SUGARCANE AT UMFOLOZI, SOUTH AFRICA: CONTRIBUTING TO THE SUSTAINABILITY OF AN ENVIRONMENTALLY AND SOCIALLY SENSITIVE AREA

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Abstract

Sugarcane has been grown on the Umfolozi Flats in KwaZulu-Natal, South Africa since 1911 and now occupies an area of approximately 9 000 ha between the Umfolozi and the Msunduzi rivers. The sugar production area is bounded by a large local population and the iSimangaliso Wetland Park, a World Heritage site. This paper considers the value of sustainable sugarcane farming in an environmentally sensitive area with a large rural population. The Umfolozi Flats are eminently suited to sugarcane production due to its deep fertile soils, high heat units and favourable annual rainfall. With a labour intensive milling operation and manual planting and harvesting, job creation is considerable, providing direct employment for 6 000 people and in this way the sugar industry contributes significantly to the local economy. The location of the sugar mill in the midst of the production area, coupled with the utilization of a narrow gauge railway results in a highly efficient transport system with a minimal carbon footprint. Current sugarcane industry research focuses on improving efficiencies in the use of chemical inputs, including fertilisers and herbicides, thereby minimising contamination of the environment. A sustainable farming tool, the Sugarcane Sustainable Farm Management System (SUSFARMS®), which aims to guide growers on critical production, environmental sustainability and social issues is currently being introduced.

Keywords: sugarcane, sustainability, environment, South Africa

1. Introduction

An expanding rural population, a World Heritage Site and a productive agricultural industry are neighbours; neither one can survive without the effective management of the other. What role does sugarcane production play at Umfolozi?

There is an increasing global demand for sugar, on average 2% per year (Illovo sugar 2011) (fig. 1). Umfolozi is one of the most productive sugarcane growing areas in South Africa under largely rainfed conditions, with sugarcane yields often in excess of 140 t/ha and average yields of 93 t/ha being obtained on a twelve month cutting cycle. The St Lucia Sugar Company was established in 1916 with the construction of the first sugar mill. After major flooding it was purchased by Umfolozi Cooperative Sugar Planters (UCOSP) in 1923, then just a small group of pioneer farmers. The Mill to this day is owned by the majority of the growers who include 2800 small scale farmers from the surrounding communal areas.

The Umfolozi Flats, which supply 65% of the sugarcane to the mill, covers approximately 20 000 ha of which 9 400 ha is planted to sugarcane. The Flats are relatively flat stretching 30 km from west to east, with an average width of 7 km. There is a large rural population surrounding

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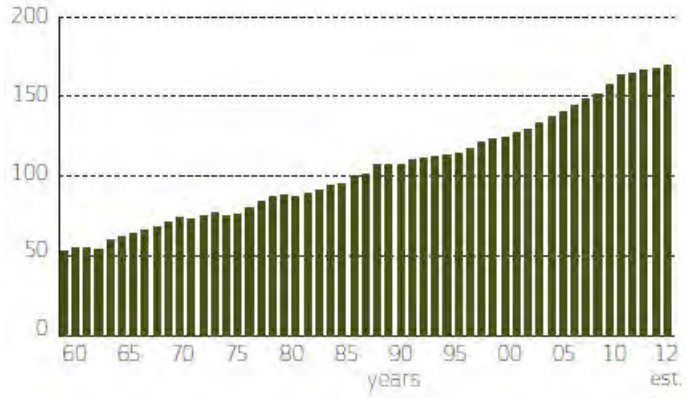

Figure 1. Global sugar demand trend

the farming area, while the iSimangaliso wetland park, a World Heritage Site of which St Lucia estuary is a part, lies to the north east.

Periodic flooding is a constant threat to farming operations. In 1984 Cyclone Demoina struck the east coast of southern Africa and caused wide spread damage, including the decimation of 1 800 ha of sugarcane at Umfolozi, which has never been re-established. Following a study commissioned by UCOSP a model was developed to simulate future flooding scenarios leading to an active flood defence system being implemented in 1986 (Bosch & Ass. 1986).

During the 1950's the St Lucia conservation authority took a strategic decision to separate the Umfolozi River from the St Lucia system due to concerns of high silt loads being carried down the Umfolozi River as a result of the deteriorating catchment. The conservation authorities adopted a strategy to continually keep the St Lucia mouth open with the construction of piers and mechanical dredging using the dredged spoil to create a sandbank preventing the Umfolozi River from entering the St Lucia lake system. iSimangaliso, the managing authority of the wetland park, initiated an investigation through a Global Environmental Facility (GEF) project to assess the effect of the Umfolozi River silt loads entering the St Lucia system with the conclusion that it was recommended to reverse the prior strategy and reconnect the Umfolozi River with the St Lucia system.

In the past ten years the area surrounding the Umfolozi Flats has seen a 20% growth in the rural population increasing the threat to the natural environment. With high unemployment (39%), subsistence farming with cash crops and vegetables is vital to the alleviation of poverty, often with detrimental impacts on the natural resources. With the average household of 4.9 people reliant on each breadwinner, employment is essential for the sustainability of the population and the survival of the ecosystems critical to the area (SA Census 2012).

2. Location

Figure 2. Umfolozi Flats showing Umfolozi River (North) and the Msunduzi River (South)

Figure 3. Location of Umfolozi in the South African Sugar industry

3. Climate

Umfolozi lies at 28° South 32° East on the eastern coastal belt of South Africa (Fig 2 and Fig 3). The average annual rainfall for the last 15 years has been 917 mm with a long term average of 1071 mm (manual measurements taken since 1957). Sugarcane requires 850 mm – 1 500 mm of rainfall in a cycle (Smith 2006).

Umfolozi's ground water table is generally high with deep, healthy, alluvial soils. Rooting depth in excess of 1000 mm, with Total Available Moisture (TAM) on most soils of 120 mm/m or higher. Supplementary irrigation is practised in the lower rainfall area during the high vegetative growth periods of sugarcane. Due to frequent coastal cloud cover, sub-optimal solar radiation is common, averaging 5730 Mj/m_2 per annum or 15.7 MJ/m_2 per day (SASRI weatherweb), optimal crop requirements are 6350 Mj/m_2 (Ramanujam & Venkataramana, 1999).

Data from the local weather stations give an average maximum temperature of 27°C and average minimum of 16°C. Sugarcane generally stops growing in the winter months when daytime temperatures remain below 16°C. (Smit, Singels 2007) At Umfolozi, therefore, there is generally active growth of sugarcane all year.

4. Demographics

There are 6 000 people directly employed by the Umfolozi sugar industry, on average one person for every four hectares of sugarcane (SA Cane Growers, 2012) and the mill employing 270 permanent staff. The 2012 census figures indicate that 29 400 people are directly supported by the Umfolozi sugar industry. In addition there are a large number of supporting industries which have established themselves in the area servicing the sugarcane farming and milling operations.

In the case of the small scale grower, most households have no income from off-farm business activities or employment and sugarcane is perceived as the greatest contributor to income (88%) (Cockburn 2012). A number of development projects are being carried out under the stewardship of Umfolozi Sugar Mill (USM), hoping to increase the number of small scale growers and to facilitate their sustainability. A number of individual growers also participate independently in projects aiding the upliftment of the rural communities.

5. Flooding and water management

The Estuary and the sugarcane growing area are intricately connected in terms of natural resources. The Umfolozi River is the biggest in the five catchments feeding into the estuarine system. With human alterations to the ecosystem and significant weather events, a number of management interventions have been required over the past 60 years. These have had some major effects on the St Lucia estuary (Zaloumis 2011).

Farming at Umfolozi requires consideration of flood water management. A system of major drains has been put in place as part of the flood defence system which accommodates flood waters in a scenario where they would overwhelm the river banks (Fig 4). Eighty per cent of the flood waters are diverted into a sand trap which prevents further sedimentation but allows flood waters to re-enter the lake system or go out to sea. The current flood infrastructure is designed to manage a flood of approximately 10 000 m^3/s. Of this amount of water only 1 200 m^3/s is contained within the levees of the river while the remainder of water is flooded onto the floodplain (Bosch & Assoc. 1986).

With peak rainfall occurring in the summer months between November and February, consideration has to be made of water volumes in excess of crop requirement, equally in the dry winter

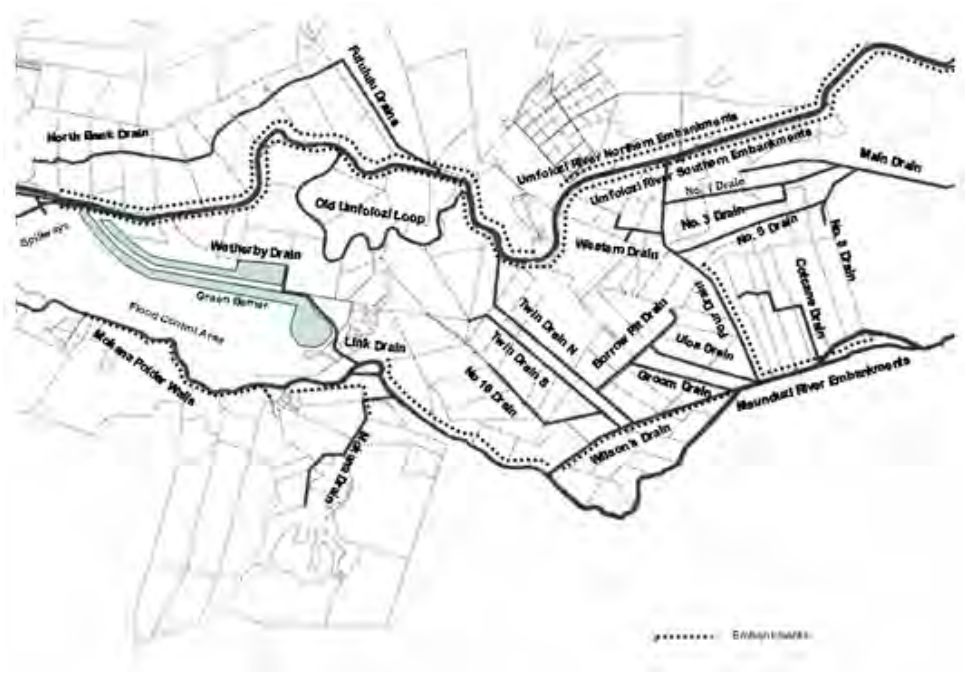

Figure 4. Map of the Drainage system used to manage flood waters at Umfolozi

months, water availability can be below crop requirement. The sugarcane harvesting season extends from April to December and most of the crop is removed from the fields during the dry months, minimising the compaction effects of loading and hauling operations. Sugarcane quality is also at its highest with the least impurities during the dry season.

In September, the sugarcane plant commences rapid growth with the rise in temperature and solar radiation; however, water supply can be a limiting factor. Umfolozi growers are often at the mercy of the weather, with only 30% having access to irrigation. Water storage capacity is limited; therefore irrigation water abstraction is directly out of the Umfolozi River. Each farm has a water use allocation right which is based on the capacity of the river in consideration of other water users. The Umfolozi River is often dry in the winter and spring months therefore water for irrigation is unavailable.

Prior to 2012 the mouth of the Umfolozi and the mouth of Lake St Lucia were separated, with the waters of the Umfolozi largely going out to sea when water levels were high enough to allow breaching of the river mouth. During times when the Umfolozi River mouth was closed, major agricultural problems were experienced with large water volumes backing up the system and flooding farms in the flood plain. Due to severe drought conditions in the past ten years, low water volumes were received from the catchment and the St Lucia Mouth remained closed. Water levels in Lake St Lucia dropped and estuarine function diminished to a critical point.

In 2012 the iSimangaliso wetland authority opened the mouth of the Umfolozi and Lake St Lucia once again forming a single estuary. High rainfall in the latter part of 2012 saw all five catchments contribute to the lake system and as a result Lake St Lucia is currently in a much healthier state. On-going studies funded by iSimangaliso's GEF have enabled investigations to fully re-establish estuarine function.

6. Nutrition

Sugarcane requires appreciable inputs of N and K for optimum yields. Assimilation of N into dry matter is, however, highly efficient relative to commonly propagated forage grasses (fig. 5).

On the Umfolozi flats much of the N requirement of cane is applied as ammonia gas injected into the soil to a depth of approximately 200 mm. Granular fertilisers are often applied using machinery that incorporates the product 200 mm plus below the surface. These application methods are designed to minimize volatilization losses of N, while deep rooting systems of the crop mean leaching losses of N are also restricted. Much of the crop's nutrient requirements are applied in a split application, assisting the plant in improving its utilization efficiency and also in reducing leaching or de-nitrification.

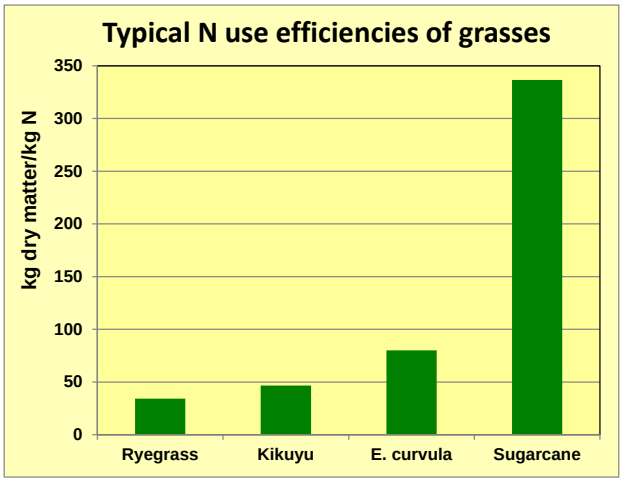

Figure 5. Nitrogen use efficiencies of grasses

7. Pests and disease

There are a number of pests associated with sugarcane production in South Africa; Management practices of the Umfolozi growers have adapted to accommodate such pests. *Eldana saccharina* Walker (Lepidoptera: Pyralidae), one such pest migrating from sedges into sugarcane, caused the reduction in cutting age from 18 months to 12 months. The South African Sugarcane Research institute (SASRI) has a plant breeding programme that has produced numerous pest and disease resistant sugarcane varieties, many of which have been planted at Umfolozi. This has contributed to the limited use of pesticides to control Eldana. As a continuation of this approach, an integrated pest management (IPM) system is currently being introduced. This approach focuses on revitalising the natural habitat of Eldana and the planting of Molasses grass *(Melinis minutiflora)* as a repellent in a so-called "push pull system" (Cockburn 2012), thus attracting the Eldana back to its natural habitat while repelling it from the sugarcane fields. Natural predators of Eldana will be given a chance to build up and in this way a natural management of Eldana levels will be encouraged with minimal environmental effects.

In 2005 sugarcane Thrip (*Fulmekiola serrata*) was first identified in the South African industry. Since then much research has been dedicated to quantifying damage and controlling this pest. Imidacloprid was registered for the control of thrip in sugarcane in 2009. Commonly used as an "in furrow" application at planting, Imidacloprid is being discouraged as a foliar application

due to the negative effects on non-target species. This is the only chemical commonly applied at Umfolozi during the target times when high Thrip numbers occur in 2 to 6 month old sugarcane.

Some soils at Umfolozi have clay content of below 15% and as such are prone to nematode damage. Aldicarb, a nematicide, has recently been de-registered and is now an illegal product in South Africa. The prior minimal use of nematicides has been further reduced due to the lack of a comparable product.

The sugarcane industry has been subjected to some serious fungal infections. There are some rust species common to the local industry; few have been of major economic significance. Sugarcane smut has historically had a major impact. Smut-resistant varieties are produced in SASRI's plant breeding programme, and those varieties which demonstrate susceptibility post-release, have generally been removed from the industry or restricted to low risk areas.

Each Mill area in the sugarcane industry has a Pest, Disease and Variety control service, comprising a team of field inspectors who carry out farm inspections daily for pest and disease risks. Their findings are reported both locally and to SASRI where any concerns are immediately acted upon. Umfolozi has maintained a low risk profile with attention paid to variety choice and to rogueing of high risk smut-infested fields. Fungicides are registered for use in the sugarcane industry; however Umfolozi has little use for these with rust levels being below economic thresholds.

Undeveloped lands at Umfolozi, mainly the flood damaged areas from Cyclone Demoina are often subject to conditions which enhance alien plant encroachment. Work is underway to control alien plant species in these areas. Despite being unproductive, these areas of land are of high importance in flood management. The release of *Anthonomus santacruzi*, – a weevil for the control of *Solanum mauritianum* an invasive plant species from South America – is an example of the control methods being used.

8. Husbandry and harvesting

The South African Sugar Industry is very labour intensive. Sugarcane on the Umfolozi flats is harvested exclusively by hand requiring a large amount of seasonal labour. Many of the day to day farming activities such as fertilising and weed control are also done manually and much of this labour requirement is drawn from local communities.

9. Transport

Umfolozi is the only sugarcane growing area in Africa to still use narrow gauge rail to transport the raw product from the field to the mill. One locomotive hauls 400 tons in contrast to a road haulage system, hauling approximately 32 tons on the same lead distance. An equivalent road haulage operation would contribute 1 555 tons of CO_2 in a given season compared to 725 tons CO_2 for the same season using the narrow gauge rail system (Buckley, 2013). This represents a 53% decrease based on fuel usage alone (Fig. 6).

Furthermore the loading operation partnered with the narrow gauge rail system has a low impact in the field with maximum axle weights below 7 tons when moving the cane from the field to the siding. This leads to low compaction and reduced damage to the soil structure.

Sugarcane is planted on a 7-10 year cycle in South Africa, thus benefiting from very few tillage operations during the life of the crop resulting in less damage to the soil structure. Due to favourable growing conditions on the Umfolozi flats, the industry average of a 7-10 year cycle is often increased to over 12 years. Minimal disturbance of soil when growing sugarcane and the naturally flat topography at Umfolozi means that there is very little soil erosion from the sugar farming area.

Figure 6. The Narrow gauge locomotive hauling trucks of sugarcane to the Umfolozi mill

10. Milling

The milling operation at Umfolozi recycles the water from the sugarcane stalk for the refining process; very little water is used from the river system. No cane is washed prior to entering the milling process, although cane does go over a slotted pan to allow sand and other foreign matter to fall through. There are by-products from the milling process: molasses, from which alcohol is distilled, and bagasse, used to fire the boilers for the milling process and to co-generate electricity. Effluent from the milling process is pumped into settling dams situated far from natural water courses or riparian areas, in compliance with government legislation. The effluent, made up mostly of organic matter is left to break down in the dams and is sometimes used as an organic fertiliser on the sugarcane fields replacing micro nutrients, organic matter and soil carbon.

11. SUSFARMS®

There is pressure on sugarcane producers and the sugar industry for more sustainable production schemes that can help promote best management practices (BMPs) and ensure desirable development conditions for communities and the environment (UNDP, 2010).

SASRI has developed the Sustainable Sugarcane Farm Management System "SUSFARMS®" (Maher 2007) as a means to measure and educate sugarcane producers on BMP's. Based on three main principles; economic, social and environmental, SUSFARMS® places significant emphasis on fair labour practices (in accordance with the various Acts) and addresses various community development and environmental issues. While SUSFARMS® provides a platform for sugarcane growers to gauge their farming impacts on the community and environment; it also provides measures for ensuring increased profitability and sustainability.

As part of SUSFARMS®, growers are required to take regular soil and sugarcane leaf samples, and send them to an analytical laboratory such as the one at the SASRI for analysis. Here, based on test results, fertiliser recommendations are made relating to the optimum and sustainable growth of the sugarcane crop. This helps to ensure that the farmer's operation is sustainable, that crop requirements are met and wastage of products that could potentially contaminate the local environment is prevented. Growers are required to keep accurate records of agricultural chemicals applied to their fields.

Similarly, it is expected that growers undertake to regularly remove alien plant species and also, where possible, to protect indigenous species and encourage the movement of wildlife through the establishment and maintenance of 'protected wildlife corridors'.

12. Concluding remarks

The Umfolozi sugar farming and milling operations have sustained the local communities for 100 years, becoming vital to the economic and social wellbeing of the area. There is little doubt that the potential unemployment rate, already at 39% locally, would be exacerbated in the absence of the local sugarcane industry. The exposure of flora and fauna in the iSimangaliso wetland park to the negative effects of an impoverished local community would be extreme, as experienced in many other parts of Africa.

With small scale grower operations being expanded, there will be increased demand for manual labour and thereby the further enhancement of the socio-economic contributions of sugarcane operations to communities.

Although in a relatively sensitive area from an environmental perspective, sugarcane growing and milling operations are carried out with an appreciation of the surrounding environment with minimal negative impacts on the natural resources in the area. The introduction of management tools, such as the Sustainable Sugarcane Farm Management System initiative, will increase awareness of environmental factors and is likely to further improve the relationship between agriculture, local communities and the natural asset of the iSimangaliso wetland park.

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