Setting Loan Support Rates for Major Feed Grains

By R. C. Kite and P. D. Velde

A multicommodity, multiregional linear programming model is employed to obtain price differentials between 16 U.S. regions for corn, barley, grain sorghum, and oats. The price differentials are used to obtain loan support rates (for the 1974 crop) in each region, for each grain, so that relative feeding values, transport rates, and supply and demand conditions are an integral part of the loan rate structure.

Keywords: Linear programming, price differentials, loan support rates, corn, barley, oats, sorghum.

The multiregional, multicommodity linear programming model described in this paper is used as an aid for establishing loan support rates for four major feed grains: corn, barley, grain sorghum, and oats. The paper is presented in three sections. The first is an overview of the loan provisions of the Agriculture and Consumer Protection Act of 1973 (which provides authority for support activities related to the 1974 crop).[1] The second section presents the mathematical framework of the linear programming model. The third section presents the empirical model and its solution.

Loan Provisions for 1974 Feed Grain Crop

The 1973 Agriculture and Consumer Protection Act, like preceding acts, provides for direct purchase, purchase agreements, set-aside payments, and nonrecourse loans for specified agricultural commodities. The three methods of support (purchase, payments, and loans) are interdependent in actual operation of the support program (*5*, p. 19). Since this paper focuses on the establishment of loan rates, the interdependencies can be ignored.

The Secretary of Agriculture is given the responsibility and authority to set loan rates, subject to legislated limits and guidelines. Eight factors which must be considered are specified by Section 401(b) of the 1949 Agricultural Act. The factors are (*5*, p. 3):

1. The supply of the commodity in relation to the demand;
2. The price levels at which other commodities are being supported and, in the case of feed grains, the feed values of each grain in relation to corn;
3. The availability of funds;
4. The perishability of the commodity;
5. The importance of the commodity to agriculture and the national economy;
6. The ability to dispose of stocks acquired through a price support operation;
7. The need to offset temporary losses of export markets; and
8. The ability and willingness of producers to keep supplies in line with demand.

The 1973 Act places additional restrictions on the loan rates to be established. The national average loan rate for corn is limited to a minimum of $1.10 per bushel and must not exceed 90 percent of parity. The support levels for all grains are to be set by the Secretary at points considered reasonable in relation to the corn rate, taking into consideration feeding values and transportation rates relative to corn (*5*, p. 19). Loan rates to individual producers reflect the national average rate, as determined by the Secretary, with adjustments for grain quality and location.

Consideration of all the specified factors represents a problem of some magnitude. The statutory requirements are such that an informal method for setting loan rates is unlikely to satisfy all necessary conditions simultaneously. An advantage of the mathematical programming model presented in the following section is that it provides a formal structure, with flexibility to incorporate alternative supply, demand, and transportation situations while taking account of the use of the grains in animal feeding.

A Model

The model is constructed to provide estimates, subject to given data, of the allocation of grains between domestic regions and from the domestic regions to export points. The domestic interregional grain movements are generated to satisfy regional feed and export requirements at each specified point.

[1] The Federal Government has engaged in some form of commodity price support activity since 1929, when the Agricultural Marketing Act established the Federal Farm Board (*3*, p. 69). Nonrecourse commodity loans were initiated in 1933 when the Commodity Credit Corporation was created (5, p. 1). Price support operations are conducted primarily by the Commodity Credit Corporation.

For this presentation we assume that a perfectly operating national pricing system exists, and that the transportation system does not use resources employed by the animal feeding sector, so it will be appropriate to seek a national objective of minimum transportation costs. This formulation enables us to obtain regional feed and grain price differentials, as well as interregional flows of grains. The price differentials may then be used to impute regional loan rates for the feed grains. The model is cast in a linear programming framework and consists of four major components:

1. Regional grain supplies, which are assumed to be known in both location and quantity.
2. An export component, for which we assume known export quantities from specific points of debarkation and fixed point-to-point transport costs from domestic points to debarkation points.
3. A domestic transport component, for which point-to-point unit transport costs are known and fixed.
4. An animal feeding component consisting of sets of alternative feed rations, for various types of animal feeds in each domestic region. Total feed requirements are assumed to be known for each feed in each region.

Figure 1 gives an overview of the linear programming model. A mathematical representation is shown in relations (1) to (7) below. (See (*2*) for a more complete discussion of the model).

Define:

t_j^{ik} = Transport cost of grain j from region k to region i

y_j^{ik} = Quantity of grain j transferred from region k to region i

w_r^i = Lagrangian multiplier relating the value of feed r to region i

U_j^i = Lagrangian multiplier relating the value of grain j to receiving region i

U_j^k = Lagrangian multiplier relating the value of grain j to shipping region k

f_{jr}^{li} = Proportion of grain j used in process l to produce feed r in region i (i.e., f_{jr}^{li} for $j = 1, J$ represents the lth feed ration of type r in region i)

A_r^{lk} = Intensity of process l in producing feed r in region k

X_j^k = Fixed quantity of grain j available in region k

Q^{ir} = Quantity of feed r required in region i

E_j^i = Quantity of grain j exported from export point i

I = Number of receiving regions, where the first I' regions are domestic points and the rest $(I-I')$ are export points

K = Number of shipping regions

OVERVIEW of MODEL COMPONENTS

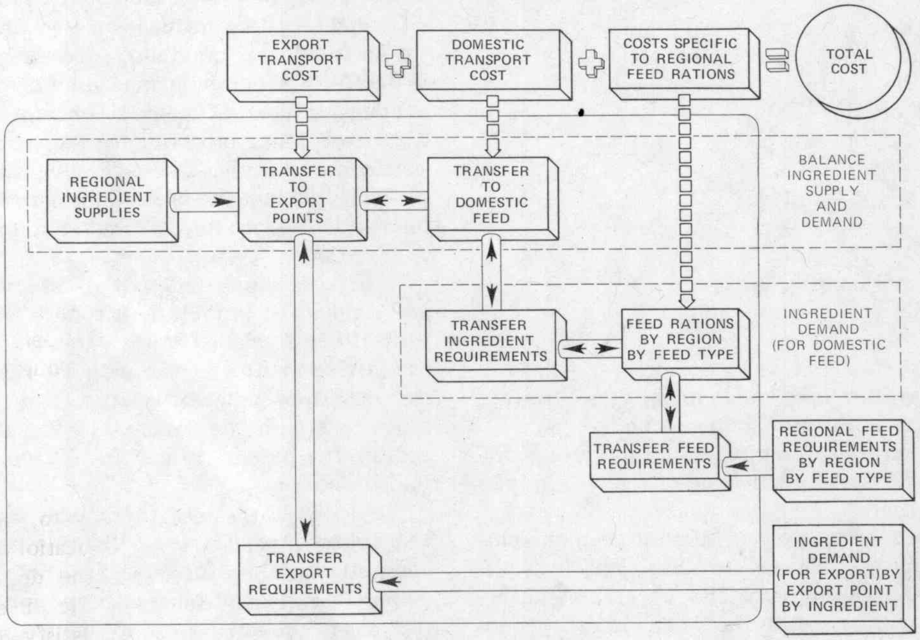

Figure 1

J = Number of grains

R = Number of feed commodities

L = Number of processes.

We wish to minimize total transfer cost:

$$(1)\quad \sum_{i}^{I} \sum_{k}^{K} \sum_{j}^{J} t_j^{ik} \; y_j^{ik}$$

This objective is to be attained subject to four conditions:

Quantity of feed r produced in region i must at least equal that region's requirement for the feed:

$$(2)\quad Q^{ir} \leq \sum_{1}^{L} A_r^{li}, \quad r = 1, R; i = 1, I'$$

Shipments of grain j from region k must not exceed that region's initial supply of the grain:

$$(3)\quad \sum_{i}^{I} y_j^{ik} \leq X_j^k, \quad k = 1, K; j = 1, J$$

Receipts of grain j by region i must at least equal the amount used for feed:

$$(4.1)\quad \sum_{1}^{L} \sum_{r}^{R} A_r^{li} \, f_{jr}^{li} \leq \sum_{k}^{K} y_j^{ik},$$

$$i = 1, I'; j = 1, J$$

and the amount shipped to export points.

$$(4.2)\quad E_j^i \leq \sum_{k}^{K} y_j^{ik}, \; i = I'+1, \; I \text{ and } j = 1, J$$

(5) All y_j^{ik} and A_r^{li} nonnegative.

Conditions for the minimization of (1) subject to (2), (3), (4), and (5) yield the usual information:

(1) If it is possible for a region to produce more feed than it needs, the implicit value of the feed in that region will be zero.

(2) If a grain supplying region, after all requirements are met, has surplus grain, the implicit value (U_j^k) of that grain in that region is zero. The U_j^k represent the prices which would maximize the value of supplies in each supplying region (considering only transportation costs). In this context, the U_j^k are a set of interregional price differentials which establish an equilibrium between grain supply and demand. They may also be interpreted as interregional loan rate differentials which would least disturb the allocation of grains for use in animal feeds. That is, these differentials reflect the value of the grains, taking into consideration the supply of grains, export demand, feed demand, and the relative feeding values of the grains in conjunction with transportation rates. In addition, the U_j^i are zero if total grain availability in a given demanding region exceeds its needs. When i and k are the same region, $U_j^i = U_j^k$. The U_j^i are equilibrium prices for the grains in the demanding regions. These data are not discussed in this report but they do have usefulness in determining competitive positions for grain supplying regions.

The model as constructed and the LP algorithm insure that the relationship between the grain supply and demand is rigorously maintained. It further insures that transportation rates are a fundamental element in determining relative values for the grains. The structure of the model also insures (through the feed rations) that the nutritional characteristics of all included grains are a significant determinant of the (imputed) values. The model, then, accounts for some, but not all, of the eight factors specified for consideration by Section 401(b) of the 1949 act and by the 1973 act. Specifically, the price differentials obtained will depend upon grain supply relative to demand, transportation rates, and the regional mix of animal and feed grain production.

Loan Support Rates for 1974/75 Crop

The empirical model used to generate loan price differentials contains 16 domestic regions and nine export points (appendix tables A-1 and A-2). In total, 16 different feeds are included in the model, several each for beef, dairy, pork, poultry, and sheep. (Specifications of the feeds are given in appendix table A-3.) The model contains several different rations for each feed type. Least-cost, linear programming formulation was used to obtain each alternative ration. The formulation model contained 22 ingredients in addition to the four grains of interest. (The ingredients are listed in appendix table A-4).

The basic supply and export data used in the model are summarized in table 1. A total of about 221 million tons of the four feed grains were assumed available for use in feed and for export with the remainder available for carryover (industrial, seed, and food uses were subtracted from total supply). The method used to allocate the supplies to individual regions is discussed in the appendix.

Table 1 also shows the model estimates of grain consumption by livestock. Since estimation of grain consumption is not the subject of this paper, we will not pursue this aspect of the model solution. Appendix table A-9 shows estimates of consumption by grain and livestock type.

Table 1. Summary of basic data used in model and model solution, four grains, 1974/75

	USDA estimates[a]				From model	
	Supply available[b]	Export	Consumed by livestock	Surplus	Consumed by livestock	Surplus
	Million tons					
Corn	172.7	32.2	122.5	18.0	114.8	25.7
Barley	8.8	1.8	4.7	2.2	6.9	.1
Sorghum	24.8	5.6	19.0	.1	18.9	.3
Oats	14.4	.5	10.2	3.8	10.9	3.0
Total	220.7	40.1	156.4	24.1	151.5	29.1
Total feed required	–	–	–	–	199.8	–

[a]Source for data is (4). See also appendix table A-5.
[b]Excludes estimates for seed, industrial, and human use.

Results: Price Differentials and Loan Rates

The price differentials resulting from solution of the model are shown in table 2. These differentials display the relationships common to interregional price surfaces. The differentials are high in regions removed from grain supplies and low in regions with large supplies. The price surface is uniformly low in regions 3, 4, 5, 6, and 7. With the exception of grain sorghum, the differentials are high in the remaining regions.

All differentials displayed in table 2 are relative to region 3 (Indiana, Ohio, and Illinois). Thus, the value of 18.1 cents per bushel of corn shown for region 2 (New York, Pennsylvania, and New Jersey) is to be interpreted as meaning the loan rates should be structured so that the rate in region 2 is 18.1 cents per bushel higher than in region 3. Similarly, the rate in region 5 (Iowa, Missouri) should be 3.7 cents per bushel lower than the rate in region 3.

The differentials given in table 2 provide basic information which can be used to establish the level of loan rates. While the differentials are based on basic supply, demand, and transportation conditions, the actual loan levels must be set in the light of additional factors. Some of these factors were mentioned earlier in the paper—the eight factors specified by Section 401(b) of the 1949 Agricultural Act and the specifications of the 1973 Agriculture and Consumer Protection Act. An important additional factor will be Government policy with respect to grain reserves and foreign affairs.

We have assumed that a loan rate of $1.10 per bushel for corn has been determined as the minimum level. Using this level and the differentials shown in table 2, we establish the loan rates shown in column 5 of table 2. The loan rates for corn now retain the appropriate differential relationships with the minimum rates ($1.10) established for regions 4, 5, and 6.

The procedure for establishing the remaining regional loan rates was as follows. We retain region 3 as the base region for which the corn loan rate has been determined exogenously. We then establish loan rates in region 3 for the remaining grains according to the relationship between the corn rate and the feeding value of the other grains relative to corn. This relationship is derived from the result in economic theory which shows that the organization of inputs to produce a given level of output should be such that the rate of technical substitution (*RTS*) is equal to an appropriate price ratio—in this case the ratio of loan rates.

The *RTS* indicates the amount of one input which must replace one unit of another to maintain the appropriate input balance. The *RTS* between, say, corn and barley is defined as the ratio of the marginal products of barley and corn, and this should be equated to the ratio of the barley and corn loan rates.

It is possible to obtain estimates of the *RTS* from an LP model. However, in contrast to the classical derivation of an *RTS*, the LP estimate can (and certainly would) exhibit many different *RTS* values for a given input combination. This is so because the marginal products can be (and usually are) discontinuous. This means the *RTS* obtained from an LP solution may not be a desirable measure of the relative feeding values needed to help specify loan rates.

A more desirable *RTS* can be obtained from a continuous function, preferably one which would specify the *RTS* at various input levels; that is, one which recognizes that the *RTS* is a function of input levels, as well as the output level. We have not followed this procedure. We have, instead, assumed that the *RTS* between corn and other inputs remains constant at all input and output levels.

The *RTS* of barley, grain sorghum, and oats were derived from data available in Hodges (*1*, p. 40). These data give the relative values of the grains compared with corn when fed to various classes of livestock. An aggregate *RTS* was obtained by weighting each value as

Table 2. Price differentials and loan rates for corn, barley, grain sorghum, and oats, 1974/75 crop

Region	Price differentials (U^k_j)				Loan rate with corn minimum at $1.10			
	Corn	Barley	Grain sorghum	Oats	Corn	Barley	Grain sorghum	Oats
	Cents per bushel				*Dollars per bushel*			
1. New England	24.6	18.7	14.9	19.4	1.383	1.053	1.215	0.775
2. New York, Pennsylvania, New Jersey	18.1	10.4	4.5	8.5	1.318	.970	1.111	.666
3. Ohio, Indiana, Illinois	0.0	0.0	0.0	0.0	1.137	.866	1.066	.581
4. Michigan, Wisconsin, Minnesota	−3.7	−10.6	−20.8	−2.6	1.100	.760	.858	.555
5. Iowa, Missouri	−3.7	−.4	−18.5	−1.6	1.100	.862	.881	.565
6. North Dakota, South Dakota	−3.7	−12.5	−20.8	−2.6	1.100	.741	.858	.555
7. Nebraska, Kansas	4.0	−5.6	−14.0	2.2	1.177	.810	.926	.603
8. Virginia, West Virginia, Maryland, Delaware, North Carolina	16.2	9.3	4.0	12.7	1.299	.959	1.106	.708
9. South Carolina, Georgia, Florida	32.1	20.6	16.5	19.3	1.458	1.072	1.231	.774
10. Kentucky, Tennessee	14.2	6.0	−1.7	10.4	1.279	.926	1.049	.685
11. Alabama, Mississippi, Arkansas, Louisiana	21.1	14.2	7.4	19.2	1.348	1.008	1.140	.773
12. Oklahoma, Texas	22.1	10.6	.1	11.5	1.358	.972	1.067	.696
13. Montana, Idaho, Wyoming	45.3	6.8	−1.1	4.2	1.590	.934	1.055	.623
14. Colorado, New Mexico, Arizona, Utah	16.6	4.9	−3.6	10.4	1.303	.915	1.030	.685
15. Washington, Oregon	48.1	44.0	37.8	30.8	1.618	1.306	1.444	.889
16. Nevada, California	57.3	39.9	39.5	42.8	1.710	1.265	1.461	1.009

given by Hodges by the number of grain-consuming animal units (1973) in each class of livestock (7). The resulting *RTS* then reflected both nutritional value and the mix of livestock. The *RTS* derived were as follows:

j	RTS_j (corn for j)	WT_j (lb./bu.)
1 Corn	1.0000	56
2 Barley	.8883	48
3 Sorghum	.9378	56
4 Oats	.8938	32

The *RTS* and the established corn loan rate in region 3 are then combined as follows:

(8) $L^3_j \quad = 1.137/56 \text{ x } (RTS_j) \text{ x } (WT_j), j = 2, 4$

where

L^3_j = loan rate for grain j in region 3

WT_j = weight per bushel for grain j

RTS_j = feeding value of grain j relative to corn (grain 1) in region 3

We then establish loan rates for the remaining regions according to:

(9) $L^k_j \quad = L^3_j + U^k_j, j = 1, 4; k = 1, 16; k \neq 3.$

The application of this procedure provides the loan rates given in table 2. This loan rate structure now contains the required balance between regional supply, demand, and the transportation rate structure—taking into account relative feeding values. The differentials between regions, for individual grains, are maintained so that (within the context of the model) the various regions will be indifferent as to source of the grain.

However, the relationships across grains have been disturbed by the procedure, which has introduced a synthetic difference between corn and the other grains in region 3. This difference is then transmitted to the other regions. For corn-barley we have 1.137 – 0.866 = 0.271 in region 3. Taking region 7 as an example, the total effect of the procedure is 1.177 – 0.810 = 0.367. For region 7 the original differential for corn-barley was 0.096 per bushel, which added to 0.271 gives the 0.367. In other words, the price surface for barley versus corn has been lowered by 27.1 cents per bushel. This shift is due to the assumption that the rates of substitution between grains are the same in all regions. This assumption has been enforced "post solution." An alternative would be to include within the model, perhaps in place of the feed rations, the appropriate regional rates of substitution (by animal type). What we have done is apply an average rate of substitution across all regions. The *RTS* used is not the same as would be devised from the model (for example, the model estimate of the average *RTS* corn for barley is 0.75) but those used are felt to be appropriate.

Summary

A formal structure has been applied to the problem of determining regional price differentials for four feed grains. These differentials are then used to estimate loan support rates. The derived rates satisfy the statutory requirement that supply, demand, transport rates, and relative feeding values be considered when the rates are established. The method presented may be usefully applied to a variety of loan rate situations. In the example presented here we have used a minimum corn support rate of $1.10 per bushel. If it becomes desirable to change the basic support levels, a new loan rate structure can be easily obtained. Naturally, the worth of a new structure would depend upon what factors caused a recalculation to be necessary. If the basic supply, demand, and transportation data used in this study were violated in a new situation, it would be necessary to obtain a new solution for the model.

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Appendix

Origin and destination points and types of feed are shown in tables A-1 to A-4. Data used in the analysis are in tables A-5 to A-8.

Grain supplies. Grains available for feed and export use were developed from estimates of beginning stocks, production, and imports. Estimates of seed, industrial, and food uses of the grains were then subtracted from the total available. Table A-5 shows the U.S. data.

Regional supplies of the grains were than estimated by assuming that the 1974/75 regional distribution would be the same as in 1973. These data are shown in table A-6.

Total feed requirements. Details concerning the method for estimating feed requirements may be found in (*2*). Basically the method was to calculate the quantity of high protein feed needed to pass an animal (or poultry) from one growth stage to another. This method requires estimates of the number of animals on feed, at various stages. For this analysis we estimated the number for the United States and allocated this to regions according to the distribution in 1971. Table A-7 shows the regional distribution of feed requirements.

Export requirements. Estimates of U.S. exports of the feed grains were obtained (A-5) and allocated to export points according to the export distribution in 1971. The allocated export quantities are shown in table A-8.

Transportation rates. Transport costs for point-to-point shipments of the grains were provided by the Agricultural Stabilization and Conservation Service. These rates were effective January 1973.

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Transportation rates. Transport costs for point-to-point shipments of the grains were provided by the Agricultural Stabilization and Conservation Service. These rates were effective January 1973.

Table A-1. Domestic regions with origin and destination points

Region	Ingredient	Origin point	Destination point
(1) Maine	Corn	Keene, N.H.	Keene, N.H.
New Hampshire	Barley	Keene, N.H.	Keene, N.H.
Vermont	Sorghum	Keene, N.H.	Keene, N.H.
Connecticut	Oats	Keene, N.H.	Keene, N.H.
Rhode Island			
Massachusetts			
(2) New York	Corn	Oneonta, N.Y.	Oneonta, N.Y.
New Jersey	Barley	Oneonta, N.Y.	Oneonta, N.Y.
Pennsylvania	Sorghum	Oneonta, N.Y.	Oneonta, N.Y.
	Oats	Oneonta, N.Y.	Oneonta, N.Y.
(3) Ohio	Corn	Bloomington, Ill.	Anderson, Ind.
Indiana	Barley	Bedford, Ind.	Bellefontaine, Ohio
Illinois	Sorghum	Centralia, Ill.	Anderson, Ind.
	Oats	Marion, Ind.	Anderson, Ind.
(4) Michigan	Corn	Mankato, Minn.	Mankato, Minn.
Wisconsin	Barley	Detroit Lakes, Minn.	Wisconsin Dells, Wis.
Minnesota	Sorghum	Detroit Lakes, Minn.	Lansing, Mich.
	Oats	Willmar, Minn.	Lansing, Mich.
(5) Iowa	Corn	Ames, Iowa	Ames, Iowa
Missouri	Barley	Waterloo, Iowa	Columbia, Mo.
	Sorghum	Sedalia, Mo.	Columbia, Mo.
	Oats	Waterloo, Iowa	Ames, Iowa
(6) North Dakota	Corn	Valley City, N. Dak.	Mitchell, S. Dak.
South Dakota	Barley	Aberdeen, S. Dak.	Aberdeen, S. Dak.
	Sorghum	Gregory, S. Dak.	Gregory, S. Dak.
	Oats	Huron, S. Dak.	Mitchell, S. Dak.
(7) Nebraska	Corn	Topeka, Kans.	Columbus, Neb.
Kansas	Barley	North Platte, Neb.	North Platte, Neb.
	Sorghum	Great Bend, Kans.	Great Bend, Kans.
	Oats	Norfolk, Neb.	Columbus, Neb.
(8) Virginia	Corn	Rocky Mt., N.C.	Fayetteville, N.C.
West Virginia	Barley	Winston Salem, N.C.	Fayetteville, N.C.
Maryland	Sorghum	Charlotte, N.C.	Fayetteville, N.C.
Delaware	Oats	Durham, N.C.	Fayetteville, N.C.
North Carolina			
(9) South Carolina	Corn	Cordele, Ga.	Macon, Ga.
Georgia	Barley	Macon, Ga.	Macon, Ga.
Florida	Sorghum	Cordele, Ga.	Macon, Ga.
	Oats	Macon, Ga.	Macon, Ga.
(10) Kentucky	Corn	Paris, Tenn.	Murfreesboro, Tenn.
Tennessee	Barley	Nashville, Tenn.	Murfreesboro, Tenn.
	Sorghum	Nashville, Tenn.	Murfreesboro, Tenn.
	Oats	Murfreesboro, Tenn.	Murfreesboro, Tenn.
(11) Alabama	Corn	Hoxie, Ark.	Little Rock, Ark.
Mississippi	Barley	Hoxie, Ark.	Little Rock, Ark.
Arkansas	Sorghum	W. Memphis, Ark.	Little Rock, Ark.
Louisiana	Oats	Pine Bluff, Ark.	Little Rock, Ark.

Continued

Table A-1. Domestic regions with origin and destination points (Continued)

Region	Ingredient	Origin point	Destination point
(12) Oklahoma	Corn	Waco, Texas	Oklahoma City, Okla.
Texas	Barley	Wichita Falls, Tex.	Oklahoma City, Okla.
	Sorghum	Lubbock, Tex.	Lubbock, Tex.
	Oats	Enid, Okla.	Oklahoma City, Okla.
(13) Montana	Corn	Miles City, Mont.	Casper, Wyo.
Idaho	Barley	Havre, Mont.	Casper, Wyo.
Wyoming	Sorghum	—	Casper, Wyo.
	Oats	Lewiston, Mont.	Twin Falls, Idaho
(14) Colorado	Corn	Spring Valley, Ariz.	Denver, Colo.
New Mexico	Barley	Boulder, Colo.	Denver, Colo.
Arizona	Sorghum	LaJunta, Colo.	Provo, Utah
Utah	Oats	Salida, Colo.	Boswell, N. Mex.
(15) Washington	Corn	Bend, Oreg.	Ellensburg, Wash.
Oregon	Barley	The Dalles, Oreg.	Ellensburg, Wash.
	Sorghum	—	Bend, Oreg.
	Oats	The Dalles, Oreg.	Bend, Oreg.
(16) Nevada	Corn	Tracey, Calif.	Fresno, Calif.
California	Barley	Carson City, Nev.	Fresno, Calif.
	Sorghum	—	Fresno, Calif.
	Oats	Carson City, Nev.	Fresno, Calif.

Table A-2. Designated export points for all ingredients

Export point	Location
1	Superior, Wis.
2	Chicago, Ill.
3	Toledo, Ohio
4	Philadelphia, Pa.
5	Norfolk, Va.
6	New Orleans, La.
7	Houston, Tex.
8	San Francisco, Calif.
9	Portland, Oreg.

Table A-3. Feed types used in the analysis

Feed number	Description
1 (Dairy)	Dairy—mature
2	Dairy replacement
3 (Beef)	Beef—700#
4	Beef—above 700#
5	Swine—breeding herd
6 (Swine)	Swine—starter
7	Swine—grower
8	Swine—finish
9	Chickens—layers
10	Chickens—raised to 6 weeks
11	Chickens—raised to finish
12 (Poultry)	Turkeys—breeding
13	Turkeys—0-6 weeks
14	Turkeys—6-18 weeks
15	Turkeys—18+ weeks
16 (Sheep)	Sheep—fed/on feed

Table A-4. Ingredients

Ingredient number	Ingredient description
Included directly:	
1	Corn
2	Barley
3	Sorghum
4	Oats
Included indirectly:	
5	Wheat
6	Rye
7	Soybean meal
8	Cottonseed meal Ex. 41
9	Cottonseed meal S. 41
10	Cottonseed meal Ex. 44
11	Fishmeal Her.
12	Fishmeal Men.
13	Fishmeal Per.
14	Corn gluten meal
15	Corn gluten feed
16	Corn fermented solubles
17	Meat meal 55
18	Meat and bone meal 50
19	Feather meal
20	Poultry byproduct
21	Animal fat
22	Vegetable and animal fat
23	Cane molasses
24	Urea
25	Dry skim milk
26	Dry whey

Table A-5. Estimated U.S. aggregate supplies available for feed, export, and carryover for corn, barley, grain sorghum and oats, 1974/75 crop year

Item	Corn	Barley	Grain sorghum	Oats	Total
			1,000 tons		
Beginning stocks	12,684	3,216	2,128	4,176	22,204
Production	172,200	8,928	22,876	11,712	215,716
Imports	28	360	0	32	420
Total available	184,912	12,504	25,004	15,920	238,340
Food, industrial, seed	12,180	3,744	224	1,488	17,636
Expected carryover	18,032	2,184	140	3,760	24,116
Expected exports	32,200	1,844	5,600	480	40,124
Expected feed use	122,500	4,656	19,040	10,192	156,388
Available for carryover, feed, export	172,732	8,760	24,780	14,432	220,704
Available for feed and export	154,700	6,576	24,640	10,672	196,588

Source: Derived from (4).

Table A-6. Estimated regional distribution of feed grain production, 1974/75 crop

Region	Corn	Barley	Sorghum	Oats
	1,000 bushels			
1	0.0	0.0	0.0	2,125.1
2	125,458.9	6,993.4	0.0	48,585.3
3	1,935,640.9	1,220.9	6,000.3	79,115.3
4	896,781.3	36,032.1	0.0	292,763.0
5	1,566,531.1	369.0	30,897.1	88,308.5
6	166,273.0	107,754.6	10,645.7	236,933.7
7	763,092.9	3,842.0	338,734.6	35,435.1
8	245,464.5	11,145.6	5,023.3	10,682.4
9	129,462.6	1,286.3	1,648.8	9,204.0
10	130,499.0	2,016.3	2,682.4	2,261.3
11	40,770.9	0.0	9,135.0	7,566.9
12	75,027.4	9,686.4	422,968.9	47,016.7
13	6,033.3	94,327.7	—	21,125.7
14	52,214.4	26,170.9	38,280.7	3,422.2
15	8,766.1	22,288.0	0.0	11,060.3
16	26,977.0	41,866.9	18,983.2	6,394.3
Total	6,169.000.0	365,000.0	885,000.0	902,000.0

Table A-7. Estimated regional feed requirements, by type of livestock, 1974/75

Region	Dairy	Beef	Swine	Poultry	Sheep	Total
			Million tons			
1	0.84	0.00	0.09	1.47	0.00	2.40
2	3.43	.54	.64	2.67	.02	7.29
3	1.94	4.17	12.45	2.75	.23	21.53
4	6.63	4.21	5.61	3.13	.49	20.06
5	1.54	11.09	17.58	1.69	.25	32.15
6	.61	2.87	2.39	.39	.32	6.58
7	.67	17.42	5.00	.55	.36	23.99
8	1.08	0.00	2.37	6.11	0.00	9.57
9	.82	0.00	2.09	6.38	0.00	9.29
10	1.14	0.00	1.86	.84	0.00	3.83
11	1.03	0.00	1.60	10.07	0.00	12.70
12	1.01	12.66	1.29	2.48	.56	18.00
13	.42	2.03	.41	.02	.51	3.40
14	.50	10.92	.50	.42	1.05	13.39
15	.58	1.40	.17	.83	.17	3.15
16	1.71	6.37	.16	4.05	.21	12.50
Total	23.95	73.66	54.20	43.84	4.17	199.83

Table A-8. Estimated regional distribution of feed grain exports, 1974/75

Region	Corn	Barley	Sorghum	Oats
	1,000 bushels			
1	100,881.5	0.0	0.0	0.0
2	81.625.8	30,767.8	0.0	25,750.6
3	87,462.7	0.0	0.0	0.0
4	53,237.0	0.0	0.0	0.0
5	102,014.7	0.0	0.0	0.0
6	704,398.5	2,785.9	11,342.4	4,249.4
7	20,379.6	3,150.7	179,019.8	0.0
8	0.0	0.0	9,637.8	0.0
9	0.0	43,295.6	0.0	0.0
Total	1,150,000.0	80,000.0	200,000.0	30,000.0

Table A-9. Model solution: Estimated feed ingredient use by specified types of livestock, United States, 1974/75

Ingredient	Dairy	Beef	Swine	Poultry	Sheep	Total
			1,000 tons			
Corn	12,137.6	40,775.8	36,805.6	22,113.0	2,957.7	114,789.7
Barley	11.9	2,572.6	2,173.5	1,144.3	1,013.3	6,915.6
Sorghum	2,190.6	11,982.8	1,829.5	2,943.0	0.0	18,945.9
Oats	538.8	2,347.3	5,175.4	2,792.9	0.0	10,854.4
Total	14,878.9	57,678.5	45,984.0	28,993.2	3,971.0	151.505.6
Other ingredients	9,071.1	15,981.5	8,216.0	14,846.8	199.0	48,314.4
Total feed ingredient	23,950	73,660	54,200	43,840	4,170	199,830