted on 46 000 ha in south eastern Zimbabwe. Before 2000, smallholder out-growers occupied 28% of the land and their share of the area had increased to 41% by 2009.

Improved livelihood opportunities on out-grower schemes

Study schemes

The Kaleya Smallholder out-grower scheme-Zambia

TThe Government of Zambia has invested in infrastructure development to facilitate the participation of smallholder farmers in the sugarcane industry through out-grower schemes. The Kaleya Smallholder Company (KASCOL) is the oldest and biggest company established in 1981 to service out-growers. Government availed 4 000 ha of land and acquired a $27 million loan from the African Development Bank to develop infrastructure for the scheme.

The Kaleya out-grower scheme has 161 smallholder farmers selected from villages that neighbour the nucleus sugar estate.

Each farmer was allocated 6-7.5 ha plots for sugarcane production and 0.5 ha for residential use and for growing subsistence crops on a 14 year renewable lease basis. The farmers are individually contracted to grow and supply sugarcane to KASCOL through a Cane Purchase Agreement (CPA) and are members of the Kaleya Smallholder Farmer Association (KASFA). In total, KASFA manages 1 070 ha of cane land while KASCOL directly manages a nucleus estate of 1 086 ha. The company provides technical training, extension services, agricultural inputs, mechanical services, irrigation water and haulage services to the farmers. Sugarcane is established by the company on a cost recovery basis. The farmers and their families carry out infield irrigation, weed control, fertilizer application and disease scouting on the cane fields. The company strictly enforces good agricultural practices to ensure high productivity. It also provides: loans to build and electrify farmers' houses; clean tapped water; and a range of social services that include a clinic, primary education and transport.

KASCOL collects sugarcane grown by the out-growers, bulks it together with its estate cane and sells it to Zambia Sugar Company under a single CPA. The latter is negotiated from time to time between KASCOL and the smallholder farmer association. A cane split payment system whereby farmers receive 43% of the cane price and the remainder goes to KASCOL is used. Farmers' incomes are dependent on cane quantity, sucrose content (Estimated Recoverable Sucrose Content) and prevailing market conditions for the cane.

Mpapa smallholder out-grower scheme-Zimbabwe

Mpapa and Chipiwa were the first smallholder out-grower schemes established in the 1980s as part of efforts by the Government of Zimbabwe to increase the participation of previously marginalized Zimbabweans in the sugar industry. Mpapa scheme was established in two phases implemented in 1989 and 1998. It has 17 members, the bulk of whom were former estate managers from Triangle sugar estates. As employees, they had previously managed between 500 and 700 ha of estate land and are therefore highly experienced sugarcane producers. Zimbabwe's two major sugar companies, through their Mkwasine estates, provided loans to the farmers in the form of land and other related developments. Each member was allocated 25-38 ha of former estate land on a hire purchase basis at very favourable terms. The farmers have since settled their land purchase obligations but the land is still legally under sugar companies as the issuing of land title deeds was suspended in 2000. The working modalities of the farmers are spelt out in a Planters Agreement that entitles the estate to provide services at subsidized rates and requires the farmers to plant a certain land area to sugarcane. The quantity of cane delivered to the milling companies is defined in annual Cane Purchase Agreements (CPA). The agreements state that the farmer sells cane to the mill and receives 73.5% of the value of raw sugar and molasses generated by the cane. The miller is the sole beneficiary of any value added/downstream products (viz. refined sugar, ethanol and electricity generated from bagasse).

Out-growers are members of the Zimbabwe Cane Farmers Association (ZCFA) which represents them in negotiations with the miller. In this regard, the Association invests in market intelligence on developments in national and international markets. In addition, it works closely with milling companies to set and monitor delivery quarters for each out-grower to ensure constant flow of cane into the mill. The association is funded from a members' levy collected by milling companies on its behalf.

Layout of out-grower scheme fields

Out-grower scheme performance

Sugarcane yields

The main husbandry practices carried out on sugarcane by Kaleya and Mpapa smallholder out-grower scheme farmers are summarized in Annex 2.

Average sugarcane yields achieved by Kaleya out-growers are 110 tons/ha. This compares favourably with and in some cases surpasses yields achieved by the KASCOL and Zambia Sugar Company estates. The relatively high productivity reflects on the high level of technical supervision provided by KASCOL. However, strict enforcement of proper farming methods by the core estate could make the out-growers mere labour suppliers with no effective participation in farm management decisions.

Cane yields achieved by estates and smallholder out-growers in Zimbabwe are in general decline (Table 2). Estate production fell from 107 tons/ha in 1999 to 88 tons/ha in 2009. Comparative figures for all out-grower schemes in the country were 109 tons/ha to 54 tons/ha over the same period. Insecurity of land tenure, poor access to inputs and credit, and inadequate crop production skills (in the case of farmers resettled after 2000) have contributed to decreases in cane productivity. However, when considered alone, the Mpapa scheme achieved average sugarcane yields of 80 tons/ha. The figure is above the average yield for all out-grower schemes and is comparable to that achieved on the estates.

Table 2: Average cane yield trends at estates and smallholder out-grower schemes in Zimbabwe

Year	All estates, tons/ha	Out-grower schemes, t/ha*
2009	88.1	53.5
2008	97.9	38.2
2007	104.7	65.7
2006	98.1	73.0
2005	89.7	69.0
2004	85.3	70.3
2003	100.9	84.0
2002	106.2	103.9
2001	96.9	94.4
2000	101.2	99.3
1999	107.1	109.1

**Includes Mpapa but excludes schemes established after 2000 whose productivity is much lower.*

Harvested sugarcane feedstock from an out-grower scheme

Smallholder out-grower incomes and welfare

The profitability of the Kaleya and Mpapa schemes is given in Table 3. The gross margin analyses are based on average plot sizes of 6.7 ha and 30 ha for the two schemes respectively.

Average annual net income per out-grower is $11 700 at Kaleya. This is well above the Zambia minimum wage and is comparable to salaries of senior management staff in formal employment. All sampled households have built iron roofed houses, 70% have electrified houses and 80% have piped water, a television set and phone.

Out-grower income at Mpapa averages $43 492 per year. The figure increases to $46 985 when the ethanol value of molasses is included into the pricing formula. The income levels are comparable to salaries earned by some company executives in Zimbabwe.

On a per unit basis, Kaleya farmers achieve net incomes of $1 731/ha compared to $1 449/ha for Mpapa out-growers despite the fact that the former achieve significantly higher cane yields (110 tons/ha versus 80 tons/ha). The yield advantage could have been partly diluted by lower raw cane and molasses price ratios received by Kaleya farmers. They are paid 43% of the raw sugar and molasses value compared to 73.5% paid to Mpapa farmers. The ratio is 60% for Malawi's smallholder out-growers. In fact, Zimbabwe's out-growers have the best share of returns on their raw sugar in the region. However, none of the region's schemes receive a share of the value of downstream products such as ethanol which can double the economic value of molasses (Table 4). Figure 2 shows the sugarcane feedstock and product price flow diagrams for the Kaleya and Mpapa schemes.

Table 3: Profitability of the out-grower schemes

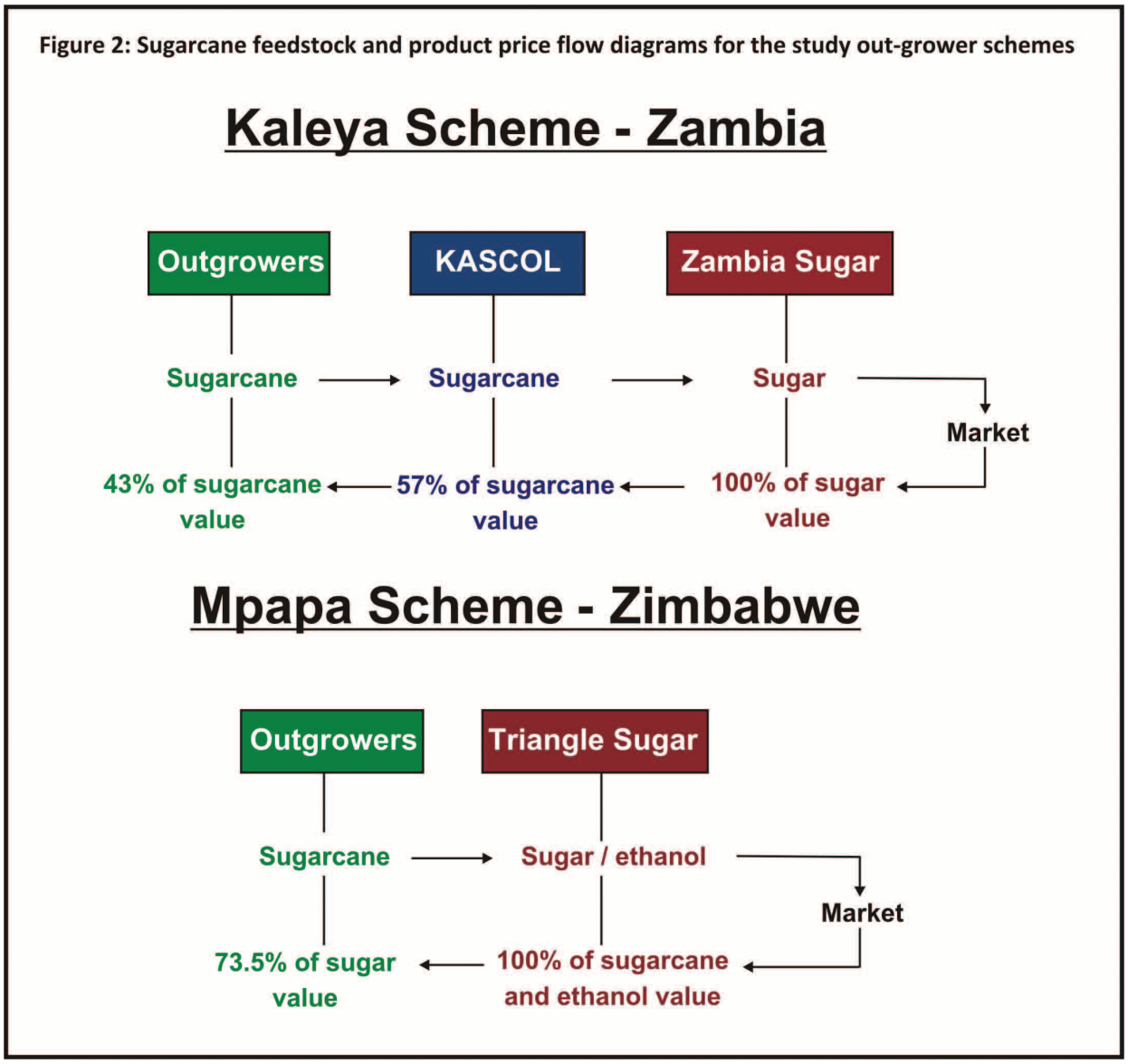
Parameter	Kaleya	Mpapa (raw sugar & molasses)	Mpapa (raw sugar & alcohol)
Average plot size, ha	6.7	30	30
Average cane yield, t/ha	110	81	81
Sucrose content, %	0.13	0.11	0.11
Net income per out-grower, $	11 700	43 492	46 985
Net income per ha, $	1 731	1 449	1 566

Given the observed cane yield decline in Zimbabwe, a yield sensitivity analysis was carried out on the Mpapa scheme (see Table 4). It showed that a 20% cane yield decrease to 60 tons/ha would reduce average out-grower income by 59% to $17 815 while a 20% increase in yield to 100 tons/ha would raise income by 59% to $69 168. This implies that at 100t/ha, plot sizes can be reduced from the current 30 ha per out-grower to a smaller size without adversely compromising profitability. This underscores the need to maintain high cane yields through improved agronomic practices coupled with favourable raw sugar price ratios.

Table 4: Sensitivity analysis on the profitability of Mpapa out-grower scheme to changes in cane yields

Parameter	80 tons/ha (current yield)	60 tons/ha	100 tons/ha
Total production costs per year, $	65 646.62	64 038.62	67 254.62
Revenue for raw sugar, $	105 751.80	79 313.85	132 189.75
Revenue for molasses, $	3 386.88	2 540.16	4 233.60
Revenue for alcohol, $	6 879.60	5 159.70	8 599.50
Profit, $ (raw sugar & molasses)	43 492.06	17 815.39	69 168.73
Profit, $ (raw sugar & alcohol benefits)	46 984.78	20 434.93	73 534.63

Figure 2: Sugarcane feedstock and product price flow diagrams for the study out-grower schemes



New bio-fuel feedstock investments and out-grower schemes

Although it does not produce bio-ethanol at the moment, Zambia's National Sugar Strategy of 2006 highlights the need to:

- Expand sugar milling and processing capacity;
- Expand sugar production through out-grower schemes; and,
- Diversify into ethanol production for petrol blending.

Zambia has prioritized sugarcane, sweet sorghum and jatropha feedstocks for bio-fuel production and highlighted the need to support smallholder out-growers. A Bio-fuels Association of Zambia was formed in 2006 to promote a bio-fuels industry. A number of pilot projects focusing on jatropha have been established in different parts of the country and considerable land areas have been earmarked for this purpose.

In Zimbabwe, the area planted to sugarcane has increased significantly since the coming on stream of the Green Fuels bio-ethanol joint venture project at Chisumbanje and Middle Sabi estates under ARDA. The initiative will result in 23 000 ha of land being put under sugarcane at full implementation. An initial area of 11 500 ha will be established during the first phase of the project. The land will come from ARDA and neighbouring communities who will come in as out-growers. Other prioritized bio-fuel feedstocks are jatropha and sweet sorghum. The former is being promoted in all the country's provinces albeit on a pilot scale.

The foregoing expansion in bio-fuel feedstock cultivation can potentially be an emerging driver of habitat alteration, biodiversity loss, food insecurity and community displacement and disenfranchisement in Southern Africa. Consequently, bio-fuel investments might not yield the desired results if not properly guided and implemented through conducive policy related measures. Unfortunately, bio-fuel policies in the region are still evolving and their provisions are general statements on biomass energy, renewable energy or bio-fuels (Shumba, et al, 2009). In the case of Zambia, a Bio-fuels development framework that contributed to the incorporation of bio-fuels into the revised National Energy policy was developed. The revised policy recognizes the potential role of renewable energy sources in the energy balance of the country. In Zimbabwe, Cabinet approved principles of bio-fuels use and development in 2007. In addition, government has developed a comprehensive national energy policy, which, to some extent, provides for bio-fuels development. However, it has been acknowledged that a national bio-fuels sector specific policy and strategy is necessary.

Jatropha is being touted as a potential bio-diesel feedstock in the region

CONCLUSIONS AND RECOMMENDATIONS

Among other things, the economic viability of sugarcane based out-grower schemes in Zambia and Zimbabwe is influenced by: security of land tenure; technical capacity of out-growers and status of farmer organizations as elaborated below.

Security of land tenure: Weak land tenure arrangements whereby farmers feel like tenants on the schemes does not provide a sense of security as plotholders live in constant fear of eviction if they do not "tow the line". In addition, insecurity of tenure can be a disincentive to investment in sugar husbandry operations.

Technically capacitated out-growers: Sugarcane production is a highly technical undertaking and cane productivity is very sensitive to crop management. Consequently, adequate on the job training and regular follow up of out-growers is critical. The Mpapa out-growers were estate managers before being allocated plots hence they had relevant professional and technical expertise on sugarcane production. On the other hand, Kaleya farmers underwent six months training as interns before being allocated plots. In addition, they are closely supervised by technical personnel from KASCOL.

Strong farmer associations: Strong associations are a must for effective coordination of cane production and marketing and negotiating better conditions for out-growers with the miller/core estate. Investment in market intelligence enables associations to negotiate from positions of strength. This has been the case with the Zimbabwe Cane Farmers Association whose members enjoy one of the highest raw cane and molasses price ratios in the region.

More importantly, the success of existing and future bio-fuel investments in Southern Africa will depend on the existence of an enabling policy environment. This is vindicated by FAO's assertion that "there is yet no country in the world where a bio-fuels industry has grown to commercial scale without a clear policy or legislation in place to support the business". Consequently, the need for an enabling national bio-fuel policy and strategy cannot be over emphasized. Such a national policy should have the following pillars: economic, social, environmental and institutional. They are elaborated in this section.

The economic pillar

The economic pillar should embrace the following elements: blending ratios and modalities; blend pricing formula; and investor incentives.

Blending ratios and modalities

In 2009 Brazil and the United States of America contributed over 80% of the bio-ethanol produced for road transportation worldwide. Both countries have mandatory blending ratios for ethanol and petrol. In the case of Zimbabwe and Malawi, mandatory blending ratios of up to 18% have been used without any modification to engines of the vehicle fleet.

Petrol and ethanol blending should be done in such a way that the product is produced cost effectively and its quality is in line with customer needs and international standards. Possible blending options include:

- Centralizing blending at few centrally located depots in situations where only a few oil companies are in operation; and,
- Setting up semi-centralized blending units (e.g. in major cities) or engaging an independent national blender in situations where many oil companies exist.

Pricing formula for fuel grade bio-ethanol

The bio-fuel industry should bring sufficient economic returns to the investor in order to attract and retain investments in feedstock production, ethanol production, blending and marketing. In fact bio-fuels should compete with fossil fuels. However, the economic viability of bio-ethanol blending will depend on the market price of petrol.

Incentives for investors

Brazil has the largest and most successful bio-fuel programme in the world. The programme was launched in 1975 and focused on national energy independence by phasing out fossil fuels in favour of sugarcane based ethanol in response to a global oil crisis that resulted in fossil fuel shortages. Consequently, the country's bio-ethanol industry was nurtured by government through subsidies during its formative years. Incentives that can make the bio-fuel business economically viable include duty free importations of machinery; tax rebates for environmentally friendly operations and for demonstrating responsible corporate social responsibility; and clear and user friendly regulatory guidelines that include licensing and registration.

The Social pillar

The pillar should provide for:

- Ensuring that local communities substantially benefit from bio-fuel investments (e.g. through involvement in economically viable smallholder out-grower scheme arrangements);
- Recognition of and respect for community land rights in situations where land is opened up for feedstock plantation development. There is therefore need for clauses that minimize community displacements and in cases of any compensation, acquisition, or voluntary relinquishment of rights by land users or owners for bio-fuel operations, these should be based on negotiated agreements including free and prior informed consent by affected communities;
- A fairer pricing formula for sugarcane: The current Cane Purchase Agreements (CPAs) state that out-growers only sell cane to the mill and any value addition benefits (e.g. white sugar, ethanol and electricity generated from bagasse) accrue to the core estate. The only other benefit provided for in the CPA is molasses. Consequently, out-growers realize less value for their product. Given that feedstock price is a major determinant of out-grower scheme profitability, the need to include value added products in CPAs cannot be overemphasized;
- Diversification of bio-fuel feedstock products including community level value addition and utilization. Bio-fuel investments are currently targeting national and international markets that are vulnerable to fossil fuel price fluctuations. Investments that develop and expand bio-fuel product markets beyond the fossil fuel extender domain can therefore stabilize demand and product price. In addition, the promotion of bio-fuels (e.g. jatropha based bio-diesel) for cooking and lighting can improve livelihoods of the poor in rural and urban areas and reduce deforestation; and,
- The balancing of bio-fuel feedstock production and food security at community level within the context of the bio-fuels versus food security debate.

Alternatives to biodiesel from jatropha

The environmental pillar

This pillar addresses environmental sustainability issues and should provide for:

- The conduct of national land assessment and zoning exercises which identify and map out potential areas for bio-fuel investments and potential "no go areas" for incorporation into national and local land use plans. This guards against pushing bio-fuel feedstock production into biodiversity sensitive areas and protects ecosystem services;
- Addressing sustainability issues around feedstocks such as sugarcane that require high fertilization and watering regimes for satisfactory yields;
- International considerations on environmental sustainability and product standards. Potential buyers of a country's bio-fuels (e.g. the European Union and South Africa) have set environmental sustainability criteria. These can be viewed as barriers to trade, but should rather be seen as guidance to develop a responsible and recognised bio-fuels industry that can also reach international markets for responsibly produced bio-fuels. Hence the adaptation and adoption of internationally recognised environmental standards in consultation with relevant stakeholders such as the Round Table on Sustainable Bio-fuels (RSB) should be considered. The RSB is a global multi-stakeholder bio-fuels certification scheme that provides a set of principles and criteria for more responsible production and use of bio-fuels; and,
- Ensuring that aggregated water rights in catchment areas do not exceed sustainable water use.

Sugarcane requires a lot of water and inorganic fertilizer that could have adverse impacts on the ecosystem

The institutional pillar

Bio-fuel production involves many actors that include policy makers, feedstock producers, buyers and sellers. A mechanism that brings together these actors for synergy, coordination and balancing of roles and responsibilities (e.g. responsibility for monitoring the implementation of sustainability criteria between government, investors and civil society) is therefore necessary. The pillar should address institutional capacity building and coordination issues across the bio-fuel value chain (viz. feedstock selection, production, processing, packaging, marketing and investment) for public, private, civil society, business and community level players. It should provide for:

- The articulation of specific strategies that support and synchronise various parts of the bio-fuels value chain;

- Targeted capacity building of institutions and individuals across the value chain; and,
- Ensuring that related sectoral policies are complementary to and supportive of sustainable bio-fuel investments across the value chain.

Testing a national bio-fuels policy model

The Government of Zimbabwe is being supported in the development of a national bio-fuels policy and strategy that embraces the foregoing policy pillars (viz. economic, social, environmental and institutional) through a bio-fuels project jointly funded by WWF and the European Commission. Other components of the four and half year project are:

- Research and development on jatropha feedstock being carried out in collaboration with the University of Zimbabwe and the Department of Research and Specialist Services; and,
- Support for community level jatropha production and utilization being spearheaded Environment Africa, a non-governmental organization.

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ANNEX 1: BIO-FUEL CONVERSION RATIOS FROM SUGRARCANE, SWEET SORGHUM AND JATROPHA FEEDSTOCKS

Sugarcane	Sweet sorghum	Jatropha
1 ton of sugarcane produces 10 litres of ethanol (via the molasses route) 4% of the sugarcane yield is molasses (1 ton of cane produces 40 litres of molasses) 1 ton of molasses produces 250 litres of ethanol 1 ton of sugarcane produces 80 litres of ethanol by direct conversion.	1 ton of sweet sorghum produces 55 litres of ethanol by direct conversion.	The oil content of jatropha seed is 30-35% The conversion ratio from oil to bio-diesel is 1:1 1 ton of jatropha seed produces 300 litres of bio-diesel.

Source: Woods, 2001; Shumba et al, 2009

ANNEX 2: SUGARCANE HUSBANDRY PRACTICES AT KALEYA (ZAMBIA) AND MPAPA (ZIMBABWE) OUT-GROWER SCHEMES

Basic sugarcane management practices applied at Kaleya and Mpapa out-grower schemes are similar despite differences in the scale of operations at the schemes. The first planting of cane is harvested after 13-14 months. Thereafter, the ratoon crop is harvested every 12 months. A general practice is to replant each plot of sugarcane every 10 years implying that a tenth of the cane lands is replanted each year with the rest remaining under ratoon crops. The following operations are undertaken to develop and maintain the sugarcane crop:

Replanting: A plough out and replanting exercise is done on a new plot or one that has been in production for 10 years. Several operations are carried out using equipment and machinery from the core estate. Given that crop vigour declines and disease incidence increases with each year of ratoon cane production, each plot is replanted every ten years with clean planting material.

Weed control: A pre-emergent herbicide is normally applied following the first irrigation of the new cane or ratoon crop. The application is effective for eight weeks by which time the cane will have formed enough canopy cover to smoother most new weeds. Thereafter, spot herbicide applications are made to keep fields clean.

Fertilization: Although fertilizer application rates vary with scheme the fertilization regimes are similar. Planting is accompanied by a basal application which is higher for a new than ratoon crop.
Top dressing is applied in three equal amounts at different times. In winter the first application is done two months after cutting (or planting), the second a month later and the final dose in the fourth month. In summer the first application is done a month after cutting with subsequent applications spaced a month between. Recommended fertilizer rates for the Mpapa scheme are: 400 kg/ha basal and 450 kg top dressing. Rates for Kaleya are: 300 kg/ha basal and 250 kg top dressing.

Irrigation: This is a critical on-going activity in sugarcane production. The first irrigation is done immediately after planting to bring the soil to field capacity following the water starvation pre-harvest. Regular irrigation scheduling commences a month thereafter based on the decision rule of irrigating when total available soil moisture drops to 50% of capacity. In winter this takes 10-12 days and during the rapid growth season (September-January) the irrigation cycle can drop to once every 4 days. The number of irrigation cycles range from 30-52 days from cutting to harvest depending on soil type. The major irrigation cost items are water and electricity.

Harvesting: Milling is done for 8 months spanning from the second week of April to end November. Irrigation water is held back 3 months before harvesting so that the crop increases its sugar concentration in the cane and to minimise excess water carried into the mill and the cost it entails in excess bagasse. This is because farmers are paid based on the estimated recoverable crystal (ERC), a measure of sugar content of the cane. The ERC varies over the growing season and tends to peak between July and September. Consequently, out-grower associations have devised a way to share the potential losses in ERC at the beginning and end of the harvest seasons. At the beginning of the milling season every farmer is asked to estimate his/her annual harvest based on the area planted to cane. Millers, associations and estates then allocate milling quotas per grower distributed over the season to ensure portions of the harvest are during the low as well as the peak ERC periods. Harvesting is the most demanding husbandry activity. Before it is done, the cane is fired to remove excess herbage. Physical labour is used to cut and stake cane into 4.5-5 ton bundles. About 20 people/cutters are needed to cover 1 ha per day. The cane is taken to the mill by rail.

Labour requirements: Out-growers in Mpapa employ 20 people to accomplish their cane husbandry activities due to labour shortages. On the other hand those in Kaleya use family labour which is complimented by casual labour at peak periods.

Sugarcane irrigation channels at the schemes