The Professional Animal Scientist 33:73–84
https://doi.org/10.15232/pas.2016-01512

Economic viability of lime-treated corn stover in finishing beef cattle diets

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ABSTRACT

Corn stover treated with a lime slurry has the potential to reduce feed costs for finishing feedlot cattle. Feed rations including lime-treated corn stover were profitable compared with the control rations for all scenarios investigated. The average annual increase in returns per feedlot space on a beef cattle feedlot operation when lime-treated corn stover was included in the rations of finishing cattle was $40.82 per feedlot space, with a range of increased returns of $7 to $90 per feedlot space depending on feed price assumptions. The range of corn prices tested was $118.10 to $196.84/Mg, and the range of corn stover prices tested was $38.58 to $60.63/dry Mg. Environmental impacts studied were soil erosion, changes in soil organic carbon, and nitrate leaching. Data from the Landscape Environmental Assessment Framework were used to quantify the environmental impacts resulting from the ration substitutions. Incorporation of environmental values with the economic results affects social values and can lead to negative social outcomes in some cases. Detrimental environmental impacts increase as the level of corn stover harvest increases, and the incorporation of environmental values to the on-farm economic values of the feed substitutions can affect the social outcome of the feed substitution.

Key words: beef feed ration economics, economic and environmental assessment, lime-treated corn stover, livestock production

INTRODUCTION

In January 2015 there were 13.1 million cattle and calves being fed for slaughter in United States feedlots (USDA, 2015). Feeding trials have been conducted using alternative corn products as feed replacements for beef cattle to investigate potential areas of improvement for feedlot margins. Shreck et al. (2012) studied the potential of treated corn cobs replacing a portion of dry-rolled corn but found a significant decrease in fat thickness. In the same study, Shreck et al. found that replacing a portion of corn grain with untreated corn stover resulted in decreased ADG, lower HCW, and diminished fat thickness. Nuñez et al. (2015) found that feeding dry distillers grains with solubles to cattle from growing through finishing resulted in adverse performance compared with cattle fed no dry distillers grains with solubles, where the optimal strategy is to feed dry distillers grains with solubles during growing but not finishing stages. On the other hand, studies have shown that alkaline-treated corn stover can be substituted into the diet of beef cattle without sacrificing performance (Russell et al., 2011; Shreck et al., 2012; Johnson et al., 2013).

Corn stover refers to the organic remnants (stalks, cobs, leaves) remaining on the field after corn grain harvest. Assuming the quantity of corn stover produced is equivalent to the amount of corn grain produced, as in Karlen et al. (2014), the United States produced 360 million megagrams of corn stover in 2015 (NASS, 2016). Harvesting corn stover can be environmentally detrimental, with effects ranging from reduction in soil organic carbon (**SOC**), an increase in soil erosion, and higher levels of nitrate leaching, among others. Up to 75% of corn stover can be harvested sustainably if managed properly with techniques including winter cover crop coverage (Pratt et al., 2014).

Three primary objectives were addressed in this study. First, the study assessed the economic viability of lime-treated corn stover as a replacement feedstock in the diet of finishing feedlot cattle. Second, the study quantified environmental outcomes under alternative corn stover harvest farm management practices. Finally, this study determined under what feed price and farm management conditions lime-treated corn stover is economically viable and environmentally sustainable.

MATERIALS AND METHODS

Definitions

Income Over Feed Cost. Income over feed cost (**IOFC**) is a simple calculation often used to assess and monitor dairy profitability. A modified version of IOFC, suitable for feedlot profitability analysis, is used in this study. Changes in IOFC are measured as $/feedlot space per year by subtracting changes in feed costs from changes in income when substituting lime-treated corn stover for base case feed ingredients. We did not measure IOFC in $/head because the feeding trials used in this study each fed lime-treated stover for different lengths of time. Thus $/feedlot space per year accounts for animals that are replaced in the feedlot within a year, and the timeframes of treated stover feeding are standardized.

Corn Stover. Corn stover refers to all nongrain portions of a corn plant remaining after the harvest of corn

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grain. The proportion of corn stover to corn grain in a field is referred to as the corn stover harvest index, which is measured by dividing the dry weight of corn grain in a field by the total dry weight of the grain plus dry stover weight. This research assumes a corn stover harvest index of 0.50, following Sesmero (2011) and Ertl (2013). This study focuses on lime-treated corn stover, which refers to corn stover treated with calcium oxide (CaO) or calcium hydroxide (CaOH). Combs (2012) and Rust (2013) prescribe the method of treatment as grinding the corn stover coarsely and hydrating the stover to 50% moisture. Lime accounts for 5% of the DM in the feed.

Soil Erosion. Wind and water erosion refer to the processes involving the detachment and transportation of soil from one location to another. Corn stover provides soil surface cover that serves as a natural defense against soil erosion. The Natural Resources Conservation Service identifies the maximum megagrams per hectare of soil erosion a landscape can tolerate each year without affecting future productivity, called the T-Factor. Midwestern soils typically have T-Factors between 2.24 and 11.21 Mg/ha per year. Decades of data collection document that increasing levels of corn stover harvest leads to increased soil erosion with no other change in management practice (Lindstrom, 1986; Pratt et al., 2014).

Soil Organic Carbon. Soil organic carbon refers to carbon held by the soil, where the stock of soil carbon is a determinant of soil health and future productivity (Lal, 2014). Depending on farm management, weather, and other factors, the stock of SOC in a particular soil can increase or decrease in a given year. Johnson et al. (2014) found that the quantity of corn stover required to maintain SOC levels is 5.74 ± 2.40 Mg/ha per year. However, the authors caution that each site is subject to unique conditions and that there is no precise quantity of stover appropriate for all landscapes. The quantity of stover that can be harvested while maintaining SOC must be determined at the field level to avoid miscalculating sustainable stover removal.

Nitrate Leaching. Nitrogen application in agriculture often results in the loss of nitrate (NO_3) through a process called leaching (Ribaudo et al., 2011). Nitrogen lost to leaching often contaminates groundwater. When the concentration of nitrogen in a body of water reaches a certain level, the water becomes toxic for human consumption and hazardous for other animal species (Christianson et al., 2013). Corn stover contains nitrogen that is naturally recycled through its decomposition. When corn stover is harvested, this loss in naturally occurring nitrogen must be replaced by greater amounts of nitrogen fertilization.

Data

Whereas past research has investigated alternative corn feeds such as corn cobs and different types of distillers grains, this study focuses on research involving lime-treated corn stover. This study employs results from 3 independent feeding trials (detailed below) involving the substitution of lime-treated corn stover for a portion of corn grain and other feedstuffs in the diets of finishing feedlot cattle as part of TMR. The 3 feeding trials did not test exactly the same control ration containing corn grain or experimental ration(s) containing lime-treated corn stover. Two of the 3 feeding trials resulted in unchanged feed performance and carcass merit, whereas the third feeding trial resulted in statistically significant changes in both categories. Relevant specifications and results that could affect IOFC from each feeding trial are outlined here. The Landscape Environmental Assessment Framework (**LEAF**), which provides the environmental data for this study, is also described.

Feeding Trial 1. The first feeding trial included in this study, referred to as "feeding trial 1," comes from the University of Nebraska Beef Cattle Reports collection (Johnson et al., 2013). One purpose of this feeding trial was to measure the effect of substituting lime-treated corn stover for corn grain on the performance of calves and yearlings. The feeding trial was divided into 2 experiments, winter and summer, where the winter experiment lasted 183 d from November to May and the summer experiment lasted 140 d from May to October. The specifications and results of the winter and summer trials were almost identical, so we only consider the summer experiment. The summer experiment was conducted with 192 steers. A control group was fed a diet with 51% DM dry-rolled corn, 5% DM untreated corn stover, and 0% DM lime-treated corn stover. The experimental group was fed 36% DM dry-rolled corn, 0% DM untreated corn stover, and 20% DM lime-treated corn stover. All other feed ingredients were fed at equal levels to the control and experimental groups, such as modified distillers grains with solubles (**MDGS**) at 40% DM.

The experiment found no difference in feed performance or carcass indicators in steers fed the control and treated stover rations. There was no statistical difference in estimated USDA YG for steers fed the treated stover versus those fed the control ration.

Feeding Trial 2. The second feeding trial also comes from the Nebraska Beef Cattle Reports collection (Shreck et al., 2012). This feeding trial can be distinguished from feeding trial 1 in that the initial steer BW is approximately 45 kg heavier, and treated corn stover partially substitutes for roughage, which is defined as equal parts corn cobs, wheat straw, and corn stover. The experiment included 336 short-yearling steers in a randomized block design. The control ration fed 46% DM dry-rolled corn, 0% DM lime-treated corn stover, and 10% DM roughage, and the experimental ration fed 36% DM dry-rolled corn, 20% DM lime-treated corn stover, and 0% DM roughage. Both rations fed 40% DM wet distillers grains with solubles.

Steers fed treated stover had comparable performance and carcass characteristics with those fed the control ration. The experiment yielded no statistically significant