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COMPETITIVE POSITION IMPLICATIONS OF AN ENERGY CONSERVATION PROGRAM FOR FEEDING LIVESTOCK AND POULTRY IN THE NORTHEAST*

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Introduction

This paper examines the potential that exists for energy conservation in feeding livestock and poultry in the Northeast by analyzing the "What if" question: "What if national policy dictates using imputed energy "costs" to minimize energy use in feed rations?" Current feed rations contain large amounts of embodied energy reflecting the quantity of fossil fuel energy required to produce, process and transport the various ingredients included in the feed rations. By changing the mix of ingredients in feed rations, perhaps considerable energy could be saved in the Northeast.

In 1976, farmers in the Northeast will feed their milk cows, layers and broilers approximately nine million tons of grain concentrates, oilseed meals, byproduct feeds and other feed ingredients. Nearly 80 percent of this volume will be purchased in the form of a commercially mixed feed ration. Such feed rations provide farmers with a particular level of protein and feed energy that matches the specific needs of the farmers' animals. Further, they usually provide all of the nutrient requirements for the nonroughage portion of the animal diet. The particular ration that a farmer buys from a commercial feed mill is a

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least cost ration or blend of ingredients that fulfills the above requirements (i.e., minimum protein, feed energy and nutrients) at the lowest possible cost (or greatest profit) to the mill. The composition of any one least cost ration is constantly in flux--changing with the availability and price of the different feed ingredients.

If fossil fuel energy usage was reflected in the price of feed ingredients, the least cost ration would tend to minimize the amount of fossil fuel energy embodied in the mixed feed ration. However, there are reasons to believe that this is not necessarily the case, because there are a number of economic factors besides energy that determine the price of feed ingredients. The present price of ingredients does not reflect to any great extent the quantity of fossil fuel energy utilized in the production, processing and transport of those ingredients. Thus, there exists a potential for energy savings in feeding livestock and poultry through a modification of the composition of the diets that they are fed.

This paper examines the extent to which least cost feed rations are not energy minimizing rations. It considers the magnitude of the energy savings that are possible in the short run (given current ingredient supply levels) if energy minimizing rations were fed. Further, it analyzes the consequent economic implications of feeding these rations to livestock and poultry in the Northeast. This paper examines the particular ingredient composition of least cost and least energy feed rations for dairy cattle, layers and broilers for a specific point in time (February 1976). It supplements studies of energy conservation possibilities conducted under an interagency agreement between the Federal Energy Administration and the Economic Research Service, USDA.

Procedure

A linear programming model was developed that would allow the comparison of both least cost and least energy feed rations. Particular feed rations were minimized with respect to cost and then with respect to energy (measured in terms of the BTU's required to produce, process and transport the feed ingredients[1/]) per hundredweight of ration subject to constraints for crude protein, feed energy, fat, fiber and amino acids (for poultry). The analysis was simplified by excluding constraints for minerals and vitamins; the justification for such an approach lies in the availability of vitamin and mineral supplements that can be added to feed rations to meet specific needs. The minimum and maximum constraints

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1/ A British thermal unit (BTU) is the quantity of heat required to raise the temperature of one pound of water one degree Fahrenheit at, or near, its point of maximum density. The energy content of the various power sources is commonly measured in terms of BTU's. For example, one kwh of electricity is rated at 3,413 BTU; gasoline at 125,000 BTU per gallon; diesel fuel at 140,000 per gallon; L.P. gas at 95,000 BTU per gallon; and natural gas at 100,000 BTU per therm.

for protein, energy, etc. used in the model were typical for species and rations considered. Quantities of the individual ingredients in the various feed rations were further constrained by (1) the ability of the particular species to consume the ingredients and (2) the historic availability of the ingredients in the Northeast. Corn grain and soybean oil meal were the only feed ingredients that were not constrained in the analysis.

Commercial feed manufacturers were contacted and asked to provide a list of feed ingredients that they used in formulating their rations. They also provided prices paid for these ingredients in February of 1976. These prices were used in developing the least cost feed rations. USDA estimates were used for the amount of fossil fuel energy utilized in the production and processing of these feed ingredients (see Table 1) and additional estimates were made of the energy utilized in transporting the ingredients to the Northeast.[2/] Throughout, no energy allocation was assigned for the manufacture of fixed inputs such as tractors, trucks and processing equipment. At the farm level, the production estimates reflected only the operational or variable farm inputs such as gasoline, the energy utilized in irrigation, and the BTU's required to produce and apply fertilizer. Where processing was considered, only the energy required to perform a certain task (e.g., dehydration) was counted. The energy figures cited in Table 1 should be construed as preliminary estimates that require refinement for future analyses.

Utilization of Feed Ingredients

Appendix Tables 1 through 5 show the particular composition of the cost and energy minimizing rations. The tables also show the cost and BTU content of the various rations. (While the authors speak in terms of "least cost" and "least energy" rations, the reader should remember that the rations are constrained by the historic availability of ingredients in the Northeast; the analysis is essentially short run in nature, and perhaps it would be best to consider the results as "quasi-least cost" and "quasi-least energy".) In an extended and more comprehensive analysis one might also wish to examine the energy implications of improved local forage, disposal costs for by-product feeds if not fed, the use of wastes and new ingredients, and the effects of geographic shifts in ingredient supply sources.

In general, it may be noted that some feed ingredients that have a large energy component are relatively low priced in comparison to other feedstuffs. For example, ingredients such as brewers and distillers dried grains, and corn gluten feed and meal enter into a number of the

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2/ The authors wish to thank Carl Vosloh (NEAD, ERS) and CED program areas of the Economic Research Service for providing much of the needed cost and energy data necessary to perform the analysis.

Table 1
Embodied Fossil Fuel Energy Input in Various Feed Ingredients, BTU per cwt. of Final Product, 1976

Feed Ingredients[a/]	Embodied Fossil Fuel Energy			
	Production[b/]	Transport[c/]	Processing	Total
	BTU per cwt. of final product			
Dehydrated Alfalfa Meal (20%)	268,500	11,300	521,350	801,150
Dehydrated Alfalfa Meal (17%)	268,500	11,300	521,350	801,150
Suncured Alfalfa Meal (15%)	258,900	10,900	240,000	509,800
Barley (12%)	161,000	3,000	---	164,000
Barley, West Coast (9%)	158,500	3,000	---	161,500
Brewers Dried Grains (26%)	---	---	500,000	500,000
Corn (9%)	181,800	3,600	35,300	220,700
Corn Gluten Feed (21%)	---	---	536,100	536,100
Corn Gluten Meal (42%)	---	---	536,100	536,100
Cottonseed Oil Meal (41%)	---	---	55,500	55,500
Distillers Dried Grains (28%)	---	---	500,000	500,000
Animal Fat	---	---	470,000[d/]	470,000
Fish Meal (Menhaden) (61%)	---	---	800,000	800,000
Fish Meal (Anchovy) (64%)	---	---	800,000	800,000
Hominy Feed (11%)	---	---	100,000	100,000
Meat and Bone Meal (50%)	---	---	370,000[d/]	370,000
Cane Molasses (3%)	---	---	250,000	250,000
Oats (12%)	113,000	5,300	---	118,300
Oats, West Coast (9%)	112,500	5,300	---	117,800
Poultry Byproduct Meal (65%)	---	---	417,300	417,300

Table 1
Embodied Fossil Fuel Energy Input in Various Feed Ingredients, BTU per cwt. of Final Product, 1976-Continued

Feed Ingredients[a]	Embodied Fossil Fuel Energy			
	Production[b]	Transport[c]	Processing	Total
	BTU per cwt. of final product			
Rice Bran (13%)	---	---	13,900	13,900
Sorghum (9%)	249,500	3,000	---	252,500
Soybean Oil Meal (44%)	189,900	3,900	47,600	241,400
Soybean Oil Meal (49%)	189,900	3,900	47,600	241,400
Hard Wheat (12%)	170,500	3,000	---	173,500
Wheat Bran (15%)	---	---	13,900	13,900
Wheat Middlings (16%)	---	---	13,900	13,900
Urea (281%)	---	---	1,248,500	1,248,500
Dried Beet Pulp (9%)	---	---	521,350	521,350
Dried Citrus Pulp (7%)	---	---	521,350	521,350
Dried Whey (12%)	---	---	2,290,000	2,290,000

a/ The approximate protein level of the various ingredients is listed after the ingredient.

b/ Based on 1974 crop production data.

c/ Allocation for only the first transport off-farm to the processing point.

d/ Includes an estimate for the assembly of the raw product.

Source: See text.

least cost rations; however, they are not part of any of the energy minimizing rations computed. These particular feed ingredients have in common a large energy component that is related to the fact that they must be dried or dehydrated from their initial high moisture content to a relatively low moisture content to retard spoilage and facilitate efficient transport and livestock feeding. These ingredients are commonly referred to as "byproduct feeds" which would have essentially no economic value if they were not fed to livestock.

The brewing and distilling industries are esentially subsidizing the livestock feeder. This peculiar phenomena is in line with the opportunity costs of alternative disposal processes for such byproducts. With cheap energy, byproduct drying was easily feasible. As energy becomes more expensive, other disposal alternatives may well become more economic.

On the other hand, there are other byproduct feeds that have both a low level of embodied energy and a low price. For example, feed ingredients such as wheat bran and wheat middlings are found in both the least cost and least energy rations. However, the availability of these millfeeds is quite limited; in general, a ration could not consist of more than 25 percent millfeeds.

Among the protein ingredients considered in the analysis, it is interesting to note the substitution of soybean oil meal for urea in the least energy dairy rations. Urea has a high energy content (more than one million BTU per hundredweight) and is not utilized in the energy minimizing rations. Alfalfa meal which also has a high energy embodiment (as well as a relatively high cost) is found in neither least cost nor least energy rations.

In terms of feed grain utilization, less corn is found in the least energy rations, while more oats are used in the energy minimizing rations than in the least cost rations. Except for the broiler rations, barley is found as an ingredient in both least cost and least energy solutions.

Least Cost/Least Energy Comparison[3/]

Farmers in the Northeast will feed approximately seven million tons of commercially mixed dairy, layer and broiler feed in 1976. The amount of fossil fuel energy required to produce, process and transport these

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3/ It should be noted that the cost and energy figures cited refer only to the feed mill and the accumulated energy usage up to the point of formulation and mixing. The cost of delivered feed to a farm would be roughly \$0.75 to \$1.50 per hundredweight higher than the figures cited; likewise, energy utilized in mixing the feed and delivering it to a farm would add between 5,000 and 14,000 BTU per hundredweight. In general, the inclusion of these other energy consuming activities would not change the results of the analysis.

seven million tons exceeds 38 trillion BTU. However, if energy minimizing rations were fed instead of those that minimize cost, an energy savings on the order of seven trillion BTU (nearly 19 percent) could be realized; this is roughly equivalent to 57 million gallons of gasoline annually. (This quantity is comparable to the amount of gasoline utilized by Northeast automobile drivers in a two day period.)

Dairy rations comprise nearly 40 percent of the volume of feed fed in the Northeast. On average, the least cost dairy rations that would be fed (on the basis of February 1976 prices) would contain about 244,000 BTU per hundredweight. If energy minimizing rations were substituted, the BTU content would fall to about 200,000 (an energy savings of 18 percent). In the aggregate, nearly 2.4 trillion BTU could be saved by feeding least energy rations; this is equivalent to about 19 million gallons of gasoline. However, the energy savings would not be without a consequent economic cost to dairymen and ultimately consumers (see Table 2). By and large, dairymen would have to pay nearly $10.00 more per ton of mixed feed. This increased feed cost would mean that dairy farmers would have to receive an additional $0.12 per hundredweight of milk just to break even. While the latter figure may appear to be small, it should be realized that the dairymen's feed bill would increase by nearly $27 million and that this increased cost would be reflected as either a higher price in the supermarket, or a decrease in farm income.

In feeding layers and broilers in the Northeast, it is estimated that approximately 3.7 and 1.1 trillion BTU respectively could be saved annually if energy minimizing rations were fed. Together this is roughly equivalent to 38 million gallons of gasoline. To accomplish this energy savings, the cost of the associated products would also have to rise. The price of eggs would need to increase by 2.6 cents per dozen and the cost of broilers by two cents per pound. In the aggregate, poultry farmers in the Northeast would have to pay about $59 million more for their feed.

Thus, in the Northeast, the cost of substituting least energy rations for least cost rations would be great--on the order of $85 million, or $1.19 per 100,000 BTU saved. In other words, this energy conservation policy would require Northeast livestock feeders to spend approximately $1.50 to save society 1 gallon of gasoline.

Competitive Position Implications

It goes without saying that any energy conservation program, such as the one discussed, would have to be part of a national rather than a regional policy so that no one region alone would be affected to the extent implied in the analysis. Thus, it would be worthwhile to consider the impact of similar conservation programs in other regions which could be construed as competitors to the Northeast.

Table 2
Summary of Least Cost and Least Energy Rations, Northeast 1976

Feed Rations	Least Cost Ration		Least Energy Ration		Percent Diff. in $/cwt.	Percent Diff. in BTU/cwt.
	$/cwt.	BTU/cwt.	$/cwt.	BTU/cwt.		
16% Dairy Ration	$5.14	240,000	$5.62	198,000	+ 9.3%	-17.5%
32% Dairy Supplement	$6.06	277,000	$6.74	214,000	+11.2%	-22.7%
20% Broiler Ration	$6.43	289,000	$7.50	258,000	+16.6%	-10.7%
24% Broiler Ration	$6.99	300,000	$7.81	276,000	+11.7%	- 8.0%
16% Layer Ration	$5.50	290,000	$5.97	207,000	+ 8.5%	-28.6%

In a larger study [1], it was found that the BTU content of dairy rations in the Lake States could be reduced by about 24 percent (or 60,000 BTU per hundredweight) at an increased cost of about 15 percent (or $0.70 per hundredweight). On the surface, it would appear that the Northeast might benefit from this situation: while dairy feed costs would increase by $10 per ton in the Northeast, they would go up by $14 in the Lake States. However, one must remember that dairymen in the Northeast purchase and feed their animals more commercially mixed feed than their counterparts in the Lake States. Thus, while the milk price in the Northeast would need to rise by $0.12 per hundredweight, Lake State farmers would need an increase of only three cents per hundredweight.

Similarly, when one considers layers, the Northeast sacrifices more than the Southeast. Feeding energy minimizing rations to layers in the Southeast would result in a 12 percent savings while increasing the cost of layer rations by $9.20 per ton. However, in the Northeast, feed costs would rise by $9.40 per ton.

In feeding broilers, it is estimated that the BTU content of rations could be reduced by about 13 percent in the Southeast at a cost of $15.80 per ton. In the Northeast, a nine percent energy savings would result in an increased feed cost of $18.90 per ton. Thus, the price received by Southeastern farmers would need to rise by 1.7 cents per pound to cover the increased feed cost associated with energy minimizing rations. On the other hand, farmers in the Northeast would need to see their broiler price go up by two cents per pound.

Overall then, the Northeast could incur greater costs than would the Lake States and the Southeast, because of the availability of certain feed ingredients in these other regions which are not in plentiful supply in the Northeast. Further, the present utilization of byproduct feeds in the Northeast should be remembered. The Northeast currently feeds a large amount of byproduct feeds (relatively low in cost, but high in embodied energy), such as brewers and distillers dried grains, and corn gluten feed and meal. Should other byproduct disposal activities become economically feasible or their price change to more fully reflect the embodied energy cost, the competitive position of the Northeast would erode even more.

Concluding Remarks

This paper estimates the magnitude of the potential that exists to conserve energy in feeding dairy cattle, layers and broilers in the Northeast. Comparing the energy embodied in least cost feed rations with the quantity contained in energy minimizing rations, it was found that more than seven trillion BTU could be conserved annually. This is the energy equivalent of more than 57 million gallons of gasoline. However, this energy savings would not be without a consequent cost.

Farmers would have to pay about $12.20 more per ton of feed, or in the aggregate about $85 million in additional feed cost. Thus, while energy savings are possible, they could be had only with higher feed prices.

References

1. Davulis, J. P. and G. E. Frick, Potential for Energy Conservation in Feeding Livestock and Poultry in the United States, N. H. Agricultural Experiment Station Bulletin 506, January 1977.

Appendix Table 1
Least Cost and Least Energy 16% Dairy Rations, Northeast, 1976

Feed Ingredients	Type of Ration: Least Cost	Type of Ration: Least Energy
	Pounds	
Feed grains		
Corn	54.6	49.0
Barley	5.0†	5.0†
Oats		7.5†
Oilseed meals		
Soybean Oil Meal (49%)		13.5
Grain byproducts		
Brewers Dried Grains	0.4	
Corn Gluten Feed	5.0†	
Hominy Feed	5.0†	5.0†
Wheat Middlings	10.0†	10.0†
Wheat Bran	10.0†	10.0†
Other ingredients		
Molasses	8.0††	
Urea	2.0††	
	100.0	100.0
Cost per hundredweight	$5.14	$5.62
BTU per hundredweight	240,000	198,000

†Upper limit on the availability of the ingredient in the Northeast.

††Upper limit related to the ability of the species to consume the ingredient.

Appendix Table 2
Least Cost and Least Energy 32% Dairy Supplement Rations,
Northeast, 1976

Feed Ingredients	Type of Ration: Least Cost	Type of Ration: Least Energy
	Pounds	
Feed grains		
Corn	6.5	9.3
Barley	5.0†	5.0†
Oats		7.5†
Oilseed meals		
Soybean Oil Meal (44%)	40.9	
Soybean Oil Meal (49%)		53.2
Grain byproducts		
Brewers Dried Grains	2.5†	
Distillers Dried Grains	5.0†	
Corn Gluten Feed	5.0†	
Hominy Feed	5.0†	5.0†
Wheat Middlings	10.0†	10.0†
Wheat Bran	10.0†	10.0†
Other ingredients		
Molasses	8.0††	
Animal Fat	0.1	
Urea	2.0††	
	100.0	100.0
Cost per hundredweight	$6.06	$6.74
BTU per hundredweight	277,000	214,000

†Upper limit on the availability of the ingredient in the Northeast.

††Upper limit related to the ability of the species to consume the ingredient.

Appendix Table 3
Least Cost and Least Energy 24% Broiler Starter
Rations, Northeast, 1976

Feed Ingredients	Type of Ration	
	Least Cost	Least Energy
	Pounds	
Feed grains		
Corn	52.7	19.2
Oats		7.5†
Oilseed meals		
Soybean Oil Meal (49%)	36.0	51.3
Animal protein ingredients		
Fish Meal	2.5†	
Poultry Byproduct Meal	2.5†	2.5†
Grain byproducts		
Corn Gluten Meal	2.5†	
Hominy Feed		5.0†
Wheat Middlings		10.0†
Other ingredients		
Animal Fat	3.8	10.0††
	100.0	100.0
Cost per hundredweight	$6.99	$7.81
BTU per hundredweight	300,000	276,000

†Upper limit on the availability of the ingredient in the Northeast.

††Upper limit related to the ability of the species to consume the ingredient.

Appendix Table 4
Least Cost and Least Energy 20% Broiler Finisher
Rations, Northeast, 1976

Feed Ingredients	Type of Ration: Least Cost	Least Energy
	Pounds	
Feed Grains		
Corn	66.1	23.3
Oats		7.5†
Oilseed meals		
Soybean Oil Meal (49%)	25.2	40.4
Animal protein ingredients		
Fish Meal	2.5†	
Poultry Byproduct Meal	2.5†	2.5†
Grain byproducts		
Corn Gluten Meal	2.5†	
Hominy Feed		5.0†
Wheat Middlings		10.0†
Wheat Bran		1.3
Other ingredients		
Animal Fat	1.2	10.0††
	100.0	100.0
Cost per hundredweight	$6.43	$7.50
BTU per hundredweight	289,000	258,000

†Upper limit on the availability of the ingredient in the Northeast.

††Upper limit related to the ability of the species to consume the ingredient.

Appendix Table 5
Least Cost and Least Energy 16% Layer Rations,
Northeast, 1976

Feed Ingredients	Type of Ration	
	Least Cost	Least Energy
	Pounds	
Feed grains		
Corn	58.8	42.6
Barley	5.0†	5.0†
Oats		7.5†
Oilseed meals		
Soybean Oil Meal (44%)	13.5	
Soybean Oil Meal (49%)		15.7
Animal protein ingredients		
Poultry Byproduct Meal		2.5†
Grain byproducts		
Brewers Dried Grains	2.5†	
Distillers Dried Grains	5.0†	
Corn Gluten Feed	5.0†	
Hominy Feed		5.0†
Wheat Middlings	7.2	10.0†
Wheat Bran		10.0†
Other ingredients		
Molasses	3.0††	
Animal Fat		1.7
	100.0	100.0
Cost per hundredweight	$5.50	$5.97
BTU per hundredweight	290,000	207,000

†Upper limit on the availability of the ingredient in the Northeast.

††Upper limit related to the ability of the species to consume the ingredient.