Effects of fertilizer prices on beef feedlot manure management

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Introduction

A whole farm planning approach offers significant potential for manure management when the production of beef feedlot cattle and crops occurs at the same site. Integration of crop and livestock production offers benefits to the operation that are not readily available to specialized operations producing strictly crops or livestock. Cropland can provide feed to the livestock portion of the enterprise and a place to apply the manure produced by the cattle. Manure supplies nutrients to cropland which would otherwise have to be purchased from off-farm sources. Therefore, what would be a cost of disposal to an operation producing strictly livestock may become an economical way to supply nutrients to crop production on an integrated crop-livestock operation. The Western Beef Feedlot Linear Programming Model has been designed to explore these types of interactions in an integrated crop and livestock production system.

Simulations and results

Simulations are conducted using the WBFM LP model in order to examine how the increased nitrogen fertilizer price of Spring 2001 impacts the optimal management decisions made by a feedlot-farm operator. In examining this impact, one must consider the effects of the price change on how manure is handled, what crops are grown and if changes in the choice of livestock diets are warranted. The question of how far manure can be hauled is also addressed in response to changes in the price of an input as significant as fertilizer. The sample feedlot-farm is assumed to have a one-time capacity of 5,000 head and a land base of 1,036 hectares within a two kilometer average hauling distance. Table 1 reports the results of the simulations conducted.

Table 1. Results of simulations examining the effects of differing fertilizer prices on a feedlot-farm operation.

Variables and management options	Units	2000 fertilizer prices		2001 fertilizer prices	
		2000 base	No manure application	2001 base	No manure application
Manure hauling distance	kilometres	2	9	2	13
Nitrogen fertilizer price	$/kilogram	$0.62	$0.62	$0.99	$0.99
Phosphate fertilizer price	$/kilogram	$0.81	$0.81	$0.79	$0.79
Feedlot-farm profit	$	$44,000	-$8,500	$18,000	-$72,000
Manure applied to corn silage	tonnes	35,000	0	35,000	0
Compost produced and sold	tonnes	0	12,400	0	12,400
Nitrogen fertilizer purchased	tonnes	71	174	71	174
Phosphate fertilizer purchased	kg	15	70	15	70
Livestock shadow value*	$/head	$75	$72	$78	$72
Cropland shadow value	$/hectare	$811	$811	$750	$750
Manure shadow value	$/tonne	-$1.00	-$2.50	$0.07	-$2.50

*Shadow value: profit contribution of one additional unit of a resource.

In all simulations, available cropland is allocated to the production of irrigated corn silage. Furthermore, all of the sixteen thousand head of cattle finished on an annual basis are done so using the barley grain-corn silage diet creating 35,000 tonnes of manure. A total of 19,000 tonnes of barley grain and 820 tonnes of supplement are purchased as diet ingredients. Corn silage production is well in excess of that required at the feedlot resulting in the sale of 39,000 tonnes of corn silage in each simulation.

In the simulation based on the year 2000 fertilizer prices and a 2 km manure hauling distance, feedlot-farm profit is approximately $44,000. All manure is applied to cropland. In addition to manure nutrients, nitrogen and phosphate must be purchased in the form of inorganic fertilizers to meet crop nutrient requirements. Even though fertilizer must be purchased, the shadow value of manure (the value that one more tonne would contribute to profit) is -$1.00 and can be interpreted to mean that each additional tonne of manure produce by the feedlot portion of the operation will decrease profit by $1.00. This indicates that applying manure to land is the least expensive means of disposing of the manure and not the least cost way to supply crop nutrients. The shadow value pertaining to feedlot pen space indicates that one additional head of pen space would contribute $75 to the feedlot-farm profit. The shadow value on cropland indicates that having one more hectare of cropland would contribute $811 to the operation's profitability. At a manure hauling distance of 9 km, profit falls to -$8,500 and it becomes more cost effective to compost the feedlot manure, sell the compost at the farm-gate and purchase inorganic fertilizer to meet crop nutrient requirements.

The simulations corresponding to the year 2001 fertilizer prices are very similar to their counterparts in the pair of simulations based on year 2000 prices. Activity levels for the 2 kilometer hauling distances based on 2000 and 2001 fertilizer prices are the same. This is not surprising because, given the set of crops, and the type of livestock produced in a given geographic area, agricultural production is likely to be relatively inflexible to change over the short run. The profit, however, is lower in the 2 kilometer hauling distance simulation based on the 2001 fertilizer prices due to the increase in the price of nitrogen. A particularly interesting portion of the output related to the increased cost of nitrogen fertilizer lies in the shadow value of manure. The shadow value of one more tonne of manure is now $0.07, a small but meaningful number.

This small positive number indicates that, based on the increased nitrogen fertilizer price, manure is a valuable resource to crop production and not a by-product to be handled in the cheapest manner possible. An additional tonne of manure contributes to, rather than detracts from, profit just as do cropland and livestock production. The shadow value of livestock has increased to $78 (an increase of $3) in response to the increased nitrogen price. This increase in the shadow value of livestock can be attributed to the increased value of the manure produced by the livestock. The shadow value of cropland decreases in this simulation due to the increased cost of crop production brought about as a result of the increased price of inorganic nitrogen fertilizer. The distance at which the production and sale of compost, while purchasing inorganic fertilizer, becomes more cost effective than land application of manure increases to 13 km in response to the increased fertilizer prices.

Conclusions

The WBFM LP model provides integrated crop-livestock producers with a tool that enables them to examine optimal choices for their operation given the biophysical and economic conditions unique to their operation. Results of this simulation indicate that, from an economic standpoint, manure cannot be transported relatively large distances. The value of manure to an operation increases with the cost of substitute commercial inorganic fertilizers. Fertilizer prices do not change the optimal activities at the feedlot-farm but will significantly the impact distances which manure can be transported in an economically optimal manner. Changes to the fertilizer prices also change the inherent value of manure to the crop-livestock production system. Finally, if nutrients can be supplied to crops by inorganic fertilizers at a lower cost than they can be supplied by manure, manure will have a negative value to the operation. If nutrients can be supplied in a more cost effective manner using manure rather than inorganic fertilizer, however, manure provides a positive contribution to overall feedlot-farm profitability.

*Important note regarding results presented in scientific posters: "The research reported here is in progress, and therefore the study results have not been subjected to scientific peer review."

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