Estimating the Demand for Sunflower Meal in the Northern Plains

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Further processing of agricultural products has been promoted as a major method for enhancing economic development in North Dakota. One effort has been the processing of oilseed sunflower. Three processing plants were built in the state after the release of a feasibility study (Helgeson et al.) which identified the conditions necessary for the success of such a plant.

The major by-product of oilseed sunflower processing is oilseed sunflower meal (sun meal), which represents 60 percent of the product by weight but only 20 to 30 percent of the value. The North Dakota livestock industry could consume less than 10 percent of the production of the three processing plants in North Dakota, even if the industry's entire demand for crude protein was switched to sun meal. Therefore, sun meal sales must be made regionally, if not nationally.

The purpose of this article is to report a method of estimating the potential demand for sun meal. Merchandisers can use the results to estimate the potential impact on sales from price changes. The difference between potential and realized sales is a measure of the barriers to sun meal use. Knowledge of this difference could be used to identify and reduce these barriers, such as different handling characteristics and the possible requirement for additional storage bins.

Estimating Procedures

Objective procedures to estimate demand typically involve econometrics and related statistical tools. Estimates of demand using these procedures have several weaknesses. They are based on historical data and therefore cannot identify future structural changes – the past often does not repeat itself. And, in the case of sun meal, history is limited and perhaps distorted because of the price incentives needed to encourage adoption of a relatively new and unfamiliar product. Statistical estimates are also limited to the range of observed data, and whether observations trace supply or demand curves or some combination of the two is difficult to know.

Linear Programming

The feed manufacturing industry has been using linear programming models for many years to calculate the optimal composition of feed ingredients. These models select the least cost combinations of ingredients that satisfy the nutrient requirements of a particular livestock class. As a particular ingredient becomes more expensive, its use declines as other feed stuffs are substituted for it.

Linear programming (LP) is a mathematical technique that selects a best alternative when the objective is to maximize profit or minimize cost. The alternatives are constrained so as not to exceed predetermined minimums and maximums. In the case of livestock feed, the constraints specify minimum (e.g., protein) or maximums (e.g., fiber) for

various nutrients. The feasible solutions include continuous combinations of several feed ingredients. These potential ingredients are included at specified prices and must be combined in a way that minimizes cost of the ration while satisfying nutrient requirements.

Normally, feed manufacturers would include sun meal when it is profitable to do so. Therefore, by solving LP least cost mix feed models for a schedule of sun meal prices, leaving other ingredient prices fixed, the percent of sun meal in a ration that gives lowest cost at each price can be determined. Estimated sun meal use can be calculated by multiplying this percentage by the quantity of feed produced. Total use is estimated by adding the use for each livestock class for a specific price.

Data needed for this analysis include the nutrient values of alternative feed stuffs and the prices of each, the nutrient requirements for the relevant livestock class, and associated quantities of manufactured livestock feed produced.

Seven species were selected to represent the bulk of feed consumed: dairy, beef, swine, growing chicken, layer, broiler, and turkey. The nutrient requirements of livestock and nutrient content of feed stuffs employbed by a major feed manufacturer were used to represent industry practice. Five pricing points (Figure 1) were used to capture major geographic differences in prices of feed stuffs. Only the results for the Northern Plains region are repor-ted in this article. The prices used were weekly averages for the 1970-1983 period adjusted to 1983 price levels. This procedure was used to capture fundamental price relationships. Prices at any one time would include short-term distortions.

The least cost ration for seven livestock classes was determined by holding the prices of alternative feed stuffs constant while increasing the price of sun meal. The price and percent of sun meal in the ration was noted each time the solution changed. This report illustrates the results using 38 percent protein sun meal. Equivalent analysis was made for 28 and 44 percent protein sun meal.[1]

Figure 1. Selected pricing points for five livestock feeding regions in the United States.

Results

The data in Table 1 illustrate the type of results obtained. Twenty-four percent of the growing chicken ration in the Northern Plains (Chicago prices) was 38 percent sun meal at prices from $.50 to $4.50/cwt. and 18 percent from $4.50 to $6.50/cwt. Sun meal dropped completely out of the solution at $9.08/cwt. and above.

[1]Detailed results for all species in the five regions for three protein levels (28, 38, and 44%) are found in Voorhees and Cobia. Copies of this publication can be ordered from the Department of Agricultural Economics, North Dakota State University, Fargo, ND 58105.

Table 1. Percentage of 38% protein sun meal in LP solutions at prices for representative livestock species based upon Chicago (Northern Plains) 1979-83 standardized livestock feed ingredient prices.

Price ($/cwt.)	Growing chicken	Layer	Broiler	Turkey	Swine	Beef	Dairy
.50	24.0	18.75	16.75	18.25	30.01	59.20	30.50
3.50	24.0	18.75	16.75	18.25	30.01	59.20	26.00
4.50	18.0	18.75	16.39	18.25	29.00	33.25	10.50
5.25	18.0	18.75	16.39	18.25	29.00	33.25	7.00
5.37	18.0	18.75	16.39	18.25	29.00	33.25	0.00
5.50	18.0	14.75	16.39	18.25	11.75	33.25	
6.35	18.0	14.75	16.39	14.75	11.75	33.25	
6.50	12.5	7.50	15.75	0.00	11.75	9.00	
6.61	12.5	7.50	15.75		11.75	9.00	
6.62	12.5	7.50	0.00		11.75	9.00	
7.00	12.5	4.50			11.75	9.00	
7.50	9.5	4.50			11.75	9.00	
7.82	9.5	0.00			11.75	9.00	
8.17	9.5				11.75	0.00	
8.50	8.25				0.25		
8.83	8.25				0.00		
9.08	0.00						

Shadowed percentages indicate change in solution as price is increased.

Demand for sun meal for each species in the region was calculated by multiplying the percentage of sun meal in the least cost solution (Table 1) by the quantity of feed produced in the region for 1983. For example, 10.5 percent of the least cost dairy ration in the Northern Plains was 38 percent sun meal when it was priced from $4.50 to $5.25/cwt. This percentage when multiplied by the 3,017 million tons of dairy feed produced in the Northern Plains equals 317,000 tons quantity demanded by dairy. Tonnages of estimated sun meal utilization for seven livestock classes are in Table 2.

Of particular interest to sunflower meal sellers is the change in quantity demanded relative to a change in price. These relative changes are directly reflected in total revenue (Table 3). There are threshold prices (e.g., 5.37) from which additional price reductions would not attract a significant increment in sales. But a slight increase in price at these levels would result in a dramatic reduction in sales and in total revenue. An 18 percent[2] reduction in price from $5.37 to $4.50 would increase sales only 9% and total revenue would fall by 9 percent. On the other hand, a slight reduction in price from $5.50 to $5.37, a 13 percent decline, would increase sales by 46 percent and total revenue by 58 percent.

To use this procedure as a merchandising tool, a sun meal producer would need to make these calculations using current feed ingredient prices. Discrepancies between estimated demand for sun meal (based on model simulations) and actual sales might be indicative of market barriers. Such barriers among feed manufacturers include unfamiliarity with handling characteristics, requirements for additional bins, and changes in labels. If these barriers were identified, and if the magnitude of lost sales is sufficiently great, steps can be taken to reduce or eliminate them.

References

Helgeson, Delmer L., David W. Cobia, Randal C. Coon, Wallace C. Hardie, LeRoy W. Schaffner, and Donald F. Scott, *The Economic Feasibility of Establishing Oil Sunflower Processing Plants in North Dakota.* Bul. 503, North Dakota Agricultural Experiment Station, Fargo, ND, April, 1977.

Voorhees, Jean, and David W. Cobia, *Synthetic Demand for Oilseed Sunflower Meal as a Feed Ingredient.* Ag Econ Rpt., Department of Agricultural Economics, North Dakota State University, Fargo, ND, (forthcoming).

[2]Percentages in this section are calculated by using the average of the two totals as the denominator.

Table 2. Northern Plains synthesized annual demand for 38% sun meal in representative livestock diets, 1979-1983 standardized prices and associated total revenue ($ million).

Price ($/cwt.)	Species: Growing Chicken	Layer	Broiler	Turkey	Swine	Beef	Dairy	Total (1,000 tons)	Total Revenue (4 million)
0.50	74,174	340,875	35,175	206,955	2,275,958	859,584	920,185	4,713	47
3.50	74,174	340,875	35,175	206,955	2,275,958	859,584	784,420	4,577	320
4.50	55,631	340,875	34,419	206,955	2,199,360	482,790	316,785	3,637	327
5.25	55,631	340,875	34,419	206,955	2,199,360	482,790	211,190	3,531	371
5.37	55,631	340,875	34,419	206,955	2,199,360	482,790	0	3,320	357
5.50	55,631	268,155	34,419	206,955	891,120	330,330		1,787	197
6.50	38,632	136,350	33,075	167,265	891,120	130,680		1,397	182
6.61	38,632	136,350	33,075	0	891,120	130,680		1,230	163
6.62	38,632	136,350	0		891,120	130,680		1,197	158
7.00	38,632	81,810			891,120	130,680		1,142	160
7.50	29,361	81,810			891,120	130,680		1,133	170
7.82	29,361	0			891,120	130,680		1,051	164
8.17	29,361				891,120	0		920	150
8.50	6,954				18,960			24	4
8.83	6,954				0			5	1
9.08	0							0	0

Shadowed quantities indicate change in least cost solution as price is increased.

Table 3. Arch elasticity of demand at selected intervals for 38% sun meal in the Northern Plains Region, 1979-1983, standardized prices.

Price	Quantity	Elasticity
($/cwt.)	(1,000 tons)	
3.50	4,577	
		-.92
4.50	3,637	
		-.52
5.37	3,320	
		-25.10
5.50	1,787	
		-1.47
6.50	1,397	
		-1.81
8.17	920	
		-47.94
8.50	24	

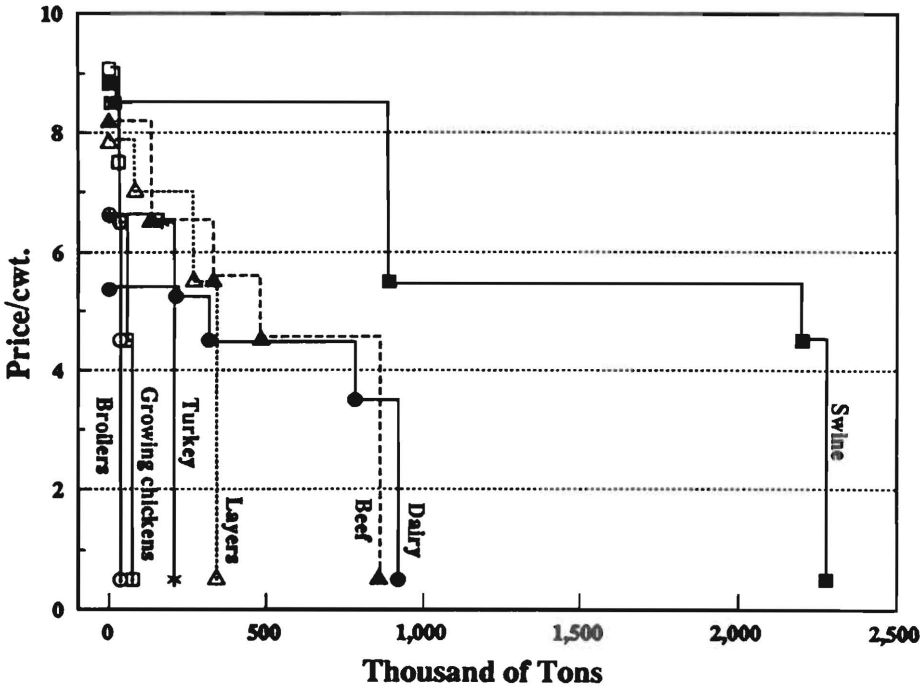

Figure 2. Individual demand of specified livestock specie for 38% sun meal in the Northern Plains Region.

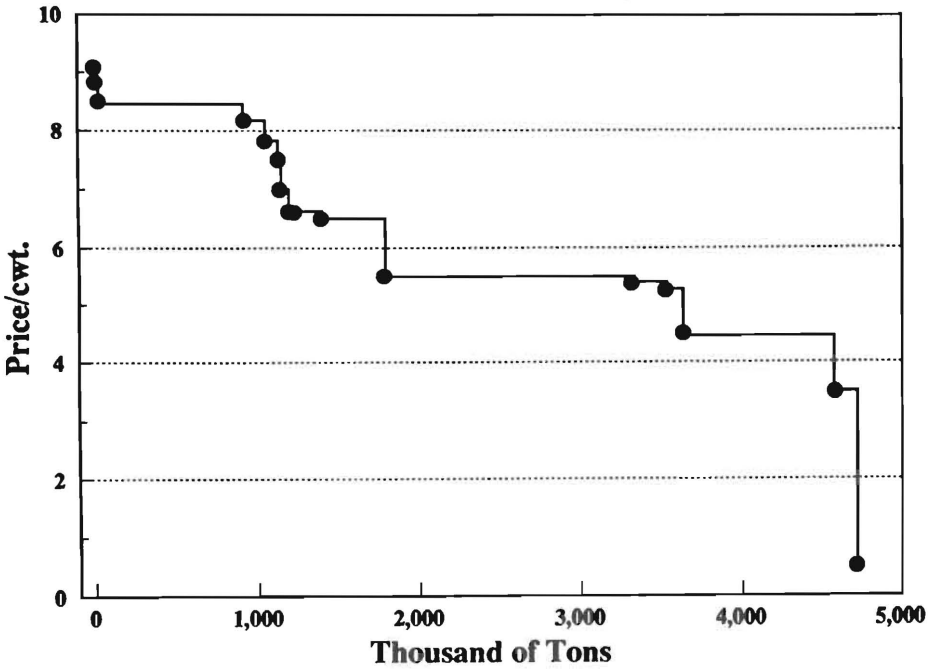

Figure 3. Total demand for 38% sun meal in the Northern Plains Region.