

Optimal distillers distribution planning in an ethanol supply chain

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Abstract. The ethanol industry in the United States is expanding rapidly, consequently, the amount of coproducts called distillers feed is also expanding at a rapid rate. These distillers can be fed to cattle because they are excellent source of protein, energy and phosphorus. As they are much cheaper than corn and soybeans, a successful attempt to replace corn and soybeans with distillers feed may provide significant advantages to both ethanol producers and the feedlots. In this paper we propose a supply chain model which minimizes the overall cost of distribution of distillers. We will present a case study on Kansas Ethanol plants.

Introduction

Since producing distillers does not require building new plant or purchasing new machinery. They are just a welcome co-product (or by product) of corn fermentation during ethanol production. Ethanol owners can make good revenue with good marketing of distillers. They produce 3.2 millions metric tons of dried distillers grains plus solubles annually [1]. Kansas is rich in feedlot industry so distillers can be fed directly from ethanol plant to these feedlots in wet or dry form which will save the cost of drying. Initially the distillers are in wet form after ethanol fermentation. This form of distillers are called wet distillers which are mixed with solubles for preservation, the end product is named as wet distillers grains plus solubles (WDGS). As the wet distillers have low shelf life (3-5 days) it is usually dried to store it for longer time. This product is named as Dry distillers grains plus solubles (DDGS).

Although other feeds like corn and soybean are extensively used in feedstock industry but due to lack of research the distillers grains has not obtained a position of primary feedstock in this industry especially in Kansas [2]. Confusion always rises whether DDGS or WDGS should be promoted in Kansas. The objective of this research is to ascertain that whether DDGS or WDGS is less costly as a feed for live cattle. The research will also show that in Kansas which ethanol plants should transport to which feedlot points to minimize supply chain cost.

Experiment, Results, Discussions, and Significance

The distillers are transported from ethanol plant to feedlots by truck in Kansas. The total capacity of ethanol plants in Kansas to produce distillers is 2676.5 MGY and the total demand of distillers in live stock industry reaches to 1593.7 MGY [1]. We have used network optimization model both for wet and dry distillers.

$$\begin{aligned} \text{Min} \quad & \sum_{i=1}^n \sum_{j=1}^m C_{ij} X_{ij} \\ \text{Demand constraint} \quad & \sum_{i=1}^n X_{ij} = D_j \quad \text{for } j=1, \dots, m \\ \text{Capacity constraint} \quad & \sum_{j=1}^m X_{ij} \leq K_i \quad \text{for } i=1, \dots, n \end{aligned}$$

- C_{ij} = Cost of shipping one unit from plant i to customer points j .
- K_i = Capacity of the plant.
- D_j = Annual demand from customer point j .
- m = Number of demand point (customer points)
- n = Number of plant locations.
- X_{ij} = Quantity shipped from plant i to customer point j

WDGS contains 70% moisture so its transportation cost is higher than that of DDGS which contains only 10% moisture but it incurs additional cost of drying. A break analysis is conducted between WDGS and DDGS

cost when it reaches to end customer. Break even point of wet and dry distillers came out to be 39.978 miles which confirms that if the distance between livestock and ethanol point is less than 39.978 miles, then its cheaper to ship WDGS. The above model suggests which ethanol plant should transport distillers to which feedstock points to minimize the cost. In case of WDGS the model has been used for those ethanol plant and feedlot points whose linear distance is less than 39.978 miles. Similarly for DDGS the data points are those ethanol plants and feedlots whose linear distance is no less than 39.978 miles.

Conclusion

This study reveals that it's not always advisable to ship WDGS. The practice of transporting WDGS to more than 39.978 miles should be avoided. Likewise, DDGS is an excellent candidate when distance between customer and shipper is large. Live stocks in Kansas should use distillers instead of corn or soybeans to minimize the cost of feed to live cattle because Kansas is rich in feedlots and distance between ethanol plants and feedlots is not high. The methodology used in this research is also valid to other state in the United States.

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[1] Renewable Fuel Agency (RFA), United States, 2007

[2] Corn and Sorghum Production Up, Soybeans Unchanged From August, Vol. 07, Chapter 09, United States Department of Agriculture, 2006.