Coordinated Logistics for Sugarcane Harvests in Brazil

Kamal Lamsal, Phillip C. Jones, and, Barrett W. Thomas

September 26, 2012

Abstract

In the face of these high sugar prices, both consumers and producers have a keen interest in increasing world sugar supplies. As the world's largest exporter of both raw and refined sugar and the country whose production costs drive world sugar prices (McConnell et al., 2010), Brazil deserves particular focus.

As with the sugar industries in other countries around the world, the focal point of the Brazilian industry is its sugar mills that crush raw cane to extract the juice from which raw sugar is eventually extracted. Sugar mills also represent significant capital investments. To maintain appropriate returns on their investment, sugar companies seek to run the mills near or at capacity over the entire nine months of the sugarcane harvest season.

To overcome the challenges of coordinating harvest and transport operations with the mill needs, an obvious solution is to decouple mill operation from the supply operation by carrying a stock of raw cane. However, cane presents a complication. Because of evaporation and bacteria growth, the sugar content in cut cane degrades considerably over time (Saska et al., 2009, Saxena et al., 2010). As a result, inventories of cut cane perish over time. We call the time between when the sugar cane is cut in the field to when it is crushed at the mill the cut-to-crush time. Improved logistics coordination offers an opportunity to reduce the cut-to-crush time and thus improve sugar yields while offering maintaining service levels at the mill.

A Brazilian sugarcane harvest is composed of three operations that must be coordinated: infield operation, over-the-road transport, the mill. The infield operations usually occur in several fronts a day. A front is a cluster of geographically close, but not necessarily contiguous, fields. The infield operations have several components. First, the cane is cut in the field, usually using a machine known as a harvester that processes the cane into uniformly sized billets. While in operation, the harvester continuously feeds billets into an infield storage unit known as a cart. The cart is pulled by an infield transporter. This infield transporter and cart combination runs along side the harvester during the harvest operations, and when the cart is filled, the transporter and cart combination must be rotated with another infield vehicle and its associated cart to allow for continuous harvest

operations. Filled carts are transported to an area known as the trans-loading zone that serves all of the fields in a front.

The second operation of the harvest begins at the trans-loading zone. At the trans loading zone, the contents of the filled carts are transferred to over-the-road transport vehicles. These vehicles take the harvested cane from the fields to the mill. The final operation of the harvest takes place at the mill where the over-the-road vehicles are unloaded. Once an over-the-road vehicle is unloaded, it can return to a front for its next load.

In this paper, we present a mixed linear integer programming model for the deterministic sugarcane harvest logistics problem in Brazil. The decision variables are the speed of harvests at the fronts and the assignment of trucks to fronts. Our objective is to minimize the cut-to-crush time of the sugarcane. The resulting math program requires considerable solution time for a daily logistics problem, if the problem can be solved at all. We present analytical results that allow us to strengthen the formulationoriginal problem

References

M. McConnell, E. Dohlman, and S. Haley. World sugar price volatility intensified by market and policy factors. *Amber Waves*, 8(3):28 – 35, 2010.

M. Saska, S. L. Goudeau, and M. Marquette. Determination of sucrose lose in clean unburnt billet cane. *Journal of the American Society of Sugar Cane Technologies*, 9:53 – 77, 2009.

P. Saxena, R. P. Srivastava, and M. L. Sharma. Impact of cut to crush delay and bio-chemical changes in sugarcane. *Australian Journal of Crop Science*, 4(9):692–699, 2010.