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WHEAT MILLFEEDS in LIVESTOCK RATIONS

An Economic Analysis

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ABSTRACT

Wheat millfeeds are economically most important in high-protein dairy and beef cattle supplements and in poultry rations with metabolizable energy requirements of less than 1,300 kilocalories per pound of ration. Economic analysis suggests that the market undervalues wheat millfeeds in dairy and beef cattle supplements. Also, if the biological availability of the naturally occurring nutrients in millfeeds could be improved, their value in high-energy poultry and swine rations would be increased. To create and maintain a market demand for improved millfeeds would require adoption and enforcement of nutritional standards for these products and a concerted promotional and educational campaign to convince potential users of their worth. These conclusions are based on an economic evaluation of wheat millfeeds in a variety of livestock rations in four different market locations and time periods.

Key Words: Wheat millfeeds, Marketing, Linear programming, Ruminant feeds, Poultry feeds, Swine feeds, Nutritional requirements, Feed ingredients, Feed prices.

PREFACE

To provide better knowledge for planning and implementing programs for expanding market outlets and increasing the efficiency of marketing farm products, the Economic Research Service cooperates with the Agricultural Research Service in evaluating the opportunities for improvements on a wide range of agricultural products. Such evaluations are needed by agribusiness firms for judging whether research results are commercially feasible and by physical scientists for guiding their research programs.

This report is the result of a cooperative effort by scientists trained in economics, animal nutrition, and chemistry. It presents a comprehensive economic evaluation of wheat millfeeds in livestock rations and indicates the potential benefits of processing techniques that would improve the biological availability of naturally occurring nutrients in millfeeds.

The authors are indebted to members of the Millfeeds Research Committee, Millers' National Federation, for consultation and encouragement throughout the study and for assistance in compiling prices of feed ingredients in the four market locations in which economic analyses were made.

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SUMMARY AND CONCLUSIONS

Wheat millfeeds have their greatest market value in high-protein beef and dairy cattle supplements and in low-energy poultry rations. Although millfeeds are already used in many types of livestock rations, their use should increase further because of their high nutritive value and comparatively low cost.

Parametric linear programming, used to impute values for wheat millfeeds in broiler, layer, turkey, swine, beef cattle, and dairy cattle rations, suggests that the market undervalues wheat millfeeds in dairy and beef cattle supplements. USDA's Western Regional Research Laboratory, supported by the Millers' National Federation, is currently investigating ways of improving the biological availability of naturally occurring nutrients in millfeeds so as to increase their use in poultry feeds.

Increased use of millfeeds in poultry rations ultimately depends on the economic feasibility of improving nutrient availability. Laboratory improvements must be evaluated by feeding trials and the increased nutritional values compared with the costs of modifications. Even if evaluations prove the benefits of substituting improved millfeeds for other ingredients, demand for them would still have to be generated among poultry feeders. To create and maintain market demand would require the adoption and enforcement of nutritional standards and a concerted promotional and educational campaign to convince potential users of their worth.

Feed ingredient prices used in this analysis were averages for four different time periods in each of four markets -- Atlanta, Boston, Los Angeles, and the Tri-cities area of Davenport-Rock Island-Moline. The nutritional matrix for making this analysis -- including nutritional requirements for all classes of livestock studied and nutritional coefficients for ingredients used in the rations -- was developed at the Western Regional Research Laboratory. These requirements, coefficients, and prices can be used to evaluate improvements on other feed ingredients.

WHEAT MILLFEEDS IN LIVESTOCK RATIONS: AN ECONOMIC ANALYSIS

By Robert V. Enochian, Donald D. Kuzmicky, and George O. Kohler[1/]

INTRODUCTION

Wheat millfeeds of one type or another are used in most types of livestock rations. The specific types and quantities of millfeeds used depend upon the class of livestock and the availability and prices of millfeeds relative to those of all other feed ingredients that may be used to satisfy ration requirements.

In poultry rations, the largest use for millfeeds is generally in layer rations having low metabolizable energy requirements. Millfeeds are also used in layer replacement, starter, grower, and breeder rations for both chickens and turkeys (5, 20).[2/] They are not generally recommended for broiler starter and broiler finisher rations because the energy requirements for these rations are usually too high. Millfeeds are recommended in swine grower rations and in complete dairy and beef cattle rations, and they comprise a major component of most dairy and beef supplements (2, 4). Despite their widespread use, the full economic potential of wheat millfeeds has never been fully evaluated. The objective of this analysis is to provide millers, feed manufacturers, and livestock feeders with a comprehensive evaluation of the potential value of wheat millfeeds in various livestock rations. The analysis also provides livestock nutritionists and feed technologists with information on the value of improvements that might be made through new and improved millfeed-processing technology.

Several types of wheat millfeeds are produced and sold in the United States, including bran, middlings, millrun, shorts, red dog, and germ meal. Each is composed of various fractions of the outer layers of the wheat grain that are milled off in the process of making flour.[3/] The specific type of

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2/ Underscored numbers in parentheses refer to Literature Cited, p. 29.

3/ Detailed descriptions of each of these fractions are contained in the Millfeed Manual, Millers' National Federation, copyright 1967, Chicago, Ill. Official descriptions are contained in Feed Control, Association of American Feed Control Officials, Inc., pp. 91-92 (1967).

millfeed produced in a given location depends largely on the demand in the market area served by the flour mill. In most regions of the United States, bran and middlings are the predominant types of wheat millfeeds produced. The major exception is the West Coast, where millrun predominates. Very limited amounts of shorts are sold in the Southwest. This economic analysis concentrates, therefore, on bran, middlings, and millrun.

METHOD OF ANALYSIS

Formulators of livestock feeds and feed consultants typically use linear programming for computer formulation of least cost feeds to meet specified nutritional requirements of livestock. An additional procedure, parametric linear programming, can be used to estimate the maximum price at which any ingredient will be accepted in a least cost diet and the affect that a change in price will have on the quantity of that ingredient in the ration. This is accomplished by assigning a high arbitrary value to an ingredient under study so that it is not initially accepted in the ration. The computer is then programmed so that it automatically reduces the price of that ingredient by small increments and recomputes the quantity that would be accepted in a least cost ration at each successively lower price. Comprehensive descriptions of the procedure are contained in (3, 7, 9, 25).

In this study, parametric linear programming is used to compute the quantities and prices at which the specified wheat millfeeds are accepted in different rations when market prices for other ingredients are used. These prices are then compared with the market prices for the millfeeds being studied.

The procedure involves specifying the nutrient levels of the ration for the livestock class being studied (i.e., the nutritional requirement plus a margin of safety); the nutritional characteristics of the available feeds, some combination of which will satisfy the ration specifications; and the prices of these ingredients. Linear programming is then used to find the particular combination of feed ingredients which meets the ration specifications at least cost.

Nutritional Specifications for Different Livestock Classes

Each class and age of livestock has different nutritional requirements to provide optimum health, growth, and rate of productivity. Because nutritionists and feeders do not always agree on what these requirements should be, published information frequently shows discrepancies. The ration specifications used for this analysis were developed at USDA's Western Regional Research Laboratory (WRRL). These specifications are a blend of information from a variety of sources (1, 2, 4, 5, 11, 15, 16, 17, 18, 19, 23, 26). Values used for the nutritional specifications in the WRRL matrix for each class of livestock included in this analysis are presented in table 1 for poultry and swine, and in table 2 for dairy and beef cattle. Because of possible differences in regional requirements, some of these specifications may have to be adjusted.

Table 1.--Nutritional specifications for poultry and swine rations: WRRL matrix

Nutrient or ingredient	Unit	Quantity of each requirement by type of ration 1/							
		Broiler		Pullet developer		Layer, light breed	Turkey developer 14-20 wk.	Swine grower	
		Starter	Finisher	Broilers	Layers			60-100 lb.	100-150 lb.
Metabolizable energy, exact	Kcal/lb.	1,350.0000	1,450.0000	1,250.0000	1,400.0000	1,350.0000	1,350.0000	1,420.0000	1,435.0000
Arginine, min.	Pct.	1.2000	1.1600	0.7500	0.8400	0.8000	1.0200	0.1500	0.1400
Glycine, min.	do.	0.9500	0.8700	0.6250	0.7000	0.6000	0.6800	0.0000	0.0000
Isoleucine, min.	do.	0.8100	0.7800	0.4688	0.5250	0.5000	0.6500	0.5000	0.3700
Lysine, min.	do.	1.1300	1.1100	0.6875	0.7700	0.5000	0.9500	0.7000	0.4500
Methionine, min.	do.	0.4200	0.4000	0.2500	0.2800	0.2800	0.3300	0.3000	0.2100
Methionine + cystine, min.	do.	0.8000	0.7700	0.4688	0.5250	0.5300	0.5600	0.5000	0.3500
Threonine, min.	do.	0.7500	0.7200	0.4375	0.4900	0.4000	0.6600	0.4500	0.3200
Tryptophan, min.	do.	0.2100	0.2100	0.1250	0.1400	0.1500	0.1700	0.1300	0.1050
Available phosphorus, min.	do.	0.4500	0.4500	0.4018	0.4500	0.3000	0.5000	0.3000	0.3000
Calcium, min.	do.	0.8000	0.8000	0.5357	0.6000	3.2500	1.2000	0.5000	0.5000
Calcium, max.	do.	1.0000	1.0000	0.7357	0.8000	4.0000	1.4000	0.6500	0.6500
Added fat, max.	do.	10.0000	10.0000	10.0000	10.0000	10.0000	10.0000	10.0000	10.0000
Fiber, max. 2/	do.	100.0000	100.0000	100.0000	100.0000	100.0000	100.0000	100.0000	100.0000
Xanthophyll, min.	Mg./lb.	3.6000	13.0000	2.6786	3.0000	7.0000	0.0000	0.0000	0.0000
Fishmeal, max.	Pct.	10.0000	10.0000	10.0000	10.0000	5.0000	10.0000	10.0000	10.0000
Ethoxyquin, exact	do.	0.0125	0.0125	0.0125	0.0125	0.0125	0.0125	0.0125	0.0125
Salt, exact	do.	0.2500	0.2500	0.2232	0.2500	0.2500	0.2500	0.2500	0.2500
Mineral-vitamin mix, exact 3/	do.	0.5000	0.5000	0.4464	0.5000	0.5000	0.5000	0.5000	0.5000
Cottonseed meal (41%), max.	do.	7.5000	7.5000	7.5000	7.5000	7.5000	7.5000	7.5000	7.5000
Meat meal (55%), max.	do.	5.0000	5.0000	5.0000	5.0000	5.0000	5.0000	5.0000	5.0000
Meat-bone meal (50%), max.	do.	5.0000	5.0000	5.0000	5.0000	5.0000	5.0000	5.0000	5.0000
Feathermeal (85%), max.	do	2.5000	2.5000	2.5000	2.5000	2.5000	2.5000	2.5000	2.5000
Poultry byproduct meal (55%), max.	do.	5.0000	5.0000	5.0000	5.0000	5.0000	5.0000	5.0000	5.0000
Alfalfa, dehy. (20%), max.	do.	5.0000	5.0000	7.5000	7.5000	10.0000	10.0000	5.0000	5.0000
Rice bran, max.	do.	5.0000	5.0000	5.0000	5.0000	5.0000	5.0000	5.0000	5.0000

1/ Rations with lower energy levels can be computed by proportionately reducing requirements for energy, amino acids, calcium, xanthophyll, salt, and mineral-vitamin mix. This was done for computations shown later in the report for broiler starter, layer, and turkey developer rations of lower energy levels than shown here.

2/ Although the fiber specification is not limited, the quantity of fiber in the ration is restricted by the metabolizable energy requirement to a range of less than 5 percent for poultry and 10 percent for swine rations.

3/ The composition of the mineral-vitamin mix varies for each ration. The prices used for these mixes in the economic analysis were quotations for typically available commercial mixes.

Table 2.--Nutritional specifications for ruminant rations: WRRL matrix

Item	Percent of each requirement by type of ration 1/			
	Milking with roughage	Beef finisher with roughage	Beef supplement, 32% protein	Dairy supplement, 42% protein
	Percent			
TDN, min.	55.00	65.00	50.00	50.00
Total protein, min.	11.00	11.00	32.00	42.00
Digestible protein, min.	7.15	8.25	30.00	40.00
NPN, max. 2/	.64	.64	4.00	5.33
Calcium, min.	.40	.25	3.50	2.00
Calcium, max.	1.40	.75	3.75	2.67
Phosphorus, min.	.30	.20	.30	.30
Phosphorus, max.	1.30	1.20	1.50	1.50
Salt, exact	.50	.25	2.50	3.33
Trace nutrient mix, exact	.50	.50	.50	.50
Total fat, max. 3/	100.00	100.00	100.00	100.00
Molasses, min.	2.50	2.50	2.50	1.25
Molasses, max.	10.00	10.00	8.00	8.00
Dry matter, min.	0.00	0.00	0.00	0.00
Dehydrated forage, min.	2.00	2.50	5.00	5.00
Fiber, max. 3/	100.00	100.00	100.00	100.00
Roughage, dry, min.	40.00	10.00	0.00	0.00
Roughage, dry, max.	50.00	20.00	0.00	0.00
Alfalfa, dehy. (17% protein) max. 3/	100.00	100.00	15.00	15.00
Alfalfa, dehy. (15% protein) max. 3/	100.00	100.00	15.00	15.00
Animal fat, max.	5.00	5.00	5.00	5.00
Beet pulp, max.	20.00	20.00	25.00	25.00
Brewers grains, dried, max.	20.00	20.00	25.00	25.00
Citrus pulp, max.	20.00	20.00	25.00	25.00
Corncobs, max.	20.00	5.00	0.00	0.00
Corn gluten feed, max.	20.00	20.00	25.00	25.00
Cottonseed hulls, max.	20.00	5.00	0.00	0.00
Distillers grains, dried, max.	20.00	20.00	25.00	25.00
Malt sprouts, dried, max.	20.00	20.00	25.00	25.00
Rice bran, max.	20.00	20.00	25.00	25.00
Safflower meal (20% protein) max.	20.00	20.00	0.00	0.00
Soybean millfeed, max.	20.00	20.00	25.00	25.00
Wheat bran, max.	20.00	20.00	25.00	25.00
Wheat middlings, max.	20.00	20.00	25.00	25.00
Wheat millrun, West Coast, max.	20.00	20.00	25.00	25.00

1/ In computing least cost beef and dairy supplement rations, all grains were restricted from the rations.
2/ NPN = nonprotein nitrogen; e.g., urea nitrogen.
3/ For nutrients where the maximum specification is not limited (100%) the quantity in the ration is effectively restricted by other nutritional requirements and is always considerably less than 100 percent.

Nutritional Coefficients of Feed Ingredients

Feed ingredients used in formulating mixed feeds contain nutrients in varying quantities that are essential for satisfying the nutritional requirements of livestock. In formulating least cost rations through the use of linear programming, feed manufacturers assign values to each of the nutrients in each feed ingredient. The actual values of different lots of a given ingredient would have to be based on analytical values and biological availabilities of that lot. These may vary widely depending on location of production, the length of time the ingredient has been stored, its moisture content, etc. Under actual operating conditions, however, there is no practical way to analyze each lot of each ingredient; therefore, nutrient values used by a feed manufacturer are based on averages he considers apply to the commodities available to him.

The values assigned to the different nutrients contained in each feed ingredient used in this analysis were developed at USDA's Western Regional Research Laboratory (WRRL). These values are a blend of information derived from many sources (1, 2, 5, 8, 10, 11, 13, 14, 18, 20, 22). Nutritional values for wheat millfeeds were derived mainly from the Millers' National Federation Millfeed Manual (10). The procedures used to do this are described in appendix I. The nutritional values used in the WRRL matrix for each ingredient are given in table 3 for poultry and swine feeds and in table 4 for dairy and beef cattle feeds. Some of these values may have to be adjusted to be representative for a particular region at any given time.

Markets, Time Periods, and Prices Used for the Analysis

In a competitive market situation the quantity of any ingredient that is used in a least cost ration depends upon the supply and prices of all ingredients that can satisfy the ration requirements. Thus, feed formulations that satisfy specified nutritional requirements can vary in ingredient composition from one location to another and from week to week, or even from day to day.

It was reasoned, however, that the potential use of millfeeds in various rations could be determined if their quantities and values[4/] in given rations were computed for a wide range of price conditions. This information would be useful in the development of marketing efforts to improve the demand for millfeeds. Such computations also would provide guides to research for improving the nutritional qualities of millfeeds by showing the rations in which millfeeds would probably have the best chance of increased use if improvements could be made in the biological availability of the nutrients in them. In addition, the information developed can be useful in guiding livestock feeders and smaller feed mills that are not using computer formulated rations.

4/ Value refers to the price at which millfeed will enter a least cost ration when prices for all other ingredients are fixed. This price can be determined through parametric linear programming.

Table 3.--Nutritional values of ingredients used in poultry and swine rations: WRRL matrix

Nutrient name	Unit	Alfalfa, dehydrated (20% protein)	Barley	Calcium carbonate	Corn	Corn gluten meal (60% protein)	Cottonseed meal (41% protein)	Deflorinated phosphate	Dicalcium phosphate	Fat, animal
Metabolizable energy	Kcal/lb.	780.00	1,210.00	0.00	1,580.00	1,580.00	850.00	0.00	0.00	3,580.00
Protein	Pct.	20.00	10.00	0.00	8.50	60.00	41.00	0.00	0.00	0.00
Arginine	do.	0.98	0.43	0.00	0.41	1.82	3.70	0.00	0.00	0.00
Glycine	do.	1.01	0.31	0.00	0.30	1.64	2.04	0.00	0.00	0.00
Isoleucine	do.	0.98	0.35	0.00	0.36	2.81	1.42	0.00	0.00	0.00
Lysine	do.	0.87	0.29	0.00	0.23	0.95	1.50	0.00	0.00	0.00
Methionine	do.	0.33	0.15	0.00	0.17	1.59	0.62	0.00	0.00	0.00
Methionine + cystine	do.	0.56	0.31	0.00	0.32	2.68	1.45	0.00	0.00	0.00
Threonine	do.	0.88	0.30	0.00	0.35	2.17	1.20	0.00	0.00	0.00
Tryptophan	do.	0.46	0.12	0.00	0.08	0.30	0.50	0.00	0.00	0.00
Available phosphorus	do.	0.27	0.16	0.00	0.08	0.19	0.37	16.50	18.50	0.00
Calcium	do.	1.47	0.06	38.00	0.02	0.15	0.15	32.00	22.50	0.00
Fat	do.	3.58	1.80	0.00	3.80	2.10	1.00	0.00	0.00	100.00
Fiber	do.	20.20	6.50	0.00	2.50	1.30	13.00	0.00	0.00	0.00
Xanthophyll	Mg./lb.	149.00	0.00	0.00	9.00	106.00	0.00	0.00	0.00	0.00
Choline	do.	730.00	430.00	0.00	240.00	150.00	1,300.00	0.00	0.00	0.00
Vitamin K	do.	6.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Alphatocopherol	do.	67.00	2.80	0.00	10.00	0.00	6.80	0.00	0.00	0.00
Vitamin A	MIU./lb.	164.00	0.00	0.00	3.10	7.50	0.00	0.00	0.00	0.00
Riboflavin	Mg./lb.	7.00	0.59	0.00	0.50	0.70	2.30	0.00	0.00	0.00
Folic acid	do.	1.20	0.23	0.00	0.09	0.10	1.00	0.00	0.00	0.00
Niacin	do.	25.00	20.00	0.00	10.00	25.00	18.00	0.00	0.00	0.00
Pantothenic acid	do.	15.00	3.30	0.00	2.30	3.80	6.40	0.00	0.00	0.00

Continued

Table 3.--Nutritional values of ingredients used in poultry and swine rations: WRRL matrix--Continued

Nutrient name	Unit	Fat, hydrolyzed vegetable + animal	Feather-meal (85% protein)	Fishmeal, herring (70% protein)	Fishmeal, menhaden (60% protein)	Fishmeal, Peruvian (65% protein)	Lysine (50%)	Methionine hydroxy analog	Meat meal (55% protein)	Meat & bone meal (50% protein)
Metabolizable energy	Kcal/lb.	3,700.00	1,078.00	1,332.00	1,246.00	1,160.00	0.00	0.00	900.00	900.00
Protein	Pct.	0.00	85.00	70.00	60.00	65.00	59.90	0.00	55.00	50.00
Arginine	do.	0.00	3.94	5.30	3.60	3.38	0.00	0.00	3.50	3.15
Glycine	do.	0.00	4.76	4.60	3.88	4.29	0.00	0.00	7.30	6.60
Isoleucine	do.	0.00	2.66	3.00	3.10	2.96	0.00	0.00	1.73	1.49
Lysine	do.	0.00	1.05	5.70	4.34	4.05	50.00	0.00	2.65	2.44
Methionine	do.	0.00	0.37	2.45	1.99	1.93	0.00	80.00	0.66	0.53
Methionine + cystine	do.	0.00	2.35	3.18	3.22	2.81	0.00	80.00	1.33	1.10
Threonine	do.	0.00	2.80	2.88	2.34	2.45	0.00	0.00	1.68	1.44
Tryptophan	do.	0.00	0.40	0.75	0.54	0.66	0.00	0.00	0.36	0.33
Available phosphorus	do.	0.00	0.75	2.00	3.00	2.80	0.00	0.00	4.00	5.00
Calcium	do.	0.00	0.20	3.00	5.00	4.20	0.00	0.00	8.00	10.00
Fat	do.	100.00	2.50	7.00	10.00	4.10	0.00	0.00	6.00	9.50
Fiber	do.	0.00	1.50	1.00	1.00	1.00	0.00	0.00	2.50	2.50
Xanthophyll	Mg./lb.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Choline	do.	0.00	400.00	1,820.00	1,400.00	1,680.00	0.00	0.00	890.00	990.00
Vitamin K	do.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Alphatocopherol	do.	0.00	0.00	12.00	4.10	1.50	0.00	0.00	0.45	0.45
Vitamin A	MIU./lb.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Riboflavin	Mg./lb.	0.00	0.91	4.10	2.20	3.00	0.00	0.00	2.40	2.00
Folic acid	do.	0.00	0.10	1.10	0.09	0.09	0.00	0.00	0.02	0.02
Niacin	do.	0.00	9.40	40.00	25.00	29.00	0.00	0.00	26.00	22.00
Pantothenic acid	do.	0.00	4.00	5.20	4.00	4.00	0.00	0.00	2.20	1.70

Continued

Table 3.--Nutritional values of ingredients used in poultry and swine rations: WRRL matrix--Continued

Nutrient name	Unit	Milo (sorghum)	Poultry byproduct meal (55% protein)	Rice bran	Safflower meal (42% protein)	Soybean meal (44% protein)	Soybean meal (49% protein)	Wheat HRW	Wheat middlings	Wheat millrun, West Coast
Metabolizable energy	Kcal/lb.	1,505.00	1,260.00	670.00	770.00	1,020.00	1,050.00	1,410.00	794.00	733.00
Protein	Pct.	8.50	55.00	13.50	42.00	44.00	49.00	11.73	11.90	12.60
Arginine	do.	0.33	3.20	1.12	3.65	3.00	3.34	0.59	0.84	0.85
Glycine	do.	0.30	2.93	0.74	2.29	1.80	1.99	0.53	0.68	0.69
Isoleucine	do.	0.40	2.33	0.53	1.68	2.17	2.42	0.45	0.36	0.38
Lysine	do.	0.21	2.57	0.65	1.20	2.58	2.88	0.33	0.50	0.51
Methionine	do.	0.17	1.16	0.32	0.68	0.63	0.70	0.20	0.18	0.19
Methionine + cystine	do.	0.32	2.11	0.63	1.39	1.29	1.44	0.53	0.47	0.47
Threonine	do.	0.30	2.03	0.51	1.30	1.72	1.91	0.36	0.41	0.41
Tryptophan	do.	0.10	0.46	0.22	0.97	0.63	0.70	0.15	0.17	0.17
Available phosphorus	do.	0.10	1.70	0.46	1.19	0.20	0.21	0.11	0.33	0.30
Calcium	do.	0.03	3.60	0.12	0.34	0.25	0.20	0.04	0.08	0.08
Fat	do.	2.80	12.00	0.80	1.00	0.50	0.90	1.50	4.00	3.80
Fiber	do.	2.50	2.50	15.20	14.50	7.00	2.90	2.24	8.80	8.00
Xanthophyll	Mg./lb.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Choline	do.	310.00	2,700.00	570.00	1,600.00	1,240.00	1,250.00	440.00	685.00	697.00
Vitamin K	do.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Alphatocopherol	do.	5.40	0.00	27.00	0.00	1.40	1.50	5.10	11.80	12.00
Vitamin A	MIU./lb.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Riboflavin	Mg./lb.	0.54	4.00	1.20	1.30	1.55	1.40	0.69	1.58	1.52
Folic acid	do.	0.11	0.23	1.00	0.87	0.32	1.60	0.15	0.42	0.39
Niacin	do.	19.00	40.00	140.00	11.00	12.00	9.80	23.60	77.10	69.00
Pantothenic acid	do.	5.20	4.00	11.00	22.00	6.60	6.60	3.90	9.90	9.50

Table 4.--Nutritional values of ingredients used in ruminant rations: WRRL matrix

Ingredient 1/	Nutrient name										
	TDN	Total protein	Digestible protein	Nonprotein nitrogen	Total fat	Calcium	Phosphorus	Vitamin E	Fiber	Dry matter	Roughage Dry wt.
	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Mg. per lb.	Pct.	Pct.	Pct.
Alfalfa, dehy. (17%)	56.00	17.00	12.70	0.00	2.30	1.39	0.26	52.60	27.80	93.00	0.00
Alfalfa, dehy. (15%)	54.00	15.00	11.02	0.00	1.90	1.31	0.25	45.90	29.90	93.00	0.00
Alfalfa hay (15%)	50.00	15.60	10.80	0.00	1.90	1.48	0.23	23.90	28.20	90.00	100.00
Animal fat	203.00	0.00	0.00	0.00	99.40	0.00	0.00	3.60	0.00	100.00	0.00
Barley, Midwest	74.00	11.60	8.70	0.00	1.90	0.08	0.42	16.50	5.00	89.00	0.00
Barley, Pacific	73.00	9.70	7.30	0.00	2.20	0.06	0.40	16.50	6.20	89.00	0.00
Beet pulp	66.00	9.10	4.10	0.00	0.60	0.68	0.10	0.00	19.00	91.00	0.00
Brewers grains, dried	61.00	25.90	19.10	0.00	6.20	0.27	0.50	12.20	15.00	92.00	0.00
Calcium carbonate	0.00	0.00	0.00	0.00	0.00	38.00	0.00	0.00	0.00	100.00	0.00
Citrus pulp	69.00	6.60	3.50	0.00	4.60	1.96	0.12	0.00	13.00	90.00	0.00
Corn, ground	78.00	8.80	6.50	0.00	3.80	0.03	0.27	9.00	2.00	86.00	0.00
Corncobs, dried	42.00	2.50	0.00	0.00	0.50	0.11	0.04	0.00	32.40	90.00	100.00
Corn gluten feed	74.00	25.30	21.80	0.00	2.40	0.46	0.77	6.70	8.00	90.00	0.00
Corn silage	28.00	3.20	1.90	0.00	1.20	0.11	0.08	0.00	9.80	40.00	40.00
Cottonseed hulls	37.00	3.90	0.00	0.00	1.40	0.14	0.09	0.00	42.90	90.00	100.00
Cottonseed meal (41%)	69.00	41.00	33.20	0.00	2.00	0.16	1.20	4.20	12.00	94.00	0.00
Deflor. phos. 33-18	0.00	0.00	0.00	0.00	0.00	33.00	18.00	0.00	0.00	100.00	0.00
Dist. grains, dried	77.00	29.10	23.10	0.00	8.90	0.20	0.55	13.80	11.50	92.00	0.00
Linseed meal	69.00	35.10	30.90	0.00	1.70	0.40	0.83	3.50	9.00	91.00	0.00
Malt sprouts, dried	64.00	26.20	20.40	0.00	1.40	0.22	0.73	1.90	14.00	93.00	0.00
Milo, steam rolled	71.00	11.00	6.30	0.00	2.80	0.04	0.29	5.50	2.00	89.00	0.00
Molasses, cane	68.00	3.20	1.80	0.00	0.10	0.89	0.08	2.50	0.00	75.00	0.00
Oats	70.00	9.00	6.70	0.00	5.40	0.09	0.33	9.30	11.00	91.00	0.00
Peanut meal	76.00	45.80	41.20	0.00	5.90	0.17	0.57	1.30	11.00	92.00	0.00
Rice bran	49.00	14.00	9.10	0.00	1.00	0.12	1.48	27.60	13.00	91.00	0.00
Safflower meal	50.00	21.40	17.20	0.00	3.90	0.34	0.84	0.40	32.30	92.00	100.00
Soybean meal (44%)	72.00	45.80	39.00	0.00	0.90	0.32	0.67	1.40	6.00	89.00	0.00
Soybean millfeed	56.00	19.20	14.50	0.00	6.10	0.38	0.19	0.00	28.00	93.00	100.00
Urea	0.00	281.00	266.00	44.80	0.00	0.00	0.00	0.00	0.00	100.00	0.00
Wheat	78.00	11.60	9.20	0.00	1.60	0.03	0.36	6.20	2.20	86.00	0.00
Wheat bran	62.00	15.10	12.50	0.00	3.40	0.09	1.30	11.00	10.30	86.00	0.00
Wheat middlings	75.00	15.60	12.20	0.00	4.00	0.08	1.09	16.00	8.80	86.00	0.00
Wheat millrun, WC	73.00	16.10	10.90	0.00	3.80	0.08	0.99	16.10	8.00	86.00	0.00

1/ Percentages shown in parentheses refer to protein content.

To achieve the objective of estimating the value of millfeeds for a wide range of conditions, it was decided to compute values in various rations for four market locations and four different time periods. These market locations, time periods, and the rations used in the analysis are summarized in table 5.

Selection of markets for the analysis was made with the intent of getting wide regional representation as well as markets with a large demand for a broad range of rations. Thus, Atlanta was selected because it is important for broiler, layer, and milking rations; Boston for layer and milking rations; Tri-cities for layer, turkey, swine, and beef rations; and Los Angeles for layer, turkey, milking, and beef rations.

The four time periods selected (November 1966-January 1967; August 1967-October 1967; November 1967-January 1968; and August 1968-October 1968)5/ correspond to quarter years. The 11/66-1/67 period was characterized by unusually high feed prices throughout the country, the 8/68-10/68 period by low feed prices. Prices during the other two periods were somewhat between these extremes.

The quarterly price of each ingredient used in the analysis is a simple average of 13 weekly prices. These prices are based largely on once-a-week quotations by the Federal-State Market News Service. Where prices were not available from market news sources, they were obtained directly from feed dealers, mixed feed manufacturers, and livestock feeders in each of the locations. In the Tri-cities area of Rock Island-Davenport-Moline, most prices are based on quotations obtained directly from feed dealers and feeders rather than on market news quotations.

Average prices used in this analysis generally represent the bulk delivered price to the feed mill or feed lot operator. Prices do not include costs of further processing of ingredients such as the grinding or cooking of grains, nor the costs of formulating or mixing the rations. The price of each ingredient for the four markets and four time periods is given in table 6.

Value of Trace Minerals and Vitamins in Millfeeds

Although, as indicated in table 3, vitamins and trace minerals are present in nutritionally significant amounts in many feed ingredients, including millfeeds, no allowance was made for the value of these nutrients in this analysis. Requirements for individual trace minerals and vitamins were not included in the nutritional specifications for each ration (tables 1 and 2). To assure that requirements for these nutrients are satisfied, many

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5/ For convenience, subsequent references to these time periods in tables and text will be by numerical notation: 11/66-1/67; 8/67-10/67; 11/67-1/68; and 8/68-10/68, respectively.

Table 5.--Markets, rations, and time periods for which economic analyses were made for different millfeeds[1/]

Ration and millfeed analyzed	Market			
	Atlanta	Boston	Tri-cities[2/]	Los Angeles
Middlings[3/]				
Broiler starter[4/]	X	...	...	...
Broiler finisher	X	...	...	...
Layer pullet developer	X	X	X	X
Broiler pullet developer	X	X	X	X
Layer, light breed[5/]	X	X	X	X
Turkey developer (14-20 wk.)[4/]	...	...	X	X
Swine grower (60-100 lb.)	...	...	X	...
Swine grower (100-150 lb.)	...	...	X	...
Milking with roughage	X	X	...	X
Beef finisher with roughage	...	...	...	X
Beef supplement (32% protein)	...	...	X	...
Dairy supplement (42% protein)	...	...	X	...
Bran				
Milking with roughage	X	X	...	...
Beef supplement (32% protein)	...	...	X	...
Dairy supplement (42% protein)	...	...	X	...

1/ Time periods for all markets were 11/66-1/67; 8/67-10/67; 11/67-1/68; and 8/68-10/68.
2/ Rock Island, Davenport, Moline (Illinois-Iowa).
3/ For the Los Angeles market the economic analysis is for millrun only.
4/ Analyses on this feed were for two different energy levels.
5/ Analyses on this feed were for three different energy levels.

Table 6.--Feed ingredient prices by market and time period

Feed ingredient	Atlanta			
	11/66-1/67	8/67-10/67	11/67-1/68	8/68-10/68
	Dollars per ton			
Alfalfa, dehy. (20%)	75.80	66.40	64.80	51.20
Alfalfa, dehy. (17%)	69.80	60.40	58.80	45.20
Alfalfa, dehy. (15%)	...	...	...	...
Alfalfa hay (15%)	37.60	35.00	39.20	34.40
Barley	61.60	60.20	59.40	52.40
Beet pulp	66.40	67.60	61.80	62.60
Brewers grains, dried	77.80	56.60	62.40	52.40
Calcium carbonate	6.60	6.60	6.60	6.60
Citrus pulp	36.00	42.40	43.60	48.80
Corn	53.00	46.20	43.60	41.00
Corncobs, dried	18.00	18.00	18.00	18.00
Corn gluten feed	59.60	45.00	59.80	49.00
Corn gluten meal (60%)	141.80	130.60	119.40	139.40
Corn silage	12.00	12.00	12.00	12.00
Cottonseed meal (41%)	87.40	77.40	80.80	73.40
Cottonseed hulls	34.00	32.80	32.20	27.60
Deflorinated phosphate	69.40	70.00	70.00	72.80
Dicalcium phosphate	93.40	73.80	73.80	73.80
Distillers grains, dried	74.20	65.60	64.60	61.80
Fat, animal	131.40	107.60	100.40	97.60
Fat, hyd. veg. + animal	...	...	...	...
Feathermeal (85%)	95.40	88.20	90.60	102.40
Fishmeal, herring (70%)	...	...	...	...
Fishmeal, menhaden (62%)	155.60	136.40	126.60	145.40
Fishmeal, Peruvian (65%)	155.20	133.80	127.40	139.20
Linseed meal	...	...	...	...
Lysine (50%)	1,250.00	1,250.00	1,250.00	1,250.00
Malt sprouts, dried	62.40	50.80	51.80	43.20
Meat and bone meal (50%)	107.80	96.40	90.00	96.20
Methionine hydroxy analog	1,701.40	1,640.00	1,640.00	1,260.00
Milo (sorghum)	51.40	49.80	48.40	45.80
Molasses, cane	35.40	37.00	37.00	36.60
Oats	56.00	52.40	55.00	45.60
Peanut meal	96.40	81.20	82.40	90.20
Poultry byproduct meal (55%)	114.00	105.80	102.80	105.60
Rice bran	61.20	48.40	46.40	44.80
Salt	20.20	20.20	20.20	20.20
Safflower meal (42%)	...	...	...	...
Safflower meal (20%)	...	...	...	...
Soybean meal (44%)	89.40	85.20	80.60	90.40
Soybean meal (49%)	99.40	91.40	87.60	100.20
Soybean millfeed	71.80	50.60	64.20	57.40
Urea	89.00	83.00	82.00	68.00
Wheat	60.80	51.00	52.00	43.00
Wheat bran	61.20	49.60	51.00	40.20
Wheat middlings	61.60	51.60	52.00	41.20
Wheat millrun, West Coast	...	...	...	...

Continued

Table 6.--Feed ingredient prices by market and time period--Continued

Feed ingredient	Boston			
	11/66-1/67	8/67-10/67	11/67-1/68	8/68-10/68
	Dollars per ton			
Alfalfa, dehy. (20%)	79.40	68.80	64.40	54.20
Alfalfa, dehy. (17%)	71.00	61.20	60.40	49.20
Alfalfa, dehy. (15%)	...	...	...	...
Alfalfa hay (15%)	46.40	40.60	42.20	40.00
Barley	65.20	63.60	61.60	54.60
Beet pulp	55.80	67.00	53.40	54.80
Brewers grains, dried	73.20	57.20	63.40	54.00
Calcium carbonate	3.60	3.60	3.60	3.60
Citrus pulp	53.20	49.40	62.60	66.60
Corn	60.40	50.80	48.60	45.40
Corncobs, dried	23.00	23.00	24.00	22.80
Corn gluten feed	69.40	61.00	58.40	56.80
Corn gluten meal (60%)	144.00	133.60	122.00	142.80
Corn silage	12.00	12.00	12.00	12.00
Cottonseed meal (41%)	103.00	99.40	94.60	93.40
Cottonseed hulls	45.00	44.40	43.60	39.40
Deflorinated phosphate	77.20	77.80	77.80	81.80
Dicalcium phosphate	100.00	84.60	84.60	84.60
Distillers grains, dried	81.60	68.20	70.00	64.60
Fat, animal	140.40	116.00	107.40	105.60
Fat, hyd. veg. + animal	147.80	127.20	112.00	104.80
Feathermeal (85%)	110.00	106.20	102.40	120.00
Fishmeal, herring (70%)	181.00	170.00	162.20	176.80
Fishmeal, menhaden (62%)	152.00	132.60	131.00	138.40
Fishmeal, Peruvian (65%)	147.60	125.60	119.60	129.20
Linseed meal	95.20	82.00	93.00	91.80
Lysine (50%)	1,250.00	1,250.00	1,250.00	1,250.00
Malt sprouts, dried	61.40	50.00	50.80	42.40
Meat and bone meal (50%)	104.80	100.20	89.60	94.80
Methionine hydroxy analog	1,701.40	1,640.00	1,640.00	1,260.00
Milo (sorghum)	59.20	57.40	56.00	53.00
Molasses, cane	31.80	31.60	30.00	26.40
Oats	43.60	43.00	45.00	36.40
Peanut meal	...	...	...	...
Poultry byproduct meal (55%)	125.00	112.40	116.20	110.00
Rice bran	...	...	...	...
Salt	43.00	43.00	43.00	43.60
Safflower meal (42%)	...	...	...	...
Safflower meal (20%)	...	...	...	...
Soybean meal (44%)	98.40	77.80	73.20	82.80
Soybean meal (49%)	86.00	85.60	79.80	92.00
Soybean millfeed	69.40	53.00	62.00	55.00
Urea	68.00	60.00	75.00	66.00
Wheat	68.20	58.40	59.40	50.20
Wheat bran	62.80	47.60	53.60	41.80
Wheat middlings	65.00	52.80	56.00	47.80
Wheat millrun, West Coast	...	...	...	...

Continued

Table 6.--Feed ingredient prices by market and time period--Continued

Feed ingredient	Tri-cities			
	11/66-1/67	8/67-10/67	11/67-1/68	8/68-10/68
	Dollars per ton			
Alfalfa, dehy. (20%)	74.80	64.80	64.80	49.20
Alfalfa, dehy. (17%)	68.20	54.20	53.80	41.60
Alfalfa, dehy. (15%)	...	...	...	...
Alfalfa hay (15%)	...	...	...	...
Barley	53.80	52.20	51.40	43.80
Beet pulp	73.60	77.40	73.80	76.20
Brewers grains, dried	65.60	53.60	57.80	48.40
Calcium carbonate	11.00	12.00	12.00	12.00
Citrus pulp	...	...	...	...
Corn	51.60	45.40	41.60	39.00
Corncobs, dried	20.00	20.00	20.00	22.60
Corn gluten feed	58.00	45.20	51.00	41.00
Corn gluten meal (60%)	134.40	120.80	110.00	130.40
Corn silage	10.00	10.00	10.00	10.00
Cottonseed meal (41%)	90.40	84.00	82.80	83.40
Cottonseed hulls	31.40	30.60	29.80	25.20
Deflorinated phosphate	74.00	74.00	74.00	73.20
Dicalcium phosphate	87.60	80.60	80.60	80.60
Distillers grains, dried	68.20	54.80	58.00	55.40
Fat, animal	139.20	116.80	111.80	103.40
Fat, hyd. veg. + animal	...	...	...	...
Feathermeal (85%)	116.20	104.60	102.20	110.00
Fishmeal, herring (70%)	197.80	170.00	170.00	182.60
Fishmeal, menhaden (62%)	163.40	147.60	142.60	156.00
Fishmeal, Peruvian (65%)	159.40	139.20	131.80	144.20
Linseed meal	83.00	79.80	80.60	79.40
Lysine (50%)	1,250.00	1,250.00	1,250.00	1,250.00
Malt sprouts, dried	54.20	43.20	44.20	35.40
Meat and bone meal (50%)	99.60	93.40	84.80	95.00
Methionine hydroxy analog	1,701.40	1,640.00	1,640.00	1,260.00
Milo (sorghum)	47.20	45.40	44.00	40.80
Molasses, cane	40.20	40.00	38.00	34.00
Oats	50.60	46.80	49.40	39.40
Peanut meal	...	...	...	...
Poultry byproduct meal (55%)	138.00	132.60	129.20	132.00
Rice bran	62.00	52.20	53.40	49.20
Salt	20.20	21.40	21.00	22.00
Safflower meal (42%)	...	...	...	...
Safflower meal (20%)	...	...	...	...
Soybean meal (44%)	86.20	82.00	77.20	88.20
Soybean meal (49%)	94.00	90.40	83.00	98.00
Soybean millfeed	62.40	43.60	55.00	47.80
Urea	80.00	71.40	79.60	60.00
Wheat	58.60	48.00	48.60	40.40
Wheat bran	56.80	42.80	47.40	38.20
Wheat middlings	58.20	44.40	49.00	39.80
Wheat millrun, West Coast	...	...	...	...

Continued

Table 6.--Feed ingredient prices by market and time period--Continued

Feed Ingredient	Los Angeles			
	11/66-1/67	8/67-10/67	11/67-1/68	8/68-10/68
	Dollars per ton			
Alfalfa, dehy. (20%)	58.00	60.00	60.00	57.00
Alfalfa, dehy. (17%)	53.40	55.20	55.20	55.20
Alfalfa, dehy. (15%)	45.00	45.00	45.00	42.40
Alfalfa hay (15%)	39.60	34.20	36.60	30.00
Barley	58.80	51.20	51.20	50.00
Beet pulp	56.40	49.60	48.00	44.80
Brewers grains, dried	56.20	62.00	62.60	60.00
Calcium carbonate	11.00	10.40	10.40	10.40
Citrus pulp	50.00	46.00	46.00	40.80
Corn	59.60	52.20	52.60	53.60
Corncobs, dried	...	...	...	...
Corn gluten feed	71.40	60.00	58.00	63.00
Corn gluten meal (60%)	157.80	144.00	141.00	150.80
Corn silage	10.00	10.00	10.00	10.00
Cottonseed meal (41%)	76.40	82.00	78.00	76.00
Cottonseed hulls	...	...	...	...
Deflorinated phosphate	92.20	86.00	86.00	89.00
Dicalcium phosphate	99.00	100.00	100.00	106.20
Distillers grains, dried	83.00	85.00	85.40	87.20
Fat, animal	131.80	105.00	102.60	100.00
Fat, hyd. veg. + animal	146.60	127.00	117.60	123.00
Feathermeal (85%)	110.00	102.00	94.20	97.80
Fishmeal, herring (70%)	...	...	...	...
Fishmeal, menhaden (62%)	...	...	...	...
Fishmeal, Peruvian (65%)	144.00	127.00	121.60	132.00
Linseed meal	91.00	92.80	92.00	93.60
Lysine (50%)	1,250.00	1,250.00	1,250.00	1,250.00
Malt sprouts, dried	...	...	...	...
Meat and bone meal (50%)	101.20	95.60	92.00	98.60
Methionine hydroxy analog	1,701.40	1,640.00	1,640.00	1,260.00
Milo (sorghum)	50.60	49.00	48.80	46.80
Molasses, cane	30.80	30.40	29.00	25.00
Oats	61.80	64.80	64.60	59.80
Peanut meal	...	...	...	...
Poultry byproduct meal (55%)	121.80	107.60	99.20	103.00
Rice bran	44.80	40.00	40.60	38.60
Salt	20.00	20.00	19.60	20.00
Safflower meal (42%)	81.60	76.40	76.40	77.00
Safflower meal (20%)	42.00	32.20	31.40	36.80
Soybean meal (44%)	99.40	94.00	92.60	101.00
Soybean meal (49%)	108.80	100.60	100.00	113.00
Soybean millfeed	...	...	...	...
Urea	92.00	91.00	77.60	79.00
Wheat	61.20	52.40	53.40	52.20
Wheat bran	62.00	47.60	50.00	45.40
Wheat middlings	...	...	...	...
Wheat millrun, West Coast	56.20	42.60	45.40	40.80

feed manufacturers routinely add a specified quantity of the appropriate trace mineral-vitamin premix to each ration. These manufacturers consider that the amounts of these nutrients naturally found in the ingredients provide a margin of safety. Other feed manufacturers make allowances for the trace minerals and vitamins that are natural to the feed ingredients and thereby are able to produce somewhat lower cost rations.

Preliminary computer analyses showed that if allowances were made for natural trace minerals and vitamins found in millfeeds, there would be no appreciable affect on the level of acceptance in different rations. However, these analyses showed that if allowances were made for these nutrients, the parametric values for millfeeds would be about a dollar per ton higher than those shown later in this report.

VALUE OF MILLFEEDS IN POULTRY AND SWINE RATIONS

Once the specifications for the various rations and the nutritional coefficients for the different feed ingredients have been specified, least cost rations can be determined for a given market and a given time period. In addition, the price and quantity at which any ingredient will enter the formulation, and its affect on the use of other ingredients, can be determined through parametric linear programming.

To determine the prices at which these ingredients would be used and the quantities that would be used in specified rations, the price of each millfeed being analyzed was allowed to range downward from a price that was initially set at $200.00 per ton.

Figure 1 illustrates graphically the results of such an analysis for middlings in a broiler starter ration in the Atlanta market, using average prices for 8/68-10/68. The average market price for wheat middlings in this market and time period was $41.20 per ton. This analysis shows that in a broiler starter ration, with specifications as given in table 1, wheat middlings would enter the diet at $42.20, but at that price would constitute less than 0.4 percent of the ration.

As the price is lowered, more middlings will enter the diet, but the function is not continuous. Thus, the price must drop to $41.50 before any more middlings enter the ration, and at that price the quantity of middlings is about 6.4 percent of the total ration. As the price continues to be lowered, more and more middlings will enter the ration until, at zero cost for middlings, about 41.5 percent of the ration would be middlings. Even at zero cost, larger quantities could not enter a least cost ration because specified nutritional requirements would no longer be satisfied. In actual practice, of course, such a situation would never occur.

Similar parametric analyses were made for all of the rations for the time periods and markets specified in table 5. When a given millfeed was analyzed, other millfeeds were eliminated from consideration so that one class of millfeed would not be competing with another. In actual practice,

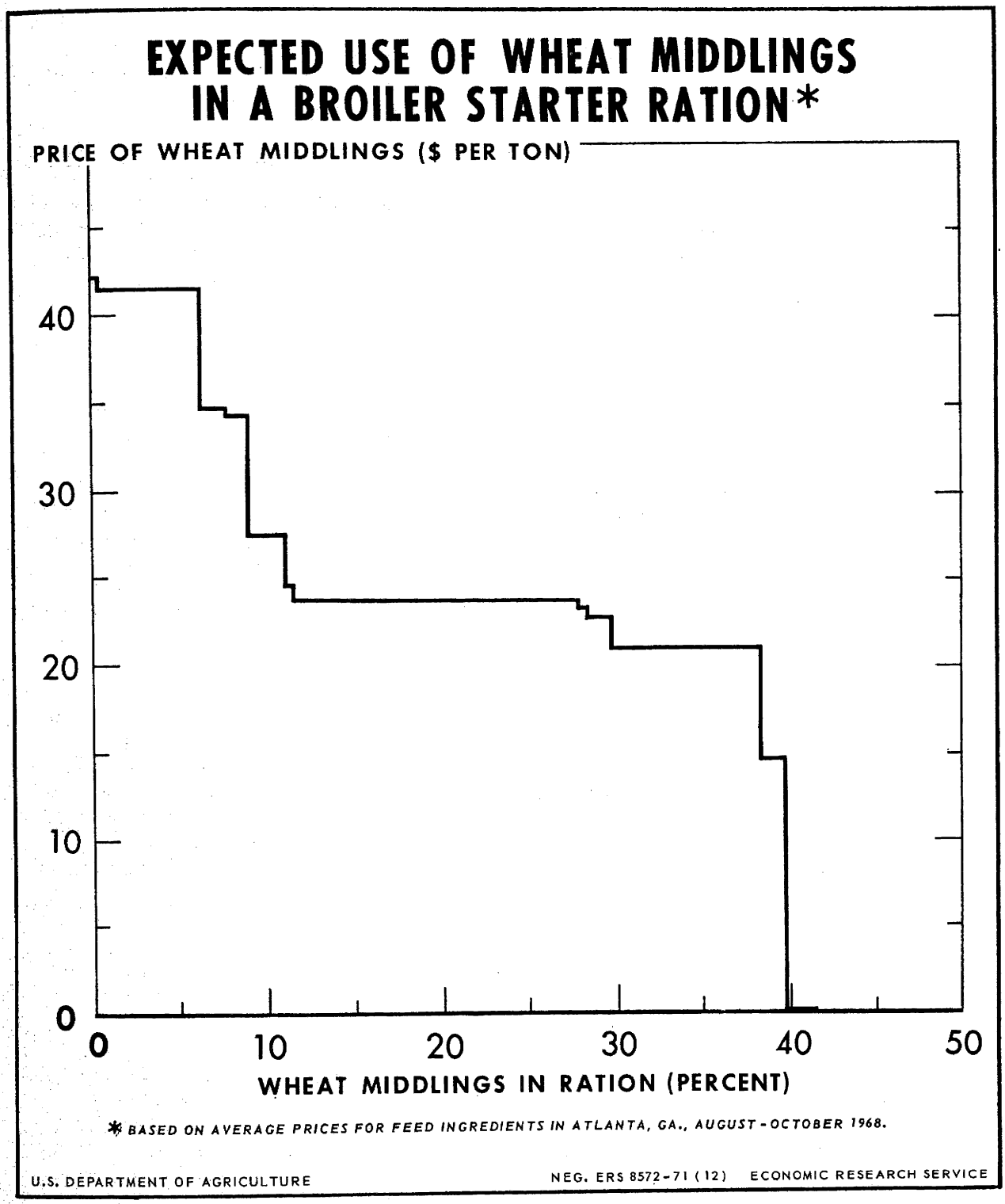
EXPECTED USE OF WHEAT MIDDLINGS
IN A BROILER STARTER RATION*
PRICE OF WHEAT MIDDLINGS ($ PER TON)
40
30
20
10
0
0
10
20
30
40
50
WHEAT MIDDLINGS IN RATION (PERCENT)
* BASED ON AVERAGE PRICES FOR FEED INGREDIENTS IN ATLANTA, GA., AUGUST - OCTOBER 1968.
U.S. DEPARTMENT OF AGRICULTURE
NEG. ERS 8572-71 (12)
ECONOMIC RESEARCH SERVICE

Figure 1

all feed ingredients are allowed to compete with each other in computing least cost rations. Since prices of different millfeeds move together, it was decided that, for this analysis, the value of a given millfeed would be more valid if it did not have to compete with other millfeeds.

Summaries of the results of all the analyses made of poultry and swine rations are given in tables 7, 8, 9, 10, and 11. These tables show the prices at which the millfeed being analyzed would enter the least cost ration in quantities exceeding 2.5 percent of the ration. Prices for quantities of less than 2.5 percent were considered to be only of academic interest. As indicated in figure 1, since prices for quantities in the high ranges of usage generally would be considerably below the actual market prices, they too are only of academic interest.

This analysis shows that in poultry rations millfeeds are the most suitable for rations with metabolizable energy requirements of less than 1,300 kilocalories per pound. Thus, in nearly 60 percent of the poultry rations analyzed, with metabolizable energy requirements of 1,300 kilocalories or less per pound, middlings or millrun made up 2.5 percent or more of the ration at or above the market price. On the other hand, only in less than 10 percent of the analyses of poultry rations, with metabolizable energy requirements over 1,300 kilocalories per pound, did middlings or millrun make up 2.5 percent or more of the ration at or above the price. Present practices in the utilization of millfeeds in poultry rations confirm these results.

Price variations of ingredients, represented by the different price periods, also are extremely important in determining the parametric value of an ingredient. Thus, during the "high" price period, 11/66-1/67, middlings or millrun made up 2.5 percent or more of the poultry rations analyzed, at or above the market price, in only 15 percent of the cases. During the "low" price period, 8/68-10/68, this situation occurred in over 50 percent of the cases; whereas, during the other two "average" price periods, it was about 40 percent. These results emphasize the need for selecting market periods that will reflect the value of an ingredient over a wide range of price conditions.

Some typical least cost poultry and swine rations with energy requirements that allow the acceptance of millfeeds at or above the market price are given in appendix II.

In the low-energy (1,300 kilocalories per pound) broiler starter ration, middlings came into the least cost formulation at higher than the market price in all price periods except the high-price period 11/66-11/67 (table 7). In such high-price situations, the nutrient requirements in poultry rations apparently can be supplied at lower cost by competing feed ingredients and therefore middlings are excluded from the least cost rations.

Middlings or millrun enter the low-energy broiler pullet developer ration at or above the market price in all markets and all time periods because the metabolizable energy content is never a limiting factor for

Table 7.--Average market prices and prices at which wheat middlings would constitute a minimum of 2.5 percent of least cost broiler rations, Atlanta, Ga.

Time period	Market price for middlings	Prices at which middlings would constitute a minimum of 2.5 percent of the ration		
		Broiler starter		Broiler finisher
		1,300 1/	1,350 1/	1,400 1/
	Dollars per ton			
11/66 - 1/67	61.60	50.70	49.10	23.30
8/67 - 10/67	51.60	52.30	45.50	19.60
11/67 - 1/68	52.00	56.50	43.70	19.00
8/68 - 10/68	41.20	44.90	41.50	22.20

1/ Metabolizable energy requirement of the ration in kilocalories per pound.

Table 8.--Average market prices and prices at which wheat middlings would constitute a minimum of 2.5 percent of least cost replacement pullet developer rations in different markets

Market and time period	Market price for middlings	Prices at which middlings would constitute a minimum of 2.5 percent of the ration	
		Broiler pullet developer 1,250 1/	Layer pullet developer 1,400 1/
	Dollars per ton		
Atlanta			
11/66 - 1/67	61.60	66.10	30.70
8/67 - 10/67	51.60	66.50	43.30
11/67 - 1/68	52.00	78.20	38.40
8/68 - 10/68	41.20	44.00	41.30
Boston			
11/66 - 1/67	65.00	76.80	52.50
8/67 - 10/67	52.80	80.20	32.40
11/67 - 1/68	56.00	77.80	32.00
8/68 - 10/68	47.80	65.90	38.80
Tri-cities			
11/66 - 1/67	58.20	65.50	22.00
8/67 - 10/67	44.40	57.20	38.60
11/67 - 1/68	49.00	64.60	39.70
8/68 - 10/68	39.80	45.30	40.30
Los Angeles 2/			
11/66 - 1/67	56.20	66.80	28.10
8/67 - 10/67	42.60	56.60	37.60
11/67 - 1/68	45.40	56.80	38.60
8/68 - 10/68	40.80	57.20	36.00

1/ Metabolizable energy requirement of the ration in kilocalories per pound.

2/ Los Angeles prices are for wheat millrun, West Coast.

Table 9.--Average market prices and prices at which wheat middlings would constitute a minimum of 2.5 percent of least cost light breed layer rations in different markets

Market and time period	Market price for middlings	Prices at which middlings would constitute a minimum of 2.5 percent of layer rations of different energy levels		
		1,250 1/	1,300 1/	1,350 1/
	Dollars per ton			
Atlanta				
11/66 - 1/67	61.60	55.80	49.50	27.80
8/67 - 10/67	51.60	62.20	41.80	29.90
11/67 - 1/68	52.00	62.30	41.40	36.90
8/68 - 10/68	41.20	44.90	36.70	23.80
Boston				
11/66 - 1/67	65.00	63.10	62.60	30.10
8/67 - 10/67	52.80	69.40	60.90	31.50
11/67 - 1/68	56.00	64.80	55.70	35.00
8/68 - 10/68	47.80	53.80	52.00	29.70
Tri-cities				
11/66 - 1/67	58.20	43.60	41.60	22.90
8/67 - 10/67	44.40	47.10	41.30	24.10
11/67 - 1/68	49.00	57.75	48.00	18.80
8/68 - 10/68	39.80	39.10	37.80	19.30
Los Angeles 2/				
11/66 - 1/67	56.20	40.20	26.20	26.20
8/67 - 10/67	42.60	40.40	37.60	35.60
11/67 - 1/68	45.40	37.00	37.00	36.90
8/68 - 10/68	40.80	34.30	32.10	32.10

1/ Metabolizable energy requirement of the ration in kilocalories per pound.
2/ Los Angeles prices are for wheat millrun, West Coast.

Table 10.--Average market prices and prices at which wheat middlings would constitute a minimum of 2.5 percent of least cost turkey developer rations in different markets

Market and time period	Market price for middlings	Prices at which middlings would constitute a minimum of 2.5 percent of the ration for 14-20 week-old turkeys	
		1,250[1/]	1,350[1/]
	Dollars per ton		
Tri-cities			
11/66 - 1/67	58.20	56.20	21.50
8/67 - 10/67	44.40	51.10	38.60
11/67 - 1/68	49.00	61.60	38.30
8/68 - 10/68	39.80	42.00	39.80
Los Angeles[2/]			
11/66 - 1/67	56.20	52.10	32.00
8/67 - 10/67	42.60	55.70	38.00
11/67 - 1/68	45.40	55.70	38.60
8/68 - 10/68	40.80	52.70	35.90

1/ Metabolizable energy requirement of the rations in kilocalories per pound.
2/ Los Angeles prices are for wheat millrun, West Coast.

Table 11.--Average market prices and prices at which wheat middlings would constitute a minimum of 2.5 percent of least cost swine grower rations in the Tri-cities market

Time period	Market price for middlings	Prices at which middlings would constitute a minimum of 2.5 percent of the ration	
		Swine grower (60-100 lbs.)	Swine grower (100-150 lbs.)
		1,420 1/	1,435 1/
	Dollars per ton		
11/66 - 1/67	58.20	21.00	21.80
8/67 - 10/67	44.40	42.70	49.60
11/67 - 1/68	49.00	42.60	48.20
8/68 - 10/68	39.80	40.20	41.60

1/ Metabolizable energy requirement of the ration in kilocalories per pound.

this ration (table 8). In the higher energy layer pullet developer ration, middlings or millrun are valued below the market price for all price periods and all markets, except for the 8/68-10/68 period in the Atlanta and Tri-cities markets (table 8). This exception was a period of very low prices for all feed ingredients. During such periods, middlings or millrun are competitive with other ingredients in supplying nutrient requirements at least cost.

Poultry nutritionists agree that delaying maturity of heavy breed pullets is necessary for most effective production of setable eggs. Most leading producers of pullets practice some form of restricted feeding. In addition to feeding a low-energy ration, "skip feeding" of a higher energy ration is an effective way of accomplishing this objective, and in some instances may be the least cost method (6).

The parametric prices for middlings or millrun in the lowest energy (1,250 kilocalories per pound) layer rations exceeded the market price in all markets except Los Angeles, and all price periods except the period 11/66-1/67 (table 9). In Los Angeles, where millrun was analyzed, parametric prices were lower than the market prices in all time periods and for all energy requirements. The apparent reason for this is that the Los Angeles market usually has a wider selection of competing feed ingredients available that provide required nutrients at lower prices than millrun.

In turkey developer rations, in both the Tri-cities and Los Angeles markets, the parametric price of middlings or millrun exceeded the market price in the low-energy ration in all time periods except the high-price period, 11/66-11/67 (table 10). As in the case of the broiler starter ration, during this period of high prices, the nutrient requirements can be supplied at lower cost by competing feeds and therefore middlings or millrun are excluded from the least cost ration.

In some rations, high-energy and relatively low-protein or amino acid requirements--such as in most swine rations--result in a relatively high price for middlings in most time periods (table 11). This occurs because large quantities of corn can enter the ration to satisfy the energy requirements, thus making it possible for bulky, relatively low-energy middlings to satisfy the protein and amino acid requirements at least cost.

The foregoing analysis shows that millfeeds are at best marginal for use in many of the high-energy poultry rations. The utilization of middlings and millrun in these rations probably could be increased if the availability of nutrients in these millfeeds were improved to their full potential.

If, for example, it was assumed that the nutritional values given for middlings in table 3 could be increased through chemical and/or physical modifications so that the metabolizable energy was 25 percent higher, and the protein, amino acids, and phosphorus were increased to 100 percent availability, the value of middlings in the higher energy poultry rations would be considerably higher. This case is illustrated by a calculation made for the Tri-cities market for the 11/67-1/68 period. As shown in table 9, the market price for middlings was $49.00 per ton in this period and the price at which middlings would constitute a minimum of 2.5 percent of a 1,300 kilocalorie per pound layer ration was $48.00. With the increased availabilities assumed above, the value of middlings would be $54.50 per ton, which is $5.50 per ton above the then current market price. Such improvements, if feasible, and if applied and generally accepted throughout the poultry-feeding industry, would surely have the effect of increasing the demand for millfeeds. Research to assess the technical and economic feasibility of such improvements--supported in part by the Millers' National Federation--is being conducted at USDA's Western Regional Research Laboratory, Albany, Calif.

VALUE OF MILLFEEDS IN RUMINANT RATIONS

As indicated earlier, millfeeds are used extensively in both dairy and beef cattle rations. To ascertain the value of millfeeds in dairy and beef cattle rations, parametric analyses were made for several markets and time periods. These analyses are summarized in tables 12, 13, and 14. The parametric prices shown in these tables are more nearly equal to the average market prices than was the case for the high-energy poultry rations.

For a complete milking ration with roughage, the parametric prices of millfeeds in Atlanta and Boston were somewhat lower than the market prices during all price periods (table 12). The only exception was for the period

Table 12.--Average market prices and prices at which different wheat millfeeds would constitute a minimum of 2.5 percent of a least cost milking ration with roughage in different markets[1/]

Market and time period	Market prices		Prices at which middlings or bran would constitute a minimum of 2.5 percent of the ration	
	Middlings[2/]	Bran	Middlings[2/]	Bran[3/]
	Dollars per ton			
Atlanta				
11/66 - 1/67	61.60	61.20	55.50	54.00
8/67 - 10/67	51.60	49.60	49.00	48.70
11/67 - 1/68	52.00	51.00	48.20	45.90
8/68 - 10/68	41.20	40.20	44.80	41.80
Boston				
11/66 - 1/67	65.00	62.80	47.60	47.60
8/67 - 10/67	52.80	47.60	46.40	47.20
11/67 - 1/68	56.00	53.60	48.60	49.40
8/68 - 10/68	47.80	41.80	40.20	41.00
Los Angeles[2/3/]				
11/66 - 1/67	56.20	...	51.50	...
8/67 - 10/67	42.60	...	48.00	...
11/67 - 1/68	45.40	...	48.00	...
8/68 - 10/68	40.80	...	42.40	...

1/ Only one type of millfeed was allowed to enter the ration for each run. The TDN value for this ration is 55 percent.
2/ The millfeed ingredient in the Los Angeles market is millrun.
3/ Prices for bran were not computed for Los Angeles.

Table 13.--Average market prices and prices at which West Coast wheat millrun would constitute a minimum of 2.5 percent of a least cost beef finisher ration with roughage in Los Angeles[1/]

Time period	Market price	Prices at which millrun would constitute a minimum of 2.5 percent of the ration
	Dollars per ton	
11/66 - 1/67	56.20	53.00
8/67 - 10/67	42.60	51.00
11/67 - 1/68	45.40	51.00
8/68 - 10/68	40.80	49.40

1/ The TDN value of this ration is 65 percent.

Table 14.--Average market prices and prices at which wheat middlings and bran would constitute a minimum of 2.5 percent of least cost beef and dairy supplement rations in the Tri-cities market[1/]

Ration and time period	Market prices		Prices at which middlings or bran constitute a minimum of 2.5 percent of the ration	
	Middlings	Bran	Middlings	Bran
	Dollars per ton			
Beef supplement (32% protein)				
11/66 - 1/67	58.20	56.80	62.20	62.20
8/67 - 10/67	44.40	42.80	52.40	52.40
11/67 - 1/68	49.00	47.40	53.80	53.80
8/68 - 10/68	39.80	38.20	48.20	48.20
Dairy supplement (42% protein)				
11/66 - 1/67	58.20	56.80	62.20	62.20
8/67 - 10/67	44.40	42.80	52.40	52.40
11/67 - 1/68	49.00	47.40	53.80	53.80
8/68 - 10/68	39.80	38.20	48.20	48.20

1/ In computing least cost rations for beef and dairy cattle supplements, all grains were restricted from the rations. The TDN value for each of these rations is 50 percent.

8/68-10/68--when market prices were at their lowest--at which time, parametric prices of both middlings and bran were higher than market prices. In Los Angeles, however, the parametric prices of millrun were higher than the market prices for all but the high-price period, 8/68-10/68, in both the milking and beef rations with roughage (tables 12 and 13). These results resemble those of poultry rations in which, during periods of high prices, nutrient requirements can be supplied by other ingredients at lower cost. Consequently, millfeeds are excluded from the least cost ration.

In all of the price periods, the parametric prices of middlings and bran for both the high-protein beef and dairy supplements in the Tri-cities market were higher than the market prices. However, the parametric prices were proportionately much higher when market prices were lowest (table 14). Although the magnitude differs, this relationship is consistent with that between the market and parametric prices for the complete dairy and beef rations discussed above. Some typical least cost ruminant rations that contain millfeeds at or above the market price are given in Appendix II.

In the Midwest, where most millfeeds originate, beef and dairy feeds usually are produced on a supplement (concentrate) basis. Millfeeds are used at maximum levels in these feeds, but supplies generally exceed the demand for use at levels that will satisfy ration requirements. Because of this, large quantities of millfeeds must be sold for use in other types of feeds in which their value is lower. Therefore, the market price for millfeeds is usually lower than the imputed values in beef and dairy supplements indicate.

As indicated earlier, research that would lead to improvements in the nutrient availability of millfeeds would increase their value in poultry feeds. Commercial production of improved millfeeds depends on whether the costs of a commercially feasible process are low enough to be covered by increases in selling prices, and whether the industry is successful in developing markets for improved millfeeds.

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APPENDIX I. DERIVED NUTRITIONAL VALUES FOR WHEAT MILLFEEDS

The nutritional values of wheat millfeeds used in this report were derived from data in the Millfeed Manual, Millers' National Federation (10). This manual gives analytical values for bran, shorts, red dog, germ, and flour for nine different lots of wheat representing four different classes. It was decided that a separate economic study of millfeeds from each class of wheat was not necessary to arrive at acceptable conclusions about the economic value of millfeeds in different rations. Instead, the nutritional values of several lots of wheat were combined into an overall average for the different millfeed fractions. This seemed justifiable because the nutritional values given in the Millfeed Manual did not show consistent differences between samples from different classes of wheat. In addition, commercially available millfeeds are always from blends of different lots and classes of wheat.

Since nutrient analyses for commercial middlings and millrun were not published in the Millfeed Manual, their nutritional values had to be derived from analyses of the other millfeeds. Middlings may be considered to be a blend of bran and shorts, and millrun a blend of bran, shorts, and red dog. In wheat milling practice, the recovery of bran and shorts is approximately one part shorts and two parts bran. However, substantial quantities of bran are sold as such, and the remainder is combined with shorts and sold as middlings. Therefore, nutritional values used for middlings were computed by taking a weighted average of the analytical values of a blend of one part bran and two parts shorts. These values may be considered to be representative for most commercially available middlings.

Nutritional values for West Coast millrun were derived from analytical values for bran, shorts, and red dog and were weighted by the proportions of these millfeeds recovered from the milling of four types of wheat used for the nutrient analyses in the Millfeed Manual. The analytical values and recovery percentages of these millfeed products are given in the Millfeed Manual.

The weights used for combining the nutritional values of millfeeds from the different types of wheat to obtain average values for middlings and millrun are given in table 15. For middlings, this was a simple average from the six most important types of wheat; for West Coast millrun, it was a weighted average of the four most important types of wheat milled on the West Coast. Weights used for averaging millrun were based on approximate quantities of each type of wheat used in a typical wheat flour blend in West Coast mills.

All of the nutritional values for middlings and millrun in the poultry and swine matrix were derived by the above procedure and further adjusted because of digestibility problems (21). Because of these problems, the protein, amino acid, and vitamin values derived for middlings and West Coast millrun were assumed to be only 76 and 78 percent available to poultry and swine, respectively (12, 22, 24).

Table 15.--Percentage of different types of wheat used in calculating average values of nutritional components in middlings and millrun[1/]

Type of wheat	Percentage of each type in each millfeed product	
	Middlings	West Coast millrun
	- - - - - Percent	- - - - -
HRW - low protein	16-2/3	20
HRW - high protein	16-2/3	40
HRS - low protein	16-2/3	--
HRS - high protein	16-2/3	20
Soft red - average protein	16-2/3	--
Soft white - average protein	16-2/3	20
Total	100	100

1/ Based on data contained in the Millfeed Manual, Millers' National Federation, 1971 (Rev.), Chicago, Ill., (In press).

The nutritional values used for middlings and millrun in ruminant rations were derived in the above manner, with no adjustments, except for TDN and digestible protein which were taken from the National Academy of Sciences sources (14). In addition, the nutritional values for bran in ruminant rations were based on a simple average of all nine lots of wheat analyzed in the Millfeed Manual except for TDN and digestible protein which also were taken from the National Academy of Sciences (14).

APPENDIX II. SOME TYPICAL LEAST COST RATIONS

Following are some typical least cost rations formulated on the basis of average market prices for all ingredients except for millfeeds. The prices used for millfeeds are the parametric prices at which they would constitute 2.5 percent or more of the ration.

Table 16.--Typical broiler rations, Atlanta, 8/68-10/68

Ingredient	Percentage in ration		
	Broiler pullet developer 1,250 1/	Broiler starter 1,300 1/	Broiler starter 1,350 1/
Wheat middlings	6.7	9.4	6.4
Rice bran	5.0	-	-
Corn, yellow	60.0	38.6	61.0
Milo	-	19.0	-
Soybean meal, (44%)	10.9	32.1	20.4
Fishmeal, menhaden, (62%)	-	7.1	9.3
Meat and bone meal, (50%)	5.0	-	1.2
Feathermeal, (85%)	-	0.6	-
Dehydrated alfalfa, (17%)	11.5	-	-
Calcium carbonate	-	1.0	0.9
Dical. phosphate, (18.5%)	0.2	-	-
Deflor. phosphate	-	0.5	-
Antioxidant	2/	2/	2/
Trace nutrients and salt	0.7	0.7	0.8
Total	100.0	100.0	100.0

1/ Metabolizable energy requirement in kilocalories per pound of ration.
2/ 0.0125 percent.

Table 17.--Typical light breed layer rations, Boston, 8/67-10/67

Ingredient	Percentage in ration	
	1,250 1/	1,300 1/
Wheat middlings	7.4	2.9
Corn, yellow	64.2	71.4
Soybean meal, (44%)	17.0	11.7
Meat and bone meal, (50%)	-	0.3
Feathermeal, (85%)	-	2.3
Dehydrated alfalfa, (20%)	0.6	0.2
Calcium carbonate	9.2	9.5
Dical. phosphate, (18.5%)	0.9	0.9
MHA	2/	0.1
Antioxidant	3/	3/
Trace nutrients and salt	0.7	0.7
Total	100.0	100.0

1/ Metabolizable energy requirement in kilocalories per pound of ration.
2/ 0.0345 percent.
3/ 0.0125 percent.

Table 18.--Typical turkey developer rations, 1,250 kilocalories,[1/] 11/67-1/68

Ingredient	Percentage in ration	
	Tri-cities	Los Angeles
Wheat millfeed[2/]	5.9	5.1
Rice bran	5.0	5.0
Corn	55.0	-
Milo	-	59.1
Soybean meal, (44%)	29.5	4.6
Fishmeal, Peruvian, (65%)	-	10.0
Feathermeal, (85%)	-	2.5
Poultry byproduct meal, (55%)	-	3.0
Dehydrated alfalfa, (20%)	-	8.4
Calcium carbonate	2.2	1.6
Dicalcium phosphate, (18.5%)	1.7	-
Antioxidant	3/	3/
Trace nutrients and salt	0.7	0.7
Total	100.0	100.0

1/ Metabolizable energy requirement in kilocalories per pound of ration.
2/ Middlings in Tri-cities and millrun, West Coast, in Los Angeles.
3/ 0.0125 percent.

Table 19.--Typical swine grower rations, Tri-cities, 8/68-10/68

Ingredient	Percentage in ration	
	60-100 pound (1,420) 1/	100-150 pound (1,435) 1/
Wheat middlings	8.3	3.3
Corn, yellow	76.3	87.3
Soybean meal, (44%)	8.2	3.8
Fishmeal, herring, (70%)	3.7	0.5
Meat and bone meal, (50%)	2.4	3.7
Calcium carbonate	0.3	0.6
Antioxidant	2/	2/
Trace nutrients and salt	0.8	0.8
Total	100.0	100.0

1/ Number in parentheses is the metabolizable energy requirement in kilocalories per pound of ration.
2/ 0.0125 percent.

Table 20.--Typical milking and beef finisher rations with roughage, Los Angeles, 11/67-1/68

Ingredient	Percentage in ration	
	Milking, 55% TDN	Beef finisher, 65% TDN
Wheat millrun, West Coast	20.6	16.2
Rice bran, solvent	14.5	-
Milo, steamrolled	-	30.2
Molasses, cane	10.0	10.0
Dehydrated alfalfa, (15%)	2.0	2.5
Alfalfa hay, (15%)	30.0	-
Citrus pulp	-	20.0
Safflower meal, (20%)	20.0	20.0
Calcium carbonate	1.9	0.3
Salt	0.5	0.3
Trace nutrient mix	0.5	0.5
Total	100.0	100.0

Table 21.--Typical high-protein cattle supplements, Tri-cities, 8/67-10/67

Ingredient	Percentage in ration	
	Beef supplement, 32% protein (50% TDN)	Dairy supplement, 42% protein (50% TDN)
Wheat middlings	18.6	16.8
Molasses, cane	8.0	8.0
Corn gluten feed	25.0	25.0
Malt sprouts, dried	25.0	25.0
Dehydrated alfalfa, (17%)	5.0	5.0
Urea	6.4	10.2
Calcium carbonate	9.0	6.2
Salt	2.5	3.3
Trace nutrient mix	0.5	0.5
Total	100.0	100.0