

SHORT COMMUNICATION

## A GLOBAL REVIEW AND SYNTHESIS OF LITERATURE PERTAINING TO INTEGRATED SUGARCANE PRODUCTION SYSTEMS

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### Abstract

Many researchers have investigated the impacts of changes to certain processes, such as mechanical harvesting, on other processes in the supply chain, such as milling. These studies sometimes do not mention the term *supply chain*, but inherently highlight important relationships and system properties that regulate sugarcane handling and processing. To date, few researchers in the world have comprehensively reviewed sugarcane handling and processing chains. This review characterises the sugarcane supply and processing chain along five different dimensions, namely, value, material handling, collaboration, information and innovation. The literature was subsequently scanned to identify universal trends and characteristics pertaining to these different dimensions. Interestingly enough, while many researchers considered value and material handling issues, few addressed the complexities related to supply chain collaboration. Also, few researchers evaluated how these supply chains should be managed and what information needs to be shared in order to stimulate an overall drive towards supply chain efficiency. The paper concludes that a lack of literature relating to supply chain improvement systems suggests that this area of research may still be relatively unexplored.

*Keywords:* sugarcane, supply chain, value chain, collaboration, information

### Introduction

Sugarcane production is exposed to high levels of risk, such as pests and diseases and unpredictable weather, and the subsequent post-harvest handling and processing are vulnerable to product deterioration up to the raw sugar stage. Because of this, the chain of activities that are executed in this system needs to be efficient and agile (Bezuidenhout, 2008), while remaining cost competitive. It is therefore not surprising that many researchers worldwide have investigated different integrated strategies in attempts to improve sugar production systems. In this paper, and based on acceptable supply chain methodologies (e.g. Cassivi, 2006; Swink, 2006; Adamides *et al.*, 2008.), the supply chain was sub-divided into five pertinent dimensions. The first, *viz. value chain*, concerns value-adding, value loss and wealth distribution through the chain. Second, a *material handling chain*, concerns the physical equipment and processes used to enable value adding. The third dimension, *viz. collaboration chain*, focuses on the way stakeholders collaborate and co-manage the material handling activity. Fourth, the collaboration chain is kept together through an efficient *information chain* that assists stakeholders to make the right decisions at the right times. Finally, only when all four of the above chains are understood and well managed, could system innovations (*viz. an innovation chain*) be considered. The interaction between the

different dimensions is so important that any innovation which does not consider all the dimensions simultaneously is likely to fail.

In attempts to improve sugar production, many researchers have investigated the causes and effects of system changes within the larger integrated system. These studies often do not mention the term *supply chain*, or *integrated system*, but inherently highlight important system properties that regulate sugarcane handling and processing. To date, few researchers in the world have comprehensively reviewed this collection of literature in order to obtain higher order knowledge, such as research gaps, trends and limitations. In this short communication a number of key formal and informal publications are selected that describe issues surrounding integrated sugarcane production and processing. The aim of the communication is to highlight research trends and limitations.

### Methods

Ninety-one sugar production related publications were reviewed (*cf.* Bibliography). This is most probably not an exhaustive list, although a concerted effort was made to include all the large sugar producing countries in the world. During revision, a list of pertinent system descriptors was compiled. These descriptors (*cf.* Table 1) point to specific issues and were categorised according to the five above-mentioned supply chain dimensions.

**Table 1. System descriptors, or attributes, that pertain mainly to one of five supply chain dimensions.**

Value Chain	Material Handling Chain		Collaboration Chain	Information Chain
alternative products	A/B/C-pan	mechanisation	administration	communication
cash	agronomics	mill gate	affairs	decision making
co-generation	bagasse	mill stop	behaviour	forecasts
cost	best management	mill yard	collaboration	information
dextran	practices	milling	committees	knowledge
economics	burn/harvest to crush	milling season	community	management
environmental issues	delay	planting	conflict	monitoring
ethanol	burning	production	contracts	planning
investment	cane supply	recovery	equity	transparency
labour costs	capacity	risk	growers	
losses	crushing	throughput	hauliers	
marketing	delivery	transportation	incentives	<b>Innovation Chain</b>
markets	deterioration	trash	labour unions	innovation
molasses	economies of scale		mill area	models
pollution	efficiency		millers	new
price	fermentation		negotiation	research
profit	foreign matter		organisational	varieties
quality	green cane harvesting		payment	
revenue	harvesting		penalty	
sugar colour	infrastructure		relationships	
value adding	loading		sharing	
waste	logistics		shifts	
	utilisation		small holders	
	weather		stakeholders	
	maintenance		trust	



production system, which comprehensively describes a successful spectrum of alternative products, but also balances these with strong socio-economic issues.

The material handling chain has been dominated by discussions concerning harvesting, transportation and milling. Transport is often associated with high costs, and issues around harvesting, burning and scheduling. The most prominent issues under discussion when researchers focus on milling are costs, capacities, quality, planning and grower issues. Publications on best management practices seldom cover more than one process in the supply chain and are still *silo* orientated.

The central theme surrounding supply chain collaboration revolved unsurprisingly around the grower/miller relationships. Two wider issues are highlighted, namely, (i) behavioural properties, such as trust, and (ii) organisational issues, such as committees and regulation. Common issues that are discussed in relation to growers and millers are contracts, product quality, length of the milling season, planning and management. Issues that are seldom discussed include mutual value adding, the sugar market and marketing beyond the mill.

The information chain appears to stand on two prominent legs, namely planning and managing. These two activities are strongly supported by forecasting, monitoring and decision-making/decision support.

Most research papers focussed on innovation. However, while many papers discuss the use of models and new varieties to overcome certain system constraints, few papers discuss operational innovation and ways to stimulate stakeholders to become innovative decision-makers in their system. This implies that to date, research has been focussing on strategic long-term solutions, such as new infrastructures, new products and new arrangements between stakeholders. With the exception of transport scheduling, research that would encourage short lead-time system improvements is seldom published.

### **Discussion and Conclusion**

Many researchers have looked at the integration of sugarcane supply systems, especially in a harvesting context. Most researchers, however, assessed long-term strategic issues. This is of concern, since innovative 'quick-fix' opportunities may be available and exploitable within the current operational systems. Because of the long-term focus of many research papers, the importance of production risk and the management thereof has also not received the appropriate attention. On-the-ground short lead-time innovation still remains an unexplored topic for sugar researchers. Until recently the majority of publications had a strong focus on material handling and value chain issues and neglected the collaboration and information flow dimensions. Almost none of the research conducted to date brings long-term sustainability, environmental issues, value adding, the sugar markets and marketing beyond the mill into an overall supply chain context. This is considered a significant shortcoming in the sugar industries of the world, since many modern supply chains do consider these issues holistically (Christopher, 2005).

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