MARKETING DEHYDRATED ALFALFA

ITED STATES DEPARTMENT OF AGRICULTURE
ricultural Marketing Service
arketing Research Division
in cooperation with the
nsas Agricultural Experiment Station

Marketing Research Report No. 254

PREFACE

This report was prepared by Kansas State College, under contract 12-25-010-13 with the United States Department of Agriculture. Both the contractor and the Department wish to acknowledge the assistance received from the American Dehydrators' Association.

The project was undertaken partly in recognition of the farmer's dual role as a producer of the raw material and buyer of the end product. The farmer, therefore, as well as the producer, benefits from increased efficiency in the industry. Although the dehydrated alfalfa industry has experienced a tremendous growth in volume of production, there is evidence that its marketing mechanism has not developed proportionately. This study was made, therefore, in an effort to establish some criteria of marketing efficiency for the industry. It is part of a continuing program of research designed to reduce the cost of marketing farm products.

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MARKETING DEHYDRATED ALFALFA

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SUMMARY

The dehydrated alfalfa industry has increased its volume of production more than 400 percent since 1943. Production is seasonal, and in the last several years it has fluctuated from year to year.

The price of dehydrated alfalfa has shown a general upward trend in the last 15 years, although the average annual price has declined somewhat since 1951. Seasonally, the price of the product fluctuates widely in comparison with that of other feed ingredients.

Alfalfa for processing is generally purchased by the ton, dry weight, and on a cutting-to-cutting basis. The price for it depends somewhat on the current market prices of dehydrated alfalfa and of baled hay. On an average, the crop from about 1,300 acres of alfalfa land was used by each dehydrating plant in 1954.

Dehydrator operators do practically all their own harvesting of the crop. This requires much harvesting equipment in addition to processing equipment. During the busiest part of the producing season, an average of approximately 27 workers and 2 supervisors per plant are needed for all operations. Only a few dehydrating firms have a full-time sales employee.

In 1954, specialized storage facilities were available for only 700 tons of dehydrated alfalfa per plant, and ordinary storage facilities for about 1,300 tons per plant.

More than half of the dehydrated alfalfa produced in 1954 was shipped as soon as it was processed. Practically all of the product goes to feed manufacturers, either directly or through brokers. With few exceptions, middlemen who handle dehydrated alfalfa do not specialize in the product; it constitutes only a small part of their total volume of business. Brokerage charges amount to an average of $0.75 to $1.00 per ton.

The dehydrated alfalfa industry has few buyers and few sellers. Thus the environment is one in which individual buyers or sellers can influence price. Product differentiation, advertising, and a basing-point system of pricing are used in the industry.

The demand for dehydrated alfalfa, as well as the supply, changes seasonally. Both demand and supply are at their peak during the early summer. At this time demand is fairly constant even if prices vary, and supply tends to change in response to price changes. Depressed prices may result from the eagerness of dehydrator operators to sell.

The winter condition of supply and demand is practically reversed from that of summer. Other seasons are characterized by gradations between the two extremes, thus accounting for the considerable seasonality of price.

HISTORY

Alfalfa was introduced into the United States during the Colonial period, but with little success. About 1850 seed was brought from Chile to the Pacific Coast, where it was successfully grown. Cultivation of the crop then spread eastward. In 1857, seed from Baden, Germany, was imported into Minnesota by Wendell Grimm (18). 1/

Chopped Alfalfa

The alfalfa meal industry may be considered as having its beginning in 1903. That year, Otto Weiss of Wichita, Kans., began to grind alfalfa hay for use in commercial feed mixes (18). Later, M. C. Peters of Omaha, Nebr., included alfalfa meal in a mixed horse feed that became famous in the South, and the Alfalfa Meal Co. of Omaha advertised that its feed contained alfalfa (9). During this period, also, Floyd Wilson built the first complete alfalfa grinding plant at Hartman, Colo., thus beginning the Denver Alfalfa Milling Co., which was the first to label meal with a guarantee of protein and fiber (23). In 1905, when there were 10 or 12 alfalfa feeds on the market, the Purina Mills came out with the statement, "Alfalfa feeds are here to stay because they are giving satisfaction to farmers" (23). These feeds met popular favor and resulted in an increased demand for alfalfa mixtures. The industry was urged to produce a more uniform product, with color being an important factor. As a result, artificial drying was attempted.

Dehydrated Alfalfa

The first dehydrating plant in this country was built in Louisiana in 1910. However, dehydration did not develop on a commercial scale until the 1930's. In 1931 the first dehydrator west of the Mississippi and probably the second of commercial value in the United States, began to operate in Kansas (1).

PURPOSE OF STUDY

The general objective of the study was to determine some criteria of marketing efficiency for the dehydrated alfalfa industry. All stages of handling

1/ Underscored figures in parentheses refer to items in Literature Cited, p. 77.

and processing were studied, from the procurement of the raw material through first sales of the finished product. Specific subjects of inquiry were: (1) Sources of supply and geographical distribution, types of receivers of the dehydrated product, and location of processing plants; (2) terms and conditions of purchases of alfalfa; (3) terms and conditions of sale, including how and by whom sales of the finished product are financed; (4) size, type, and capacity of the facilities and equipment used for drying, handling, storing, loading, shipping; and processing, in relation to volume produced; and (5) market channels used and services rendered by middlemen in marketing dehydrated alfalfa.

Mail surveys and personal interviews were used to acquire information. Secondary data and the survey results were analyzed as part of the study, to determine (1) trends in production, prices, and use of dehydrated alfalfa and of the leading competing products for livestock feeds, and (2) the degree of competition in the marketing of dehydrated alfalfa, the effectiveness of marketing information available, the number and bargaining power of buyers and sellers, and other factors that affect price making.

NUMBER OF UNITS AND SAMPLE PROCEDURE

Nearly all of the approximately 350 alfalfa dehydrating plants in the country replied to the mail portion of the survey. Managers of 280 plants supplied sufficient information to be included in the analysis.

For the personal interview the United States was divided into 4 regions (fig. 1). The samples were drawn at random. A 25-percent sample from the Southwest and another from the North Central area, a 20-percent sample from the South Central area, and a 35-percent sample from the Northeast made a total of 69 dehydrators. The different percentages were used because of the variations in size of area and in number of dehydrators in the area. Alternates were similarly chosen.

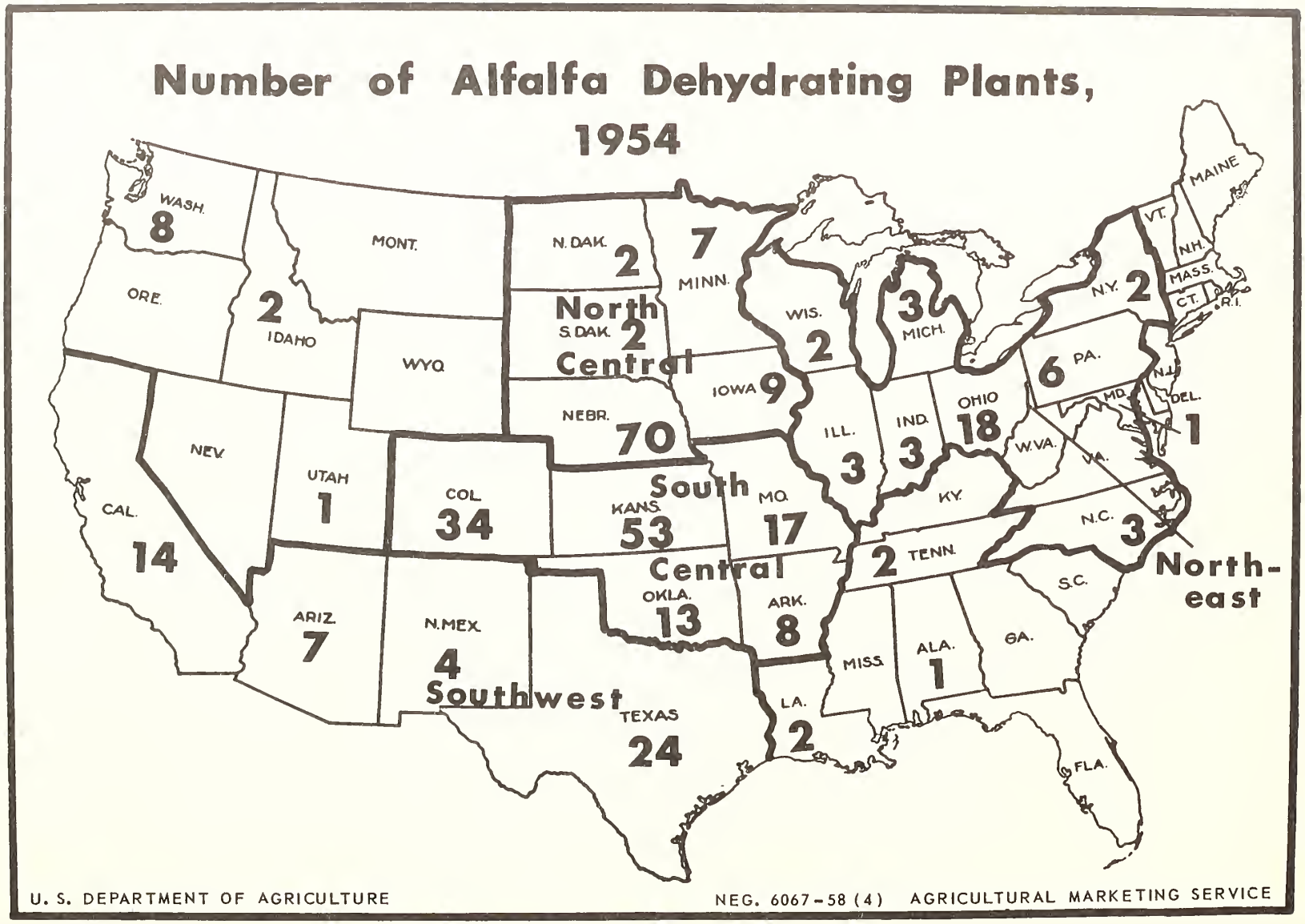
The plants thus selected were visited later, and detailed interview schedules were filled out. The plants by geographic area and by plant size are shown in table 1.

The questionnaires returned by operators showed that there were 60 middlemen associated with the dehydrated alfalfa industry. Five middlemen were randomly selected from each of the 4 regions.

PRODUCTION OF DEHYDRATED ALFALFA

Trend

Production of dehydrated alfalfa has increased steadily since 1944 (fig. 2). During the production year 1943-44 (April through March), 238,000 tons of the product came from dehydrating drums. By 1954-55 production had grown to 1,067,000 tons, an increase of more than 400 percent. In 1955-56, 1,173,200


Number of Alfalfa Dehydrating Plants, 1954
WASH. 8
ORE.
MONT.
2 IDAHO
WYO.
N. DAK. 2
7 MINN.
North Central
S. DAK. 2
NEBR. 70
IOWA 9
WIS. 2
3 MICH.
N.Y. 2
MAINE
VT.
N.H.
MASS.
CT.
R.I.
6 PA.
N.J.
MD.
DEL. 1
NEV.
UTAH 1
COL. 34
KANS. 53
South Central
MO. 17
ILL. 3
IND. 3
OHIO 18
W.VA.
VA.
KY.
N.C. 3
North-east
CAL. 14
ARIZ. 7
N.MEX. 4
Southwest
OKLA. 13
TEXAS 24
ARK. 8
2 TENN.
MISS.
ALA. 1
GA.
S.C.
LA. 2
FLA.
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NEG. 6067-58 (4) AGRICULTURAL MARKETING SERVICE

Figure 1

Table 1.--Sample of alfalfa dehydrating plants, by size and region, 1954

Region	Number of plants		
	Single drum	Multiple drum	Total
Northeast	11	3	14
North Central	11	10	21
South Central	15	7	22
Southwest	5	7	12
United States	42	27	69

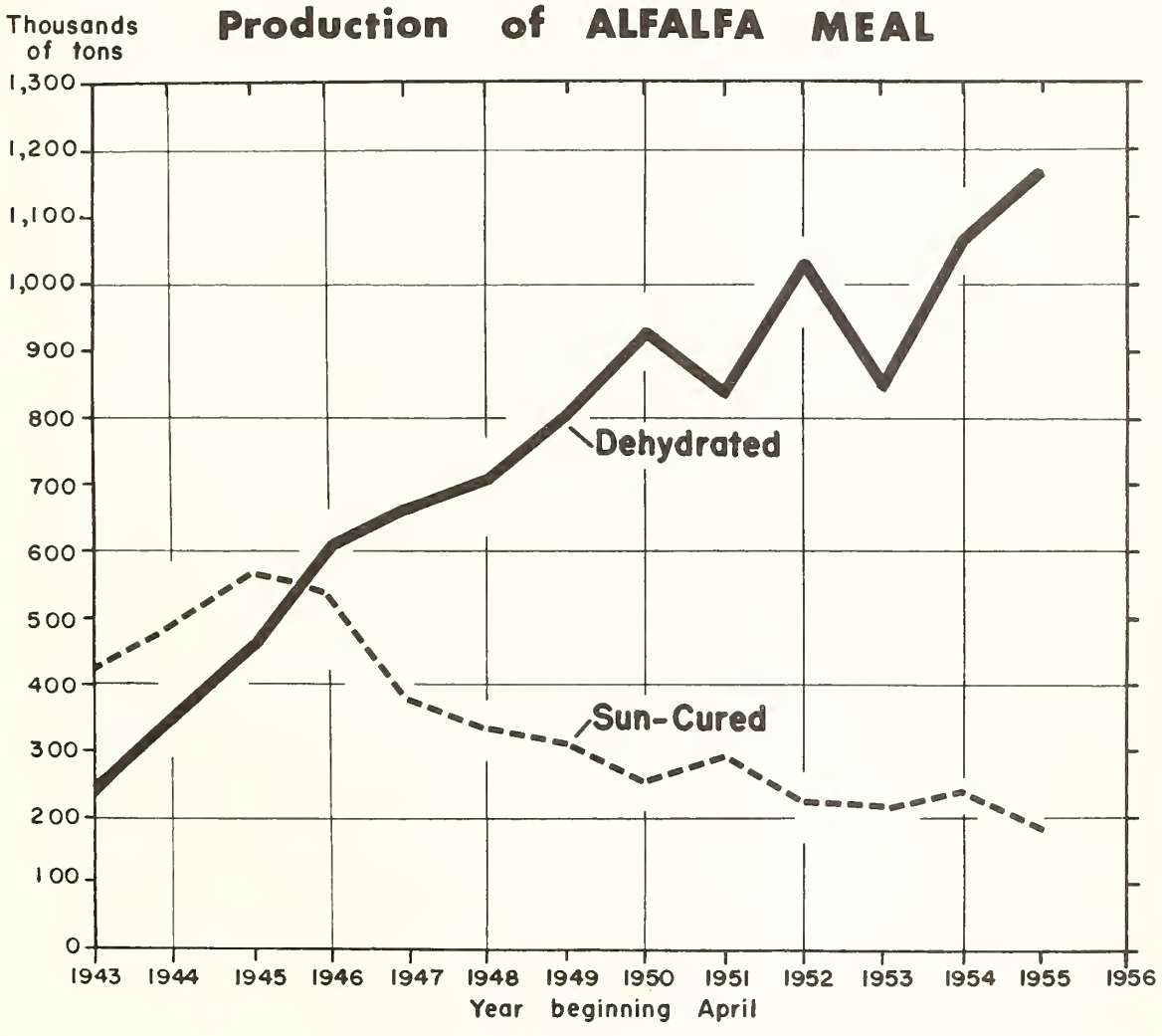

Figure 2

tons were produced in the United States. Production in this 12-month period exceeded that of any previous year.

Production of sun-cured meal, a competing feed ingredient, has declined since 1945. During 1954-55, 236,800 tons of sun-cured meal were produced. From April 1955 to March 1956, 189,800 tons of sun-cured alfalfa meal were produced (table 2).

Table 2.--Production of alfalfa meal, by States, 1954-55 and 1955-56 1/

State	Sun-cured meal		Dehydrated meal		Total	
	1954-55	1955-56	1954-55	1955-56	1954-55	1955-56
	Tons	Tons	Tons	Tons	Tons	Tons
Arizona	2/	2/	16,300	11,500	16,300	11,500
Arkansas	2/	2/	8,100	13,900	8,100	13,900
California	129,600	103,800	120,100	101,000	249,700	204,800
Colorado	24,400	21,000	99,500	108,100	123,900	129,100
Idaho	16,100	14,700	2/	2/	16,100	14,700
Iowa	2/	2/	23,400	32,000	23,400	32,000
Kansas	3,100	2,000	155,100	177,200	158,200	179,200
Michigan	2/	1,100	15,700	18,500	15,700	19,600
Minnesota	2/	2/	19,700	15,400	19,700	15,400
Missouri	2/	2/	59,100	71,800	59,100	71,800
Nebraska	21,600	13,200	334,700	382,300	356,300	395,500
New Mexico	2/	2/	9,200	8,800	9,200	8,800
Ohio	11,500	12,800	67,200	92,000	78,700	104,800
Oklahoma	2/	2/	18,600	19,100	18,600	19,100
Pennsylvania	2/	2/	23,400	24,000	23,400	24,000
Texas	2/	1,900	43,900	34,600	43,900	36,500
Illinois, Indiana, and Wisconsin	2/	2/	16,900	26,400	16,900	26,400
North and South Dakota	2/	9,900	8,700	9,600	8,700	19,500
Washington	2/	2/	9,600	10,300	9,600	10,300
Other States	30,500	9,400	17,800	16,700	48,300	26,100
Total	236,800	189,800	1,067,000	1,173,200	1,303,800	1,363,000

1/ Years refer to production years, April 1 to March 30.
2/ Data for States where production is small or where less than 4 companies operate are not shown separately.

U. S. Dept. Agr., Agr. Mktg. Serv., mimeographed report, April 1956.

Dehydrated alfalfa production by individual plants in 1954 ranged from 120 tons to 27,400 tons. The United States average per plant was 4,161 tons.

Seasonality of Production

Production of dehydrated alfalfa is highly seasonal. Even though California and other Southwestern States enjoy relatively long producing seasons, production in the country as a whole, and especially in northern States such as Nebraska, Kansas, and Colorado, is concentrated into comparatively few months.

An index of seasonal variation was calculated to ascertain the degree of month-to-month variability in production of dehydrated alfalfa. Indexes also were computed for other feed ingredients for purposes of comparison. 2/

The seasonal variation in production of dehydrated alfalfa reaches a high index of 234 in July and falls to a low of 8 in January (fig. 3A). 3/ The months from May through October have indexes of over 100, and 3 of these months (June, July, and August) have indexes of well over 200.

Production of sun-cured alfalfa meal is much less seasonal. The highest index occurs in January at 121, the lowest in May at 67 (fig. 3A).

Production of soybean cake and meal, cottonseed cake and meal, and linseed cake and meal are represented in figure 3B. Within this group, cottonseed cake and meal has the greatest variation.

For wheat millfeeds, the highest production index occurs in October at 112, and the lowest in April at 90 (fig. 3C). Corn gluten feed and meal has high and low points in March at 107 and July at 94. As both points are close to 100, they indicate a relative lack of seasonality. Production of brewers' dried grains is relatively concentrated in July and August, when the index is 121 in each month; the low is 84 in February. The high and low indexes for distillers' dried grains are 128 in March and 80 in July.

The output of tankage, as well as of meat scraps, is rather evenly distributed throughout the year (fig. 3D). Production of dry or powdered skim milk for animal feed is highly seasonal; the index ranges from a high of 185 in June to a low of 44 in November.

Some 12 feed ingredients were compared with respect to seasonality of production. Only 3 of these exhibit notable peaks or troughs. They are dehydrated alfalfa, cottonseed cake and meal, and dry or powdered skim milk. Of these, production of dehydrated alfalfa has much the greatest seasonal amplitude.

2/ The 13-month moving average was used, and all indexes were based on data reported in Grain and Feed Statistics, U. S. Dept. Agr., 1944-54.

3/ The numerical indexes from which the graphs were drawn are presented in appendix B.

FEEDSTUFFS: PRODUCTION, UNITED STATES, INDEX of SEASONAL VARIATION, 1944-1954

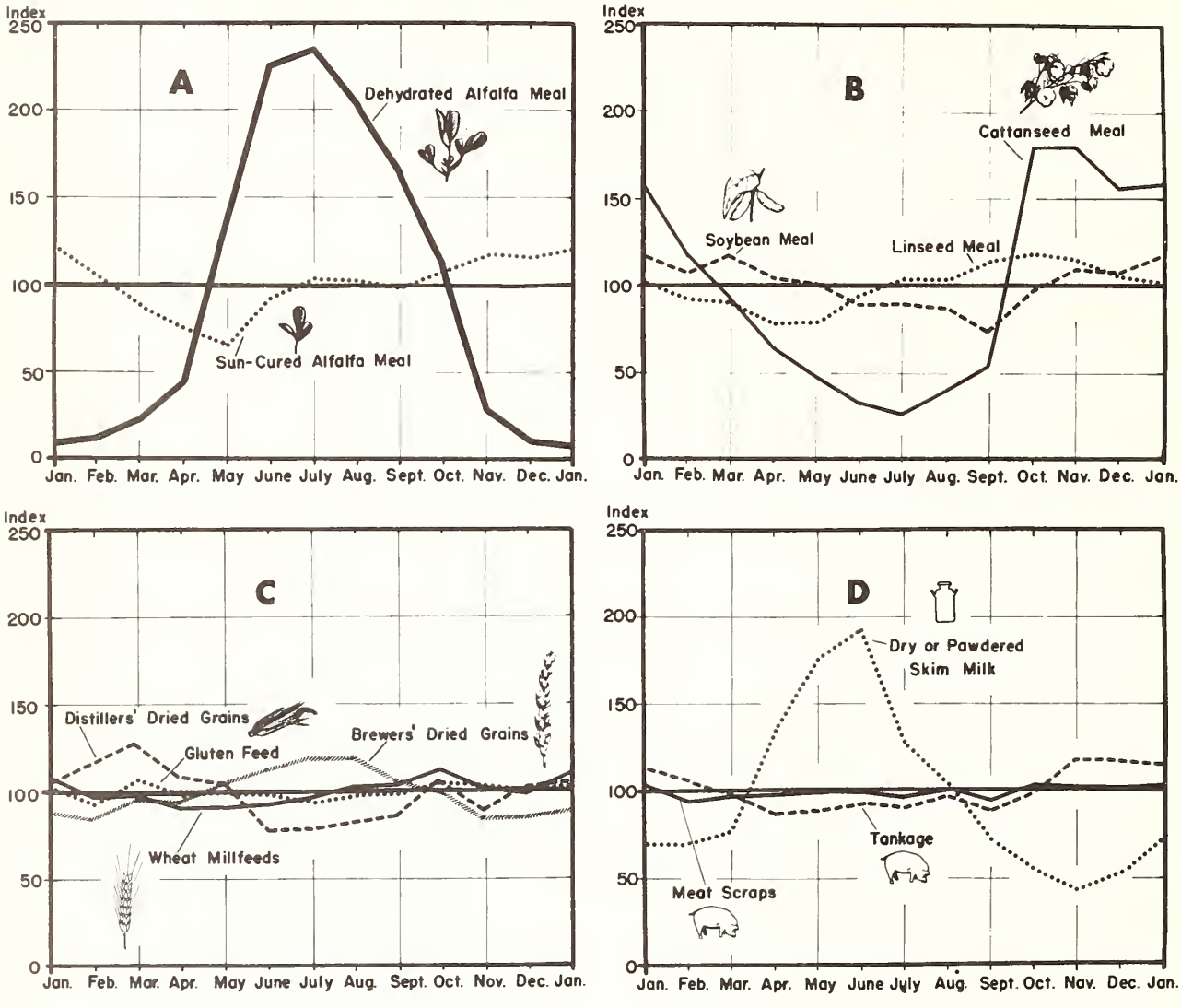

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Figure 3

PRICES OF DEHYDRATED ALFALFA

Generally, wholesale prices for dehydrated alfalfa rose from 1938 to 1955. The average annual price rose steadily from 1938 to 1944. From 1944 to 1947, controls held prices at a relatively even keel. Since 1947, annual average prices have fluctuated from year to year, and since 1951, they have declined. The price relationships (fig. 4) indicate clearly that dehydrated alfalfa has sold for a premium over sun-cured meal.

The price of dehydrated alfalfa fluctuates more than the price of sun-cured alfalfa. The comparison indicates greater instability for producers of the dehydrated product. Producers must meet this problem through expansion of storage facilities and through research on better storage at lower cost. Also, users of dehydrated alfalfa meal need to know when prices favor including it in formulas or rations.

Not only do prices of dehydrated alfalfa fluctuate from year to year, but they also vary widely within each year. The relationship between annual high and low prices is shown as a time series in figure 5, covering the period 1940-1956.

There was not much spread between high and low prices within each year from 1940 to 1945, when controls were in effect (fig. 5). That high and low prices have diverged rather widely since 1945 is another sign of instability within the industry. Part of the solution of the problem lies in cheaper and more widespread usage of storage facilities. More adequate knowledge of production costs would possibly lead operators to resist the low prices.

A more even sales pattern would open up the possibility of paying higher prices to alfalfa producers either by increasing season average prices or by broadening the market. It would also assist in making better balanced feeds available throughout the year.

Prices are lowest during the production season, when the supply of dehydrated alfalfa is at its height during the year. The high prices occur during the winter months when less dehydrated alfalfa is available. The high prices also reflect the addition of storage costs which must be covered in the price of the meal.

Seasonality of Prices

Indexes of seasonal variation in prices were calculated for 10 feed ingredients 4/ including dehydrated alfalfa, sun-cured alfalfa meal, bran, wheat

4/ The seasonal price index is a statistical device used to measure the tendency for prices to repeat during certain seasons of the year. The indexes were computed by using a 13-month moving average. This seemed to offer the best means of removing the nonseasonal elements.

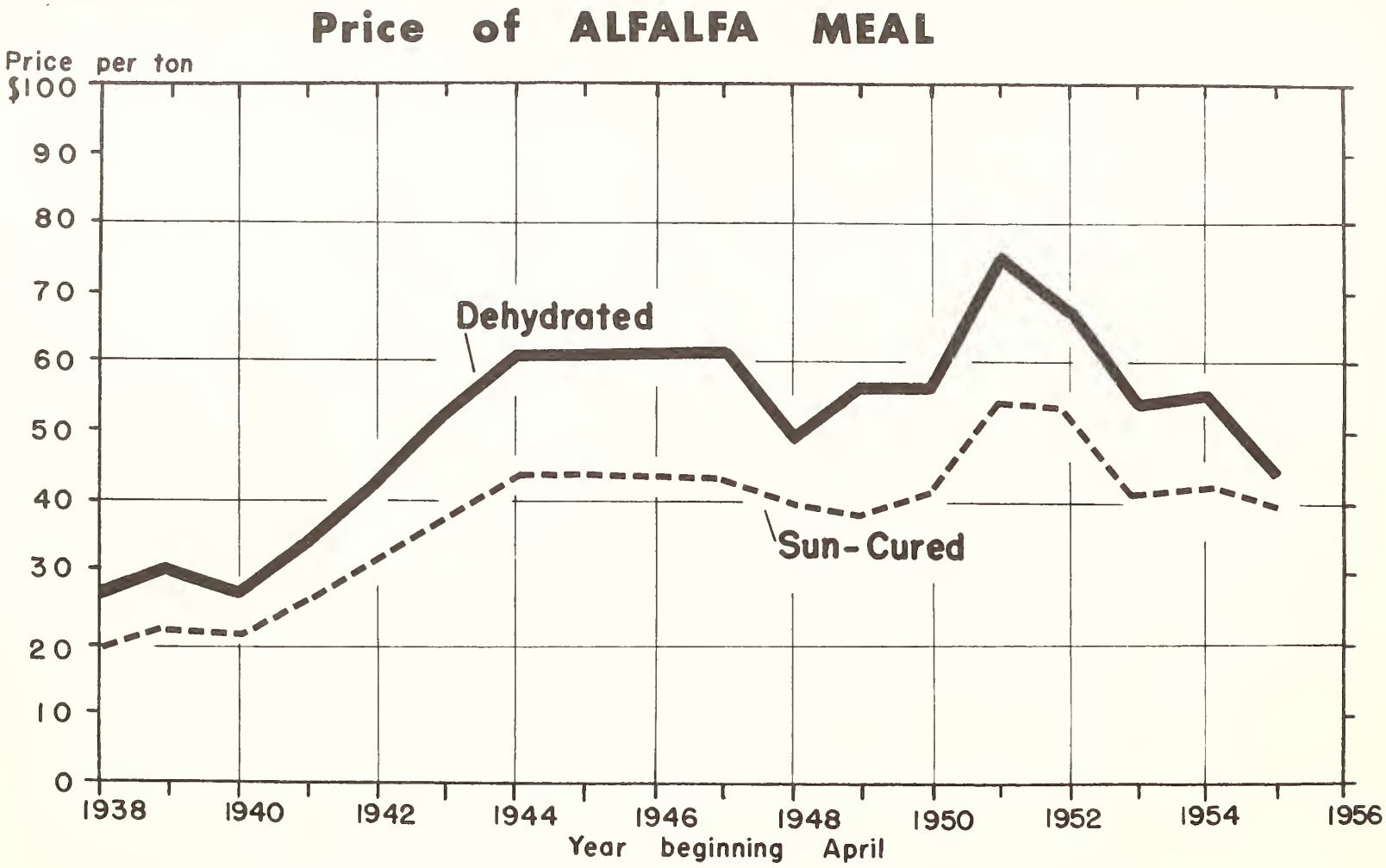

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Figure 4

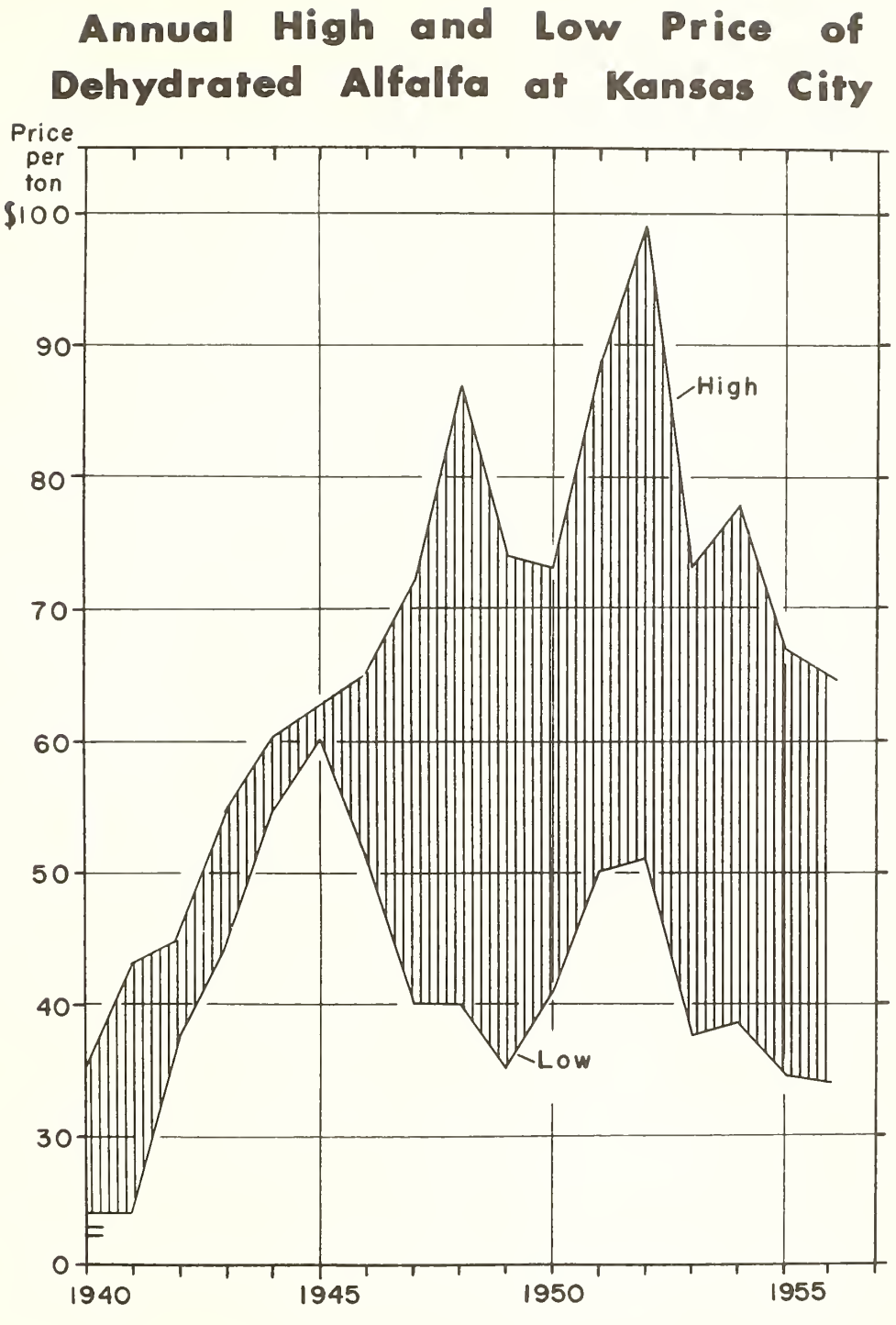
Annual High and Low Price of Dehydrated Alfalfa at Kansas City
Price per ton
$100
90
80
70
60
50
40
30
0
1940
1945
1950
1955
High
Low
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Figure 5

shorts, gluten feed, soybean meal, cottonseed meal, linseed meal, meat scraps tankage, and fish meal. 5/ The indexes cover the period from 1938 to 1955.

Dehydrated alfalfa prices have a great seasonal movement, the index reaching a high of 110 in January and a low of 86 in June (fig. 6A). 6/ The high and low indexes for sun-cured alfalfa meal are 105 in November and 92 in June. Sun-cured alfalfa meal prices are relatively high in November, December, and January, coinciding with its highest production period. Prices are low in the summer when activity has somewhat slackened.

Price indexes of soybean, cottonseed, and linseed meals are presented in figure 6B. Among these, linseed meal varies the most, from 107 in January to 95 in June.

The seasonal price variation of bran approaches the amplitude of that of dehydrated alfalfa (fig. 6C). It reaches an index of 111 in April, somewhat higher than dehydrated alfalfa's high of 110 in January. But it falls only to 93 at its lowest point in August compared with dehydrated alfalfa's low of 86 in June. Prices of wheat shorts also have a noticeable peak and trough, 106 in May and 94 in August, but this is much milder than for either dehydrated alfalfa or bran. The other commodity, gluten feed, deviates relatively little from the 100 average.

Prices of tankage range from 104 in January to 94 in June; prices of meat scraps range from 105 in August to 98 in March (fig. 6D). Fish meal prices are high in February, with an index of 104, and low in August with an index of 96.

Month-to-Month Price Relationships

Seasonal indexes are averages, and averages hide certain relationships. They do not, for example, indicate how many times and in what direction prices change from one month to another. There is, however, some advantage to the seller or buyer of dehydrated alfalfa in knowing what is likely to happen in month-to-month prices.

5/ The dehydrated alfalfa prices were obtained from reports of the Market News Branch, Grain Division, Agricultural Marketing Service, U. S. Department of Agriculture. The other product prices (except fish meal quotations) were found in the Kansas City Grain Market Review of the Kansas City (Mo.) Board of Trade. All these, including dehydrated alfalfa, are Kansas City prices. Fish meal prices are for the Buffalo, N. Y., market.

6/ The table from which the graphs are drawn is given in appendix C. The inclusion of the war years in this analysis has a tendency to understate the seasonality of prices because of the influence of price controls during that period.

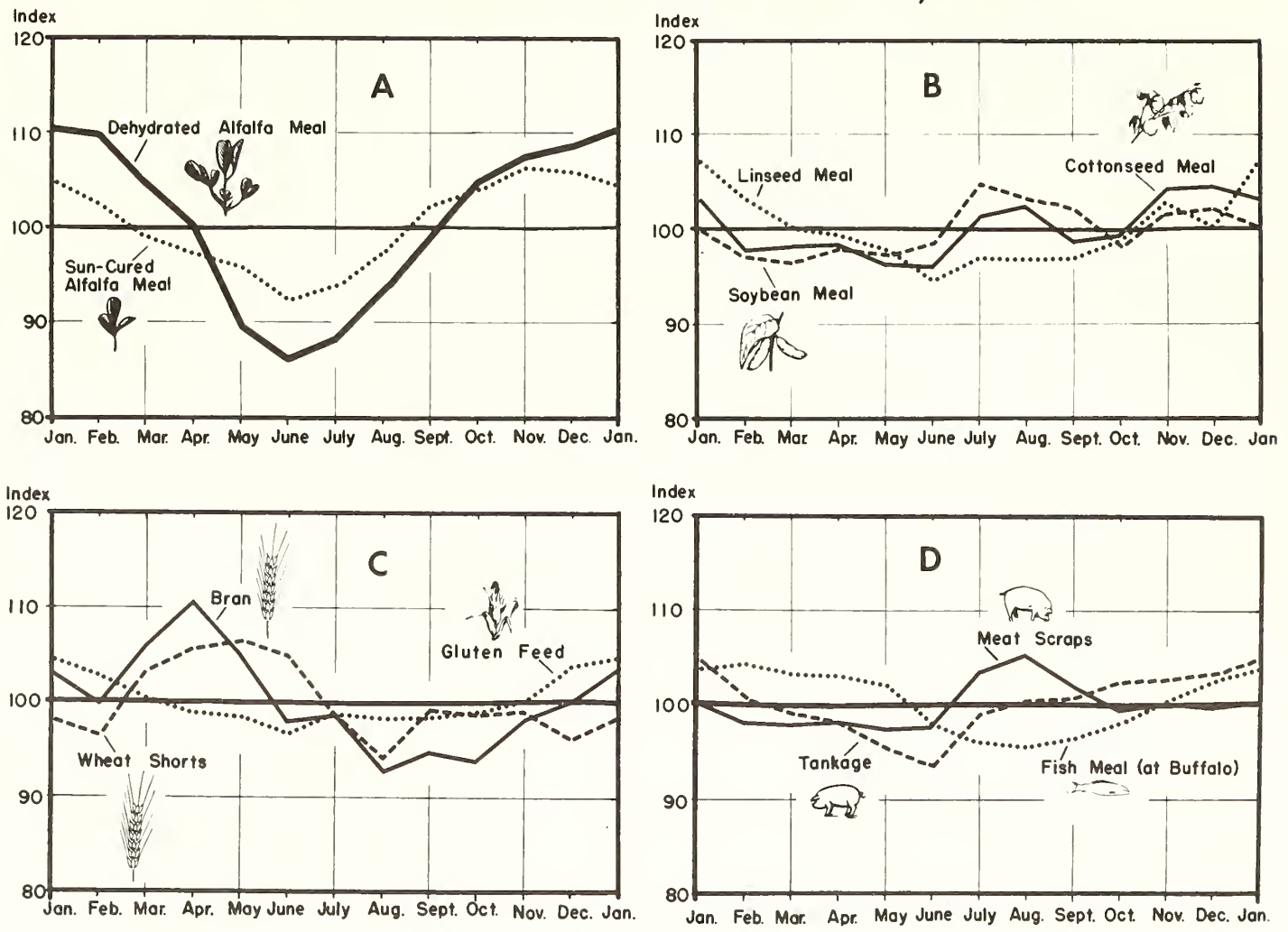
FEEDSTUFFS: KANSAS CITY WHOLESALE PRICE PER TON, INDEX of SEASONAL VARIATION, 1938-1955
Index
120
110
100
90
80
A
Dehydrated Alfalfa Meal
Sun-Cured Alfalfa Meal
Jan. Feb. Mar. Apr. May June July Aug. Sept. Oct. Nov. Dec. Jan.
B
Linseed Meal
Cottonseed Meal
Soybean Meal
C
Bran
Gluten Feed
Wheat Shorts
D
Meat Scraps
Tankage
Fish Meal (at Buffalo)
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Figure 6

The percentage of times during the period 1938-56 that prices have been higher after a given or base month is summarized in table 3. To use the table, locate the base month in the first column, then read over to the subsequent month's column on the same line. For example, if it is desired to find out how frequently prices have moved upward from January to February, locate January under the base month column, then follow the line to the figure under the February column. In this case, the number is 39, which means that 39 percent of the time prices have been higher in February than in January. In similar fashion it is found that May prices have never been higher than April prices; that August prices have been higher than July prices 63 percent of the time.

The use of this table is not confined merely to finding how one month compares with the month immediately succeeding it. Comparison may be made with respect to any 2 months of the year, or for the same month in successive years. Thus, it may be found that October prices have been higher than the preceding January price 61 percent of the time or that July prices have exceeded March prices only 11 percent of the time. Moreover, it is shown that January prices have been higher than those during January of the preceding year 65 percent of the time.

Tables 4 and 5 show the percentage of times that prices have remained the same or have gone down. These two tables are read in the same way as table 3.

In table 4, for example, April prices were below those of March 56 percent of the time. Table 5 indicates that April had the same price as March 22 percent of the time.

An operator who has dehydrated alfalfa in storage the first of March should be interested in knowing what his prospects are for a better price if he waits for later sale. He will find from these tables that prices in April have been higher than in March 22 percent of the time, lower 56 percent of the time, and the same 22 percent of the time. On an average, his chances for realizing a gain by waiting a month to sell do not appear very bright. Of course, the average may not hold, so judgment as to the proper course of action will be conditioned by the situation peculiar to the year involved.

The tables indicate that May prices have never been higher than April's and that October prices have never been lower than September's of the same year. There is no guarantee that these relationships will always hold. The tables show only that they have held in the past.

The tables also have some analytical uses. The figure for the base month and for the same month in the following year (e.g., from January to January) will show price advances most of the time. For example, January prices have advanced 65 percent of the time from the January of the preceding year. A rather significant number of price rises are indicated for months having a high seasonal index. At the other extreme, May prices have increased over the previous May only 39 percent of the time, and they have declined from the previous May 50 percent of the time. These data suggest that there has been a year-to-

Table 3.--Dehydrated alfalfa meal, 17 percent protein, Kansas City, Mo.: Percentage of times price went up from base month to subsequent months, 1938-1956

Base month	Subsequent months																					
	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.
April	0	5	21	26	42	53	56	56	61	56	56	56											
May		21	37	47	68	84	83	89	89	83	78	67	39										
June			58	68	79	89	89	94	94	89	83	72	50	50									
July				63	79	95	94	94	89	89	83	72	56	39	56								
August					74	95	94	94	94	89	78	67	39	22	28	56							
September						84	89	89	89	83	72	56	28	22	28	44	61						
October							67	78	78	56	44	28	11	11	33	28	50	67					
November								67	61	56	33	22	11	11	17	22	50	67	65				
December									56	44	33	22	11	11	17	22	44	61	59	59			
January										39	6	17	6	11	11	22	44	61	59	59	65		
February											0	11	0	6	11	11	50	56	53	53	59	53	
March												22	0	6	11	28	50	56	53	59	59	59	53

Table 4.--Dehydrated alfalfa meal, 17 percent protein, Kansas City, Mo.: Percentage of times price went down from base month to subsequent months, 1938-1956

Base month	Subsequent months																							
	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	
April	68	74	63	63	53	42	39	39	33	33	39	39												
May		58	47	42	26	11	6	6	6	6	17	22	50											
June			26	21	16	0	0	0	0	6	11	22	39	44										
July				21	16	0	0	0	6	6	11	22	33	50	39									
August					21	0	0	0	0	6	17	28	56	72	67	39								
September						0	0	0	0	6	17	33	61	67	61	50	39							
October							11	6	6	28	33	50	72	78	61	61	50	33						
November								6	17	22	44	61	72	78	72	67	50	33	35					
December									11	33	50	61	72	78	72	72	56	39	41	41				
January										33	67	67	78	78	78	72	56	39	41	41	35			
February											67	67	78	78	78	78	44	39	41	41	35	41		
March												56	78	78	72	56	44	39	41	35	35	35	41	

Table 5.--Dehydrated alfalfa meal, 17 percent protein, Kansas City, Mo.: Percentage of times price of base month was the same in subsequent months, 1938-1956

Base month	Subsequent months																							
	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	
April	32	21	16	11	5	5	6	6	6	11	6	6												
May		21	16	11	5	5	11	6	6	11	6	11	11											
June			16	11	5	11	11	6	6	6	6	6	11	6										
July				16	5	5	6	6	6	6	6	6	11	11	6									
August					5	5	6	6	6	6	6	6	6	6	6	6								
September						16	11	11	11	11	11	11	11	11	11	6	0							
October							22	17	17	17	22	22	17	11	6	11	0	0						
November								28	22	22	22	17	17	11	11	11	0	0	0					
December									33	22	17	17	17	11	11	6	0	0	0	0				
January										28	28	17	17	11	11	6	0	0	0	0	0			
February											33	22	22	17	11	11	6	6	6	6	6	6		
March												22	22	17	17	17	6	6	6	6	6	6	6	

year tendency for prices to increase. This is especially true of the months with high seasonal price indexes. For some months having low seasonal indexes, price advances have not been as frequent as price declines. The result has been an increase in the range of yearly high and low prices, or in other words, an increase in seasonal variation.

DISTRIBUTION, SIZE, AND OWNERSHIP OF PLANTS

Geographic Distribution

The dehydrated alfalfa industry is centered in the Midwest. Nebraska has the largest number of plants, followed by Kansas and Colorado (fig. 1). The heaviest concentration of plants is in Dawson County, Nebr., where some 56 drums were operating in 1955. 7/ In all 3 States plants are generally located along the river valleys near the alfalfa supply.

During the production year 1954-55 (April-March), 1,067,000 tons of dehydrated alfalfa were produced in the United States (table 2). This was an increase of 226,300 tons over the previous production period. The 1954-55 production for Nebraska was 334,700 tons, 31 percent of total United States production. Kansas produced 155,100 tons, 14 percent of the total, and California 120,100 tons, 11 percent of the total. Thus these 3 States combined accounted for more than 57 percent of total United States production of dehydrated alfalfa, and the 4 leading States produced more than two-thirds of all the dehydrated alfalfa.

Nearly half the plants in the United States are in Nebraska, Kansas, and Colorado. Other concentrations of dehydration plants are in northwestern Ohio, northeastern Arkansas, southeastern Missouri, and southern California. A few plants are located in 22 other States.

Capacities of Plants

The 69 plants visited had 24-hour dehydrating capacities ranging from 14 to 125 tons (table 6). The average 24-hour capacity for all plants in the sample was 39.9 tons. This was composed of an average of 30.8 tons for the 42 single-drum firms and of 61.3 tons for the 27 multiple drum plants.

The maximum capacity reported among single-drum plants exceeds the maximum reported among multiple-drum plants in the South Central region, i.e., 85 tons as against 70 tons. The plant reporting this capacity had a large drum, however, which evaporated twice as much moisture per hour as most of the drums reported. It was included as a single-drum establishment.

There are many reasons for the existence of such a range of capacities. Among the larger plants, the number of drums operating would account for some of the differences. Drums also differ in their rated capacity. Other

7/ Interview, J. J. Dillard, manager, Nebraska Alfalfa Farms, Darr, Nebr.

Table 6.--Average and range of capacities of 69 plants surveyed, and type of plant, 1954

Region and type of plant	24-hour capacity		
	Average	Range of capacities	
		Maximum	Minimum
	Tons	Tons	Tons
Northeast:			
Single drum	29.1	50	14
Multiple drum	70.0	90	40
All plants	39.1	90	14
North Central:			
Single drum	32.0	50	20
Multiple drum	60.8	100	40
All plants	45.7	100	20
South Central:			
Single drum	31.0	85	20
Multiple drum	56.4	70	40
All plants	39.1	85	20
Southwest:			
Single drum	27.8	30	24
Multiple drum	63.0	125	38
All plants	48.3	125	24
United States:			
Single drum	30.8	85	14
Multiple drum	61.3	125	38
All plants	39.9	125	14

differences may arise from the kind of forage involved, moisture content, the condition of the air entering the dehydrator, and the fineness and uniformity of chopping.

The capacity of a drier is frequently described in terms of tons of dried material delivered per hour. This method gives an indication only of the tonnage that may be expected under certain conditions. It may be misleading unless reference is made also to the initial moisture content. Most dehydrators now in use are rated by the manufacturer to evaporate 6,000 to 12,000 pounds of water per hour from material passing through. As moisture content of alfalfa differs according to the season and to the time of day at which it is cut, a given capacity will produce varying amounts of dried material. Two examples may help to make this point clear.

The weight of uncured alfalfa necessary to produce a ton of dehydrated alfalfa may be obtained from the formula:

$$\frac{\text{Pounds of dry material in a ton of dehydrated alfalfa}}{1 - \text{moisture content of cut alfalfa}} = \text{Total pounds of alfalfa needed to produce a ton of dehydrated alfalfa}$$

If, then, it is desired to produce dehydrated alfalfa having 8 percent of moisture, and the alfalfas we begin with have moisture contents of 70 and 55 percent, the following relationships evolve:

(a) $\frac{1840}{.30}$ = 6,133 pounds of alfalfa of 70-percent moisture; and

(b) $\frac{1840}{.45}$ = 4,089 pounds of alfalfa of 55-percent moisture.

In (a), 6,133 - 2,000 = 4,133 pounds of water which must be removed to obtain a ton of dehydrated alfalfa with 8 percent moisture content, and in (b), 4,089 - 2,000 = 2,089 pounds of water which must be removed to obtain the same product. A drum having an evaporative capacity of 6,000 pounds would require a little more than 41 minutes to produce a ton of dehydrated alfalfa from alfalfa containing 70 percent of moisture, and somewhat less than 21 minutes to produce a ton from alfalfa containing 55 percent of moisture. In part, at least, some of the regional differences shown in table 6 may be due to variations in moisture.

Average Production Per Plant

The average production for all plants in 1954 was 4,161.7 tons. This was composed of an average of 2,471.8 tons for single-drum plants and 6,790.5 tons for multiple-drum plants (table 7). The two regions which have averages above the national average are strongly influenced by production performances among the multiple-drum units. The North Central area ranks first in both size categories, and for all plants. The Southwest ranks lowest among the regions with respect to its single-unit firms, but ranks second for average production among multiple-drum plants. The Southwest also contains the largest single plant.

Type of Ownership

Almost three-fourths of all the dehydrating plants in the United States are corporately owned. Some 70 percent of plants with a 24-hour dehydrating capacity of 30 tons or less are owned by corporations. Larger installations, with a 24-hour capacity of 31 tons or more, have a corporate ownership of 77 percent. The other types of business organization, such as partnerships, individual proprietorship, and cooperatives, are represented to a much lesser degree (table 8).

Table 7.--Average production of dehydrated alfalfa per plant, by region and type of plant, 1952, 1953, and 1954

Region and type of plant	1952 1/	1953 2/	1954 3/
	Tons	Tons	Tons
Northeast:			
Single drum	1,959.8	2,103.2	2,499.2
Multiple drum	4,015.7	4,371.0	5,391.3
All plants	2,434.2	2,626.5	3,118.9
North Central:			
Single drum	2,614.1	2,329.9	2,845.3
Multiple drum	6,759.5	6,028.3	7,946.1
All plants	4,696.9	4,090.0	5,226.6
South Central:			
Single drum	2,328.6	2,131.9	2,439.6
Multiple drum	4,848.4	4,907.6	5,554.1
All plants	3,366.2	3,103.4	3,430.6
Southwest:			
Single drum	1,932.3	1,768.8	1,686.0
Multiple drum	6,395.5	6,535.3	7,118.4
All plants	4,907.8	4,802.0	4,854.9
United States:			
Single drum	2,267.6	2,142.9	2,471.8
Multiple drum	5,844.4	5,685.1	6,790.5
All plants	3,843.7	3,614.2	4,161.7

1/ 1952 figures based on 59 operating units.
2/ 1953 figures based on 65 operating units.
3/ 1954 figures based on 69 operating units.

The preponderance of corporate ownership would be expected in view of the capital outlay necessary to establish a plant. There may be other considerations also, such as the limited liability attached to corporate ownership.

Cooperatives rank last among the types of ownership represented, being fewer than individually owned plants.

Table 8.--Type of ownership of alfalfa dehydrating plants in the United States, 1954

Capacity of dehydrators in 24 hours	Corporation	Individual	Partnership	Cooperative	Total dehydrators reporting
	Percent	Percent	Percent	Percent	Number
30 tons or less	70	12	16	2	135
31 tons and over	77	6	13	4	155
All dehydrators	74	9	14	3	290

PROCUREMENT OF ALFALFA

Ownership of Alfalfa-Producing Land

Only about 7 percent of the firms own their entire source of supply. The other 93 percent purchase over 70 percent of their crop directly from farmers, own acreage producing 20 percent, and secure the remainder from acreage under leasing arrangements.

There are some distinct variations indicated among geographical regions and between single-drum and multiple-drum plants with respect to the source of alfalfa supply (table 9). A tendency for owned acreage to be higher among the smaller dehydrators may be noted, the one exception being in the Northeast. The Southwestern units own the largest acreage, and those in the South Central region own the smallest.

It is fairly easy to account for some of the differences. Southwestern firms, for example, on an average, own 41 percent of the land supplying their raw material. Percentages for single-drum and multiple-drum units are 82 percent and 32 percent, respectively. In this area, especially in Texas, dehydrating plants are largely an adjunct to some other enterprise, usually to ranching. The smaller dehydrators are more likely to serve an auxiliary purpose than the larger ones. When sufficient capital is raised to erect a multiple-drum plant, it is reasonable to expect that a commercially profitable dehydrating activity is the principal end in view.

The South Central region falls at the other extreme in the level of land ownership. Here only 5 percent of the alfalfa acreage is owned by dehydrating plants, with single-drum units owning 9 percent of their alfalfa supply and multiple-drum plants owning none. There may be several reasons for the low degree of ownership indicated in this area. For one thing, the dehydrating industry is of fairly recent development and perhaps has not had time nor opportunity to acquire extensive land holdings. Most of the plants that do own land appear to have been erected or acquired by local people and to be operated as individual proprietorships or as partnerships.

Table 9.--Ownership of alfalfa acreage and distance from plants, 1954

Region and type of plant	Alfalfa supply obtained from acres--			Alfalfa supply within--			Average number of acres harvested
	Owned	Leased	Other	5 miles	10 miles	Over 10 miles	
	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Acres
Northeast:							
Single drum	14	13	73	48	35	17	885
Multiple drum	8	38	54	55	45	0	1,409
All plants	12	20	68	50	38	12	997
North Central:							
Single drum	15	2	83	59	31	10	844
Multiple drum	17	10	73	64	32	4	2,303
All plants	17	7	76	63	31	6	1,539
South Central:							
Single drum	9	8	83	60	36	4	786
Multiple drum	0	4	96	71	27	2	1,426
All plants	5	6	89	65	32	3	990
Southwest:							
Single drum	82	0	18	96	4	0	836
Multiple drum	32	0	68	51	42	7	2,549
All plants	41	0	59	60	35	5	1,835
United States:							
Single drum	22	7	71	61	30	9	835
Multiple drum	19	8	73	60	36	4	2,081
All plants	21	7	72	61	32	7	1,337

In the North Central area ownership of land is slightly higher for multiple-drum plants (18 percent) than for single-drum plants (15 percent). One possible explanation is that alfalfa is irrigated extensively in the Platte Valley of Nebraska, an important point of industry concentration. Irrigation requires financing, which may be more easily obtained by larger companies.

The practice of leasing is strongest in the Northeast. This is probably a derivative of managerial decision rather than custom.

Acreage Requirements

Dehydrator operators say that they need from 750 to 1,000 acres of alfalfa to supply a single-drum unit. The average number of acres cut in 1954 was 835

by plants with 1 drum and 2,081 by plants with more than 1 drum. The average for all plants was 1,337 acres. The average numbers of acres cut by single- and multiple-drum units for the 4 regions are shown in table 9. The acreage needed depends upon both the dehydration capacity of the plant, and the annual alfalfa yield per acre.

Dehydrator operators over the country purchase alfalfa by the ton, based on the dry weight after dehydration. Only two firms, both in the Northeast, indicated that they did any purchasing at all by the acre. One firm purchased about 50 percent of its alfalfa by the acre, and the other less than 5 percent.

Types of Contracts

Oral contracts.--Most operators bargain for their alfalfa orally and on a cutting-to-cutting basis. Those interviewed suggested that this is a desirable practice because of the risks involved in fluctuations of both yields and prices.

Written contracts.--Written contracts were utilized by only 7 of the 69 plants investigated. These were not enough to establish a pattern for either size or location of plants.

The written instruments themselves vary a great deal. All 7 provide for a price, but similarity ends there. Contracts vary in the extent to which they bind buyer and seller, in duration, in the basis of measure (tonnage or acreage), and in quality and time of payment specified.

These firms write their contracts in the early spring, and usually the price varies for each cutting. The number of cuttings depends upon the length and nature of the growing season. There are several reasons given for this practice, such as that the different cuttings are thought to vary in quality, that the supply of and demand for alfalfa varies, and that the market price of dehydrated alfalfa is subject to change. The usual practice is to set a price for the first cutting at the beginning of the season. The price for the later cuttings is determined at the time of harvesting.

Pricing of Alfalfa

What are the factors that dehydrator operators consider when they are arriving at a price for alfalfa? Responses to this question varied. Some operators indicated that only one factor was involved in their bargaining, but most of them mentioned a combination of factors. Following are conclusions drawn from a summary of the factors reported as receiving consideration.

The price paid for alfalfa was--	Number of firms mentioning
Related to current market price for dehydrated alfalfa	19
Competitive with the price for baled hay	19
In pattern with prices paid by other dehydrator operators	13
Related to expected market price for dehydrated alfalfa	9
Competitive with price paid by other dehydrator operators	8
A result of the supply and demand for alfalfa at each cutting	13
Determined by the supply of alfalfa available	6
Dependent upon expected returns from other crops	6
Dependent upon differences in quality	5
Related to experience in current and previous years	4
Related to cost of production	3
Dependent upon distance of field from plant	2
Dependent on size of field	1
Related to price of meal marketed during the season	1
Related to products that compete with dehydrated alfalfa	1
Dependent upon protein content	1
A flat rate with patronage dividends	1
A flat rate	1

Several inferences may be made from the foregoing. The dehydrator operator must pay the farmer at least as much for his alfalfa as he can obtain from other outlets. In this connection, it is important to remember that alfalfa had a market as baled hay or in sun-cured meal before the dehydrating industry developed. In the minds of the operators, and probably farmers too, these alternatives still exert an influence. The farmer thus has a choice as to where he will market his alfalfa, and self-interest would dictate that he choose the most profitable. This establishes a minimum price which the dehydrating firm must meet if it is to obtain its raw material.

On the other hand, the dehydrator operator is constrained in what he can pay by the necessity of maintaining a desirable long-run cost-price relationship for his product. In the short run, though, other considerations may outweigh the need for immediate profit

Such factors as quality, distance from plant, size of field, protein content, etc., operate to modify the price between what must and what can be paid. The factor of ready cash for the farmer is also important. Selling alfalfa to dehydrators provides the farmer with several cash sales during a season. In areas where 3 or 4 cuttings may be normal for haymaking purposes, perhaps 5 or 6 cuttings may be made for dehydration.

Distance of Alfalfa Fields From Plant

Alfalfa dehydration plants are located as closely as possible to their source of supply. The raw material is several times as heavy and many times as bulky as the final product. Most operators feel that it is not economical to haul farther than 10 miles. Over the United States as a whole, 60 percent of the acreage cut for dehydration lies within 5 miles of the plant, and another 30 percent within 5 to 10 miles.

As a general practice, single-drum units reach out further to obtain their alfalfa than the larger firms (table 9). At least 3 reasons for this suggest themselves. First, a 1-drum establishment may be all a particular locality can support in good crop years. Second, where alfalfa is grown primarily for its beneficial effects upon other crops, as in rotation systems, it would usually offer a submarginal supply for multiple-drum units. Third, observations made in taking the schedules indicate that larger firms keep better records than smaller ones, and a better knowledge of costs may cause the larger plants to resist reaching far out for their supply of alfalfa.

Reasons for geographical differences in distance of supply are similar to reasons for differences in sizes of dehydrator plants. Among single-drum units, there is a marked tendency for a greater portion of the alfalfa to be obtained within 5 miles of the plant in the Northeast than in the Southwest (table 9). Alfalfa is more a rotation crop in the Northeast than in the other areas. Portions of the North Central and South Central regions utilize alfalfa as both a soil builder and a forage crop, hence its importance and concentration increase. In the Southwest, it is grown primarily as a hay crop. Moreover, as mentioned previously, single-drum dehydrator operators in the Southwest own a large portion of the land which supplies their raw material. Not only can they establish their plants strategically with respect to the available alfalfa, but they can also control the location of alfalfa fields.

Operators of multiple-drum plants in the Southwest, owning a smaller percentage of the crop acreage needed for their operations cannot readily concentrate cultivation of alfalfa near the plants. Furthermore, because of scanty and uncertain rainfall, yields per acre are relatively low and subject to year-to-year fluctuation. Thus, in an area where a single-drum plant may obtain 96 percent of the alfalfa it needs within a 5-mile radius, multiple-drum units obtain only 51 percent within the same radius.

Approximately the same pattern holds for distances of 5 to 10 miles for plants of both sizes. One notable exception is the South Central region, where only 27 percent of the raw material is obtained by multiple-drum plants, and 36 percent by single-drum plants, in the 5- to 10-mile radius. In view of the 71 percent obtained within 5 miles by the larger firms, not much remains to be secured at greater distances.

HARVESTING

Mechanics

The practice of doing their own harvesting may be considered as one way in which dehydrator operators control quality. Most operators now cut the standing alfalfa with a field cutter, 28 percent using self-propelled and 72 percent using tractor-drawn cutters (table 10). By this method the hay is cut, chopped, loaded directly on the truck or trailer, and hauled to the plant for immediate dehydration. The immediate removal of the alfalfa from the field to the dehydrator helps to reduce the loss of nutrients, especially of carotene.

Equipment

Owners of dehydrating plants visited did practically all their own harvesting, and owned the necessary equipment. The equipment used consisted of cutters, tractors, trucks, and trailers, plus a few odds and ends of other items.

Cutters.--Out of 69 firms interviewed, 9 of the 27 multiple-drum plants and 11 of the 42 single-drum plants used self-propelled cutters. The 20 plants using self-propelled cutters were scattered over all regions of the country. A few of these plants also used tractor-drawn cutters.

Tractor-drawn cutters were used by 57 of the 69 plants. Multiple-drum operations averaged slightly over 3 cutters per plant and single-drum plants slightly over 2 per plant. Thus, 60 out of the 69 plants owned a total of 181 tractors (table 10).

Trucks.--One single-drum plant in the South Central area indicated that it had used no trucks in its harvesting operations. With this exception, all plants owned trucks and used them in harvesting. A total of 317 trucks were spread among 68 plants. Forty-one single-drum plants operated a total of 145 trucks. Twenty-seven multiple-drum plants had a total of 172 trucks.

Three multiple-drum plants in the Northeast had 31 trucks, or a little more than 10 per plant. Seven multiple-drum plants in the Southwest had a total of 47 trucks, or almost 7 per plant. The rest of the plants did not deviate much from the national average.

Trailers.--Only a few plants used trailers in their harvesting operations, possibly because many of them used trucks for hauling. Only 42 of the 69 plants visited had trailers, an average of about 4 per plant (of those that did use trailers). Twenty-two, or about half, the single-drum plants utilized a total of 60 trailers. Twenty multiple-drum plants owned a total of 104 trailers. Thus, of the plants that used trailers, the average was about 3 per plant for single-drum units and about 5 for multiple-drum units. This is about $1\frac{1}{2}$ trailers for all single-drum plants and between 3 and 4 for multiple-drum units.

Table 10.--Harvesting equipment owned and operated by 69 plants, by region and type of plant, 1954

Region and type of plant	Cutters				Tractors		Trucks		Trailers	
	Self propelled		Tractor drawn							
	Plants	Items	Plants	Items	Plants	Items	Plants	Items	Plants	Items
	No.	No.	No.	No.	No.	No.	No.	No.	No.	No.
Northeast:										
Single drum	4	5	11	26	11	28	11	40	6	19
Multiple drum	1	3	2	8	2	21	3	31	1	3
All plants	5	8	13	34	13	49	14	71	7	22
North Central:										
Single drum	3	6	9	21	10	22	11	38	7	14
Multiple drum	2	4	9	33	9	35	10	61	7	30
All plants	5	10	18	54	19	57	21	99	14	44
South Central:										
Single drum	4	7	12	29	13	32	14	49	9	27
Multiple drum	3	7	5	18	6	18	7	33	7	43
All plants	7	14	17	47	19	50	21	82	16	70
Southwest:										
Single drum	0	0	5	12	5	10	5	18	0	0
Multiple drum	3	13	4	13	4	15	7	47	5	28
All plants	3	13	9	25	9	25	12	65	5	28
United States:										
Single drum	11	18	37	88	39	92	41	145	22	60
Multiple drum	9	27	20	72	21	89	27	172	20	104
All plants	20	45	57	160	60	181	68	317	42	164

PROCESSING

Mechanics

The alfalfa is hauled directly from the chopper in the field to the dehydration plant. It is then dumped into a feeder, which usually feeds the drying drum automatically.

The drums in use are of several makes, designs, and sizes. Most of the drums used are rated at 6,000 pounds of moisture evaporation per hour. Drums with an 18,000-pound evaporative rating are now being manufactured.

As the hay leaves the drier it passes to the grinder, where it is ground into fine meal. This may be accomplished by 1 grinding or by the 2-pass system. In the 2-pass system, the hay is first ground through a coarse screen, then through a second and finer one. Some operators believe this to be more economical than using only 1 grinder, as it does not require as much power. After grinding, the alfalfa goes to the pelleting machine or to the bagging room. The pellets are usually stored in bulk, whereas meal is usually stored in burlap or paper bags.

The producer is paid for his alfalfa by the ton, dry weight. Several different types of scales are used in determining such weight, depending on the type of operation. If the final form is meal it is weighed on ordinary platform scales or automatic scales. With paper bags, an automatic scale is used in conjunction with a valve packer. Where the dehydrated alfalfa is handled in bulk, it is weighed by an "in line" scale as it is moved from the grinder.

There are many devices for loading processed alfalfa. Some plants have grain elevators, where the alfalfa is elevated to tanks or bins and then loaded by gravity. Others have a system of screw conveyors (augers) for handling the bulk product. The bagged meal is handled by belt or chain conveyors, or by pallets and a forklift truck. In some plants, bagged meal is handled entirely by hand.

Another process that is becoming more important is the spraying of alfalfa meal with animal fats, vegetable oils, and modified vegetable oils such as methyl ester of cottonseed oil and methyl ester of soybean oil. These fats reportedly help control dust, increase pelleting efficiency, and increase the palatability of the feed. Many of the devices for mixing fats with the meal are homemade.

Processing Equipment

Processing equipment found among the 69 firms visited consisted primarily of drums, hammermills, feeders, blenders, pelleting machines, weighing equipment, sackers, loaders, coolers, and sprayers (table 11). The quantitative breakdown among the plants and regions showed the following relationship:

Table 11.--Processing equipment owned and operated by 69 plants, by region and type of plant, 1954

Region and type of plant	Drums		Hammermills		Feeders		Blenders		Pelleters	
	Plants	Items	Plants	Items	Plants	Items	Plants	Items	Plants	Items
	No.	No.	No.	No.	No.	No.	No.	No.	No.	No.
Northeast:										
Single drum	11	11	11	20	11	11	5	6	2	2
Multiple drum ..	3	6	3	9	3	6	2	2	0	0
All plants	14	17	14	29	14	17	7	8	2	2
North Central:										
Single drum	11	11	11	15	11	11	0	0	2	2
Multiple drum ..	10	23	10	22	10	23	4	5	7	9
All plants	21	34	21	37	21	34	4	5	9	11
South Central:										
Single drum	15	15	15	22	15	16	4	4	6	6
Multiple drum ..	7	15	7	16	7	15	4	4	5	7
All plants	22	30	22	38	22	31	8	8	11	13
Southwest:										
Single drum	5	5	5	6	5	5	2	3	2	2
Multiple drum ..	7	22	7	27	7	19	6	6	2	5
All plants	12	27	12	33	12	24	8	9	4	7
United States:										
Single drum	42	42	42	63	42	43	11	13	10	10
Multiple drum ..	27	66	27	74	27	63	16	17	14	21
All plants	69	108	69	137	69	106	27	30	24	31

Continued -

Table 11.--Processing equipment owned and operated by 69 plants, by region and type of plant, 1954--Continued

Region and type of plant	Scales		Baggers		Loaders		Coolers		Sprayers	
	Plants	Items	Plants	Items	Plants	Items	Plants	Items	Plants	Items
	No.	No.	No.	No.	No.	No.	No.	No.	No.	No.
Northeast:										
Single drum	11	12	5	6	3	4	2	2	3	3
Multiple drum ..	3	4	1	1	1	5	1	2	0	0
All plants	14	16	6	7	4	9	3	4	3	3
North Central:										
Single drum	9	10	6	6	7	8	3	3	4	4
Multiple drum ..	9	15	6	10	8	15	2	2	2	2
All plants	18	25	12	16	15	23	5	5	6	6
South Central:										
Single drum	14	15	7	8	10	15	4	4	1	1
Multiple drum ..	5	9	5	12	6	11	2	2	2	2
All plants	19	24	12	20	16	26	6	6	3	3
Southwest:										
Single drum	5	5	1	1	3	5	0	0	0	0
Multiple drum ..	7	17	4	5	2	2	2	2	1	1
All plants	12	22	5	6	5	7	2	2	1	1
United States:										
Single drum	39	42	13	21	23	32	9	9	8	8
Multiple drum ..	24	45	16	28	17	33	7	8	5	5
All plants	63	87	29	49	40	65	16	17	13	13

Drums.--A total of 108 drums were encountered among the 69 plants. The number per plant ranged from 1 to 6. Most of these had a 6,000-pound evaporative rating per hour, several had a 12,000-pound rating, and 1 had an 18,000-pound rating.

Hammermills.--All 69 plants had hammermills. There was a total of 137 mills in a variety of makes and sizes.

Feeders.--All 69 plants also had feeders, a total of 106. These also represented a variety of makes, a few even being homemade. Sizes of most of them were not indicated.

Blending equipment.--There were only 30 blenders among 27 plants in the survey. For the United States, 11 of these plants were single-drum units, and 16 were multiple-drum plants. The percentage of plants having such equipment was higher in the Southwest than in any of the other regions. The lowest percentage was among plants in the North Central region. The 1-ton blender seemed to be the most common size. The 30 blenders were of various makes, with some being homemade.

Pelleting machines.--Only 24 of the 69 plants had pelleting machines. 8/ The Northeast was lowest in the use of pelleting equipment, only 2 of the 14 plants there indicating the use of them. The South Central area used them to the greatest extent, 11 of the 22 firms indicating their use. There was a total of 31 pelleting machines, so some firms had more than 1. There were several sizes and makes mentioned.

Weighing equipment.--Most of the firms had weighing equipment of some kind. Sixty-three of the plants maintained a total of 87 weighing devices of various types. It is probable, however, that the other 6 firms also had some manner of weighing their alfalfa, both before and after processing.

Sacking equipment.--Twenty-nine firms owned a total of 49 sackers, the largest representation being among multiple-drum plants. Geographically, there seems to be little difference among the regions with respect to this equipment. As mentioned previously, these are of various types. They are also of various makes, including homemade equipment.

Loading equipment.--Forty of the 69 firms had some sort of loading equipment. This means that quite a few still do their loading by hand. There was a total of 65 items of various types listed in this category.

Cooling.--Sixteen firms used coolers to reduce the temperature of the processed alfalfa after it leaves the hammermill and before it is sacked. There was a total of 17 such coolers in operation.

8/ Joseph Chrisman, Executive Vice-President of the American Dehydrators Association, in a letter to the authors, estimated that the use of pelleting machines has probably doubled from 1954 (the year for which the survey figures were taken) to 1957.

Cooling helps to control quality, because the rate of carotene loss is greater at high temperatures.

Spraying.--Only 13 of the 69 plants mentioned sprayers, and there were only 13 of such items listed in total.

Fuel Used in Dehydrating Alfalfa

The type of fuel used in powering dehydrating operations varies from 1 region to another (table 12). Natural gas is the most common fuel, being used by 51 of the 69 plants, or 73 percent. Only in 1 region, the Northeast, is natural gas secondary as a fuel.

Table 12.--Type of fuels used, by region and type of plant, 1954

Region and type of plant	Plants in region	Number of plants using--			
		Natural gas	Liquid petroleum gas	Fuel oil	Coal
	No.	No.	No.	No.	No.
Northeast:					
Single drum	11	3	4	3	1
Multiple drum 1/	3	1	0	2	1
All plants 1/	14	4	4	5	2
North Central:					
Single drum	11	8	0	2	1
Multiple drum	10	8	0	2	0
All plants	21	16	0	4	1
South Central:					
Single drum	15	13	0	2	0
Multiple drum	7	7	0	0	0
All plants	22	20	0	2	0
Southwest:					
Single drum	5	4	0	1	0
Multiple drum	7	7	0	0	0
All plants	12	11	0	1	0
United States:					
Single drum	42	28	4	8	2
Multiple drum	27	23	0	4	1
All plants	69	51	4	12	3

1/ One firm used both fuel oil and coal.

Over the whole survey, only 6 percent of all plants used liquid petroleum (LP) gas, 17 percent used fuel oil, and 4 percent used coal. Some operators estimated that the cost of drying was 3 to 5 times as much with fuel oil or LP gas as with natural gas.

Equipment to Control Quality

The question of control of quality arises during processing, as well as in harvesting and storing of dehydrated alfalfa. Twenty-eight of the dehydrator operators used their own laboratory equipment for testing the product, and 41 used commercial facilities for testing (table 13). Two operators used both their own and commercial facilities.

Table 13.--Ownership of laboratory equipment used in dehydrating plants and tests made, by region and type of plant, 1954

Region and type of plant	Number of plants using their own or commercial laboratory equipment			Number of plants making tests for--			
	Own	Commercial	Both	Protein	Moisture	Fiber	None
Northeast:							
Single drum	5	6	1	10	7	9	1
Multiple drum	1	2	0	3	1	2	0
All plants	6	8	1	13	8	11	1
North Central:							
Single drum	4	7	0	11	11	11	0
Multiple drum	3	6	0	9	9	9	0
All plants	7	13	0	20	20	20	0
South Central:							
Single drum	5	10	0	14	14	14	1
Multiple drum	6	1	0	7	7	7	0
All plants	11	11	0	21	21	21	1
Southwest:							
Single drum	0	5	0	5	5	5	0
Multiple drum	4	4	1	7	6	6	0
All plants	4	9	1	12	11	11	0
United States:							
Single drum	14	28	1	40	37	39	2
Multiple drum	14	13	1	26	23	24	0
All plants	28	41	2	66	60	63	2

Specific items mentioned for testing were carotene, protein, moisture, and fiber content of the dehydrated alfalfa The guarantee of carotene content as it applies to shipment is described in the section on marketing processes.

Tests for carotene were made by 67 of the 69 plants surveyed. One plant in the Northeast did not guarantee the carotene content of its meal and made no test for it. One plant in the North Central area did not guarantee its meal, made no tests of its own, and did not use commercial facilities for testing. However, it sold its product through another dehydrating firm, and so the meal was presumably tested before entering market channels.

Protein content was tested by 66 of the firms. All of the multiple-drum plants made tests for protein. One single-drum plant in the Northeast and one in the South Central region did not test for protein.

Moisture content was tested by 60 of the plants. Fewer plants made such tests in the Northeast (only 7 of 11 single-drum plants and 1 of 3 multiple-drum plants) than in any other region.

Testing for fiber content of the processed alfalfa was done by 63 of the plants; again, only a few of those in the Northeast made such tests.

All plants in the North Central area made tests for moisture, as well as for protein and fiber. Two plants, 1 in the Northeast and 1 in the South Central region, made no tests at all.

LABOR

Interviews with dehydrator operators have indicated that the labor used is mostly local. The labor force is composed of all types: farm hands, part-time farmers, town and city laborers, students, and itinerant laborers. Some firms have year-round work for at least part of their help, while others depend almost entirely upon seasonal help. Most operators indicated that they paid their help by the hour, with time and a half for overtime. During the peak season of 1954, most of the 69 plants operated 24 hours a day, 7 days a week, using two 12-hour shifts. Many operators run 7 days a week during practically all the processing season.

During the period of maximum production the average number of employees, based on a 40-hour week, ranged from 16.8 in the Southwest to 23.1 in the North Central region among single-drum plants (table 14). The average for multiple-drum plants ranged from 28 employees in the Southwest to 44.3 in the North Central area. The average for all plants in the survey was 21.8 for single-drum firms and 35.2 for multiple-drum plants. This gave an overall average of 26.8 employees per plant during the busiest season.

Supervisory functions, also based on a 40-hour week for the busiest season, show an average of 1.9 supervisors for all plants. For multiple-drum

Table 14.--Number of employees during period of maximum production, based on 40-hour week, by region and type of plant, 1954

Region and type of plant	Number of laborers			Number of supervisors		
	Average	Maximum	Minimum	Average	Maximum	Minimum
Northeast:						
Single drum	21.8	32	14	1.4	2	1
Multiple drum	28.5	32	25	1.5	2	1
All plants	22.9	32	14	1.4	2	1
North Central:						
Single drum	23.1	38	16	1.5	2	1
Multiple drum	44.3	63	32	3.1	7	1
All plants	33.7	63	16	2.3	7	1
South Central:						
Single drum	22.6	42	13	1.6	3	1
Multiple drum	29.7	38	24	1.8	4	1
All plants	24.6	42	13	1.7	4	1
Southwest:						
Single drum	16.8	22	10	2.4	3	2
Multiple drum	28.0	44	14	2.0	3	1
All plants	22.9	44	10	2.2	3	1
United States:						
Single drum	21.8	42	10	1.6	3	1
Multiple drum	35.2	63	14	2.4	7	1
All plants	26.8	63	10	1.9	7	1

plants the average was 2.4; for single-drum plants, 1.6. A number of firms indicated that only 1 supervisor was used. One plant in the North Central area (multiple-drum) used as many as 7.

There were only a few plants that engaged a full-time sales employee. In most plants, someone in the office did clerical work associated with sales, with a broker doing most of the actual selling. Some plant owners and managers devoted part of their time to selling, especially during the slack periods, and when their plant was not operating.

STORAGE

Methods of Storage

Dehydrated alfalfa is produced seasonally, but used throughout the year, so some provision must be made for storing the processed product. Dehydrated

alfalfa has certain characteristics that make it unstable under ordinary storage conditions.

The carotene of dehydrated alfalfa diminishes rapidly as a result of oxidation. The successful maintenance of this pro-vitamin A depends upon the utilization of processes in storage which effectively reduce the activity of oxidizing agents. This has usually been done by storing at reduced temperature, or in an atmosphere of inert gas. Considerable research has been directed at finding a chemical antioxidant which would retain carotene in dehydrated alfalfa, but to date none has proved satisfactory for widespread use. The emphasis at present seems to be on inert-gas storage.

There are serious disadvantages in refrigerated or inert-gas storage. Both are expensive. Operators have estimated that the cost of erecting inert-gas storage facilities with all equipment needed for operation is between $20 and $25 per ton of the dehydrated product. Moreover, neither cooling nor inert gas has carryover effects. This means that, when dehydrated alfalfa is removed from storage, carotene again begins to disappear, so that by the time the product is finally utilized in the feed lot, a considerable loss of carotene may have occurred.

It is hoped that chemical antioxidants will be less expensive than cooled or inert-gas storage, and that they will afford greater protection against loss of carotene.

Use of inert-gas storage has increased greatly in the last 2 years and will probably continue to increase for at least another year or so. Many operators, however, hesitate to construct facilities for inert-gas storage because of the uncertainty of its future. Some of them believe that inert-gas storage will become obsolete as soon as an acceptable antioxidant is found.

Although antioxidants are known which effectively reduce carotene loss in dehydrated alfalfa, they have not been acceptable because of their toxic effects upon the livestock that eat the product containing them. This, in essence, points out the present direction of research with respect to antioxidants, that is, to find a substance which is effective and at the same time harmless to livestock.

Storage Facilities

The average storage capacity (table 15) of plants in 1954 was: cold storage, 480 tons; gas storage, 220 tons; and uncooled storage, 1,370 tons. This is an average of about 2,070 tons per plant, of which approximately 700 tons is designed to maintain the carotene content of dehydrated alfalfa. Average production per plant in 1954 was 4,162 tons, so there was storage during that year for about half the processed meal.

Uncooled storage is not suited for holding meal for long periods of time. Many operators do not store their product at all, but market it as it is

Table 15.--Average capacity of storage facilities of alfalfa dehydrating plants and tons stored on September 30, by region and type of plant, 1954

Region and type of plant	Capacity of cold storage 1/		Capacity of gas storage 1/		Capacity of uncooled storage 1/		Tons in storage September 30, 1954	
	Bag	Bulk	Bag	Bulk	Bag	Bulk	Total	Average per plant
	Tons	Tons	Tons	Tons	Tons	Tons	Tons	Tons
Northeast:								
Single drum	0	0	0	0	1,774.5	0	11,807.0	1,073.4
Multiple drum ..	400.0	0	466.7	0	1,906.7	0	5,608.0	1,702.7
All plants	85.7	0	100.0	0	1,802.9	0	16,915.0	1,208.2
North Central:								
Single drum	24.8	29.4	0	227.5	957.8	103.3	14,673.9	1,330.7
Multiple drum ..	27.2	32.3	0	250.0	1,603.9	990.9	24,669.2	2,466.9
All plants	25.9	30.8	0	238.2	1,265.5	526.0	39,343.1	1,873.5
South Central:								
Single drum	12.1	31.6	0	111.1	576.2	102.4	8,280.7	552.0
Multiple drum ..	71.3	2,084.7	0	1,012.2	1,883.3	297.6	29,340.5	4,191.2
All plants	30.9	648.8	0	397.8	992.1	164.6	37,621.2	1,710.0
Southwest:								
Single drum	0	0	0	0	532.0	0	1,656.4	414.1
Multiple drum ..	0	2,143.0	0	0	507.1	0	11,625.0	1,660.7
All plants	0	1,250.0	0	0	517.5	0	13,281.4	1,106.8

1/ Maximum capacity of any one plant.

processed. Some accept low prices rather than store in uncooled warehouses; others have no storage facilities.

Regional differences in storage facilities may be seen in table 15.

On September 30, 1954, there was an average of 1,599 tons of dehydrated alfalfa per plant in storage. This was 42 percent of 1954 production, and 77 percent of the storage space available.

Storage Practices

Storage practices were predicated upon (1) the market situation, (2) the production situation, (3) a regular sales policy, (4) a regular storage policy, or (5) miscellaneous factors. Some operators mentioned several determinants which fitted into separate groups.

The listing which follows places under the five groupings specific factors which determine storage practices among dehydrator operators. The number of operators using each is indicated at the side.

Determinants of storage practices	Number of plants reporting
1. The market situation:	
a. Current market price of dehydrated alfalfa	12
b Current price and expected future price	7
c. Current price and cost of production	2
d. Local current price and demand by local feeders ...	2
2. The production situation:	
a. Current production and sales situation	7
b. Expected future production and sales situation ...	3
3. A regular sales policy:	
a. Plant sells throughout the year, and stores accordingly during producing season	9
b. Plant sells to regular customers when price is low, and stores the rest	7
c. Plant sells what it can during the season, and stores the rest	3
d. Plant sells early production if price holds up, and stores the rest	3
e. Plant sells all meal by June and July to make way for cottonpicking season	1

Determinants of storage practices	Number of plants reporting
4. A regular storage policy:	
a. Plant fills storage capacity by end of processing season	6
b. Plant fills storage capacity at beginning of season and keeps it full	4
c. Storage policy depends upon how much storage space is available	2
d. Plant stores enough for local sales only	2
e. Plant stores until price reaches what is expected to be the peak	1
f. Plant keeps only low-grade meal in storage	1
g. Plant stores enough to supply customers during cold weather	1
5. Miscellaneous factors:	
a. Contract or affiliation with another dehydrating company determines storage policy	3
b. Plant does not store at all	2
c. Plant uses own formula: sells one-third PDS (price at date of shipment) before season starts, sells one-third during season, and stores one-third	1
d. Plant finds it necessary sometimes to store during wheat harvest because of car shortage	1
e. Plant stores enough meal to fill winter orders, plus whatever amount seems indicated by projection of PDS bookings on year-round account	1

CONTROL OF QUALITY

Recent Progress

The dehydrated alfalfa industry has effected great improvements in control of quality since World War II. The accomplishment can be measured to a certain degree by the experience of feed manufacturers who use dehydrated alfalfa in their formulas. For example, a feed manufacturing company analyzed samples taken from 1,400 cars of dehydrated alfalfa received in 1947. The company purchased meal on a basis of 17-percent protein and a guarantee of a minimum of 100,000 units of vitamin A per pound. Some 50.7 percent of the cars met the guarantee on both protein and vitamin A content; 31.0 percent were below 17-percent protein; 30.7 percent were below the vitamin A guarantee; 12.9 percent, or 1 car out of 8, failed to meet either the protein or the vitamin A requirement (3). In 1954, however, the same buyer received about 3,000 cars, of which fewer than 100 needed to be diverted because of poor quality (33).

There are important economic consequences when dehydrated alfalfa does not meet the guarantees specified for it. Additional blending, supplementing, and changing are required to maintain proper nutritive levels. These add to costs for both the shipper and the feed manufacturer (3).

Because quality is so important, it seems appropriate to explore the subject in some detail. Good dehydrated alfalfa does not just happen; it is brought about by conscious effort. The dehydrator operator can exercise a large degree of control in this respect.

Improvement of Quality Before Cutting

The value of dehydrated alfalfa as feed depends upon its nutrient content. This is determined by the composition of the live plant and by the preservation of constituents after the alfalfa is cut.

Calcium, phosphorus, and potassium are the principal minerals essential to alfalfa. Other elements are needed in smaller amounts. When any plant nutrient is deficient, proper fertilizers will generally increase the yield and improve the quality of the crop. One case is cited in which a 6.8 percent increase in yield per acre was accompanied by a 30.8 percent increase in total protein (6). In an experiment in Nebraska, an investigator found that lime and commercial fertilizer increased the protein content of a crop almost 40 percent (11). The same investigator found that second-year cuttings on 1 fertilized plot contained 17.6 percent of protein, while those on a second plot, with the same treatment plus sulfur, contained 21.1 percent of protein. A continuing test indicated that the more complete fertilizer increased the yield of hay more than 4 times, while total protein increased 6 times.

Vitamin A potency of alfalfa was investigated in another experiment. Phosphate fertilization produced hay with 156,000 units of vitamin A per pound. A sulfur amendment used alone brought the figure to 175,000 units. Used together, the phosphate and sulfur nutrients raised the vitamin A level to 196,000 units (11). It appears, therefore, that both the protein and the vitamin content of alfalfa can be improved by proper fertilizers.

The requirement for moisture is closely related to the need for nutrients, for these are available only when they are in solution. Dependence upon natural rainfall involves risk. Irrigation makes possible more uniformity in a field, and generally better quality. Fertilizers are a necessary adjunct to irrigation, and they are more fully utilized in an irrigated firld. Irrigating also allows better scheduling of cuttings (6).

In some areas, alfalfa is irrigated from a subsurface source. This may present several problems. The plant seldom succeeds if the water table is near the surface of the soil (16), possibly because deep rooting is restricted. Better results are possible where roots penetrate the soil deeply. Also, subsurface irrigation gives the soil a moisture pattern which is the reverse of that usually encountered, and which sometimes requires a shift of emphasis from surface to subsurface nutrition (12).

Different varieties of alfalfa respond differently to a given soil or climate. It is usually recommended that the grower use a good certified seed of a variety adapted to his particular locality. Because many of the factors controlling the quantity of nutritional ingredients in alfalfa are inheritable (15), it follows that these nutrients are more abundant in some varieties than in others.

The objective of plant breeding research is to develop varieties that have better local adaptation, higher yield, more resistance to disease, varying maturity or flowering date, and added leafiness (21). The importance of leafiness was emphasized by California investigators who concluded, after extensive studies, that the leaf-stem ratio was as good an index of nutritive value as was available. In general, it has been found that carotene content is directly proportional to leaf percentage. One study indicated that, on the average, 77 perc ent of the carotene was found in the leaves, and that strains and hybrids differed inherently in content of the pigment (20).

Researchers have felt that breeding new varieties of plants would bring the most rapid improvement in productivity and quality. Varieties bred for resistance to leaf spot have given better hay than older varieties on spring cuttings when leaf spot was severe. Analysis of samples taken from plots under heavy infestation showed that varieties which were able to retain most of their leaves had higher protein and carotene values. California Common, which retained only 38 percent of its leaves, contained 12.9 percent of protein and 96 parts per million of carotene. Caliverde, a resistant variety which kept 51 percent of its leaves, contained 18.4 percent of protein and 204 parts per million of carotene (6).

Disease and insect pests not only curtail production, but they also adversely affect quality. One observation on a field attacked by leaf hoppers indicated that strains showing least yellowing were higher in carotene content than those which yellowed badly (20). Development of resistant varieties is the only answer to certain problems, e.g., the problem of bacterial wilt.

Insecticides may be used to combat pests, although the residues of insecticide remaining in the dehydrated alfalfa may be harmful (7). At least 4--aldrin, chlordane, parothion, and toxaphene--have been investigated from this standpoint. For the test, the alfalfa was sprayed in the field, immediately cut, and hauled to the dehydrator. The sprayed alfalfa was then run through a commercial dehydrator, and dehydrated samples were collected. Over 400 assays indicated that the residues of the 4 insecticides were reduced considerably by dehydration (31). Table 16 is adapted from the results of the test.

The investigators remarked on their findings: "It is interesting to speculate on the probable final insecticide residue of these four insecticides in the alfalfa meal which is used in mixed feeds and what these residue might be ultimately in the human diet" (31).

Table 16.--Reduction of insecticide residue by dehydration

Insecticide	Insecticide applied per acre of crop	Average residue on alfalfa before dehydration	Reduction by dehydration
	Pounds	Parts per million	Percent
Aldrin	0.5	19	69
Chlordane ...	1.5	100	81
Parothion ...	0.5	18	84
Toxaphene ...	2.25	81	66

Control of Quality in Harvesting

Although there have been great improvements in harvesting and processing techniques and in equipment, the stage of maturity at which alfalfa is cut remains the most important determinant of the quality of the final dehydrated product (22). Many experiments indicate that both protein and carotene content decrease with continuing growth of the plant. If quality were the only consideration, the dehydrator operator could advantageously harvest his crop at the earliest possible stage of maturity. Such procedure, however, would shorten the life span of the alfalfa stand. It is necessary, then, for cutting practices to reflect a compromise between quality of product and relative permanency of the standing alfalfa (22).

That protein content varies with stage of maturity was shown in a test of a 3-year-old stand of alfalfa. Cutting during the prebloom stage yielded 4,451 pounds of hay per acre (12 percent of moisture), providing 989 pounds, or 23.2 percent, of protein. The alfalfa cut during first bloom produced 7,005 pounds of hay with the same moisture content. This provided 1,398 pounds of protein per acre, or 21.5 percent. Alfalfa which was allowed to stand until the 10-percent bloom stage yielded 6,796 pounds of hay per acre, also containing 12 percent of moisture. This cutting produced 1,249 pounds, or 19.9 percent, of protein per acre (4).

In the spring, the stand of the 3 plots was uniform and estimated to be about 75 percent. At the end of the season, the stand on the prebloom plot was estimated at not more than 25 percent, while the other 2 plots were nearly as good as at the beginning of the season (4).

Another investigation, which divided the stage of maturity into more minute categories, measured the relative proportions of protein and fiber in hay. The results, however, are applicable to dehydration problems. Cuttings at various stages of maturity showed the following percentage contents for protein and fiber: Bud stage, 19.5 percent of protein, 28.0 percent of fiber; one-tenth bloom stage, 18.0 percent of protein, 30 percent of fiber; one-third to one-half bloom stage, 17.3 percent of protein, 32.8 percent of fiber; full bloom stage, 16 percent of protein, 33 percent of fiber; and stage at which seeds are ripening, 14.5 percent of protein, 35 percent of fiber (18).

Ten varieties of alfalfa were studied in Colorado. In every variety, both the protein content of the leaf and the leaf percentage decreased during the growing period of the plant. As approximately 90 percent of the vitamins and between 60 and 70 percent (22) of the proteinacious materials of the alfalfa plant reside in the leafy portion, the practical importance of cutting at the proper stage of maturity becomes evident.

A few of the specific tests in the Colorado experiment showed that, in about a month, leaf percentage of Meeker Baltic alfalfa decreased from 53.5 to 34.1 percent, while the percentage of protein in the leaf decreased from 39.6 to 29.5 percent. In a similar manner, leaf percentage of Ladak alfalfa decreased from 52.0 to 31.9 percent, and the percentage of protein in the leaf decreased from 36.0 to 27.0 percent. Leaf percentage of Buffalo alfalfa dropped from 53.0 to 36.7 percent, and protein dropped from 36.6 to 26.2 percent (22).

Tests have shown that the carotene content also decreases during the growth of the alfalfa plant. It has been found that new growth is higher in carotene content than more mature growth (20), and that carotene is much more stable in the leaves of alfalfa than in the stems (17).

What is the best cutting practice to follow with respect to stage of maturity? This may, in part, depend upon local circumstances. One suggestion, however, may be helpful to the dehydrator operator. Carr said, "Our results for the two years show that we can expect a significantly higher annual production per acre of both hay and protein if alfalfa is allowed to reach the bloom stage before cutting. The difference in the percentage of protein between the prebloom stage and the early bloom stages does not appear to be great enough to compensate for the loss in hay or stand that results from prebloom currint" (4).

What applies to protein very likely applies to carotene also, as both appear to depend largely upon the leaf-stem ratio.

After alfalfa has been cut, the preservation of nutrients, and especially carotene, becomes of paramount concern. From cutting to final utilization, 4 factors are involved in the destruction of carotene in alfalfa: (1) Light in the field, (2) enzymic action in the field, (3) heat in the dehydrator, and (4) oxidation in storage (3). The first 2 factors are discussed immediately below; the other 2 are discussed later.

It has been suggested that oxygen is necessary for destruction of carotene in alfalfa, and that other factors act as accelerators (17). Carotene retention is possible to the extent that oxygen or accelerators are controllable.

Light is an important factor in the destruction of carotene. The rate of destruction seems to depend upon both the intensity and the type of light involved. A study involving an extract of dehydrated alfalfa meal has shown the following losses of carotene: (1) Under normal (daylight) laboratory illumination, 2 hours of exposure gave 4.6 percent loss, and 3 hours of exposure, 12.4 percent loss; (2) exposure to direct sunlight for one-fourth hour, 31.5 percent

loss; (3) exposure to ultraviolet light from a source 1 foot away for half an hour, no loss; and (4) exposure to a 100-watt incandescent lamp 3 feet away for 1 hour, 1.2 percent loss (26).

There is evidence that the destruction of carotene on exposure to light involves a photochemical process. The pigment is destroyed when dissolved in acetone or petroleum and then exposed to light in the presence of chlorophyll. Both light and chlorophyll are necessary to the reaction; in the study no loss occurred when one factor was absent. Moreover, time is a factor, for the longer the exposure to light, the greater the loss of carotene. It was found that the rate of destruction depends upon the quantity of chlorophyll present; this indicates that chlorophyll is directly involved and does not act merely as a catalyst (27).

Investigators have found reason to believe that alfalfa has an enzyme, probably lipoxidase (25), whose activity can destroy carotene in the absence of light. A test of alfalfa leaves left in the field to dry overnight showed a decrease in carotene from 296,000 to 208,000 micrograms per pound, samples being taken at 7:40 p.m. and then again at 7:40 a.m. the folowing day (22).

When light and enzymic action combine to destroy carotene, the loss can be tremendous. It has been found that alfalfa leaves having 282,000 micrograms of carotene per pound at 8:15 a.m. had only 182,000 micrograms per pound at 4:00 p.m. the same day (22). In this case, high daytime temperature no doubt acted as an accelerator.

Procedures in handling the cut alfalfa affect carotene loss. Starting with growing alfalfa containing 187,000 micrograms of carotene per pound, it has been found that (1) 2 hours in windrow had reduced the content to 161,000 micrograms per pound; (2) chopping in the field reduced it to 150,500 micrograms per pound; (3) chopping the alfalfa in the field and taking the sample at the dehydrator after about two and one-half hours gave a content of 121,200 micrograms per pound (22). A series of tests have shown that grinding alone may reduce the carotene content of alfalfa by more than 20 percent (30).

It appears, therefore, that the chopping of alfalfa leaves has a destructive effect on carotene, presumably because of increased enzyme activity (22). The destruction may not always be serious. An investigator found, for example, that alfalfa chopped in the field lost only 4 percent more carotene before dehydration than long alfalfa chopped just before dehydration, and that this was partially compensated by a smaller loss of carotene during dehydration. The conclusion was that field chopping does not seriously reduce the carotene content of alfalfa meal (29).

Methods, and consequently the equipment used in harvesting, and later processing operations govern to a large degree the value of dehydrated alfalfa for feed. It is for this reason that specialized implements have been developed to shorten the period between cutting and dehydrating.

Control of Quality in Processing

The dehydration of alfalfa is the process which transforms it into its dry state. The final form is subject to variation among different dehydrating plants, depending upon the number of operations involved.

Dehydrating is primarily a process of removing moisture. In the dehydrated alfalfa industry, it means the artificial and rapid drying of freshly cut alfalfa. The generally stated purpose of dehydrating is to capture and retain the nutrients contained in the living plant. Yet this operation can destroy the nutrients it is designed to save.

It is well known that heat destroys some nutrients, among which is carotene. An experiment has been made on the loss of carotene during dehydration and also during grinding operations before and after the drying process (30). In this experiment, grinding of the freshly stripped alfalfa resulted in carotene losses ranging from 7.6 percent to 20.8 percent in 6 tests. Dehydration raised the losses even further, from 40.2 percent to 55.0 percent (including loss in grinding before dehydration). Total losses resulting from the sequence of grinding, dehydration, and grinding ranged from 46.2 percent to 79.8 percent. In general, the greatest losses appeared to occur during dehydration.

The report of the experiment was printed in 1944. There have been many improvements in techniques since then. It is probable that the magnitude of loss as represented in the citation would be rare today. But loss in the dehydrating process is still possible, and can be avoided only by attention to detail.

What makes for quality in processing? Generally it results from a series of operations, as described in the following quotation:

"Quality in processing is accomplished in the following systematic series of operations:

"1. Perfect controlled feeding of the fresh chopped alfalfa to the dryer according to temperature changes in the dryer proper.

"2. Supplying oxygen free gases to the dryer chamber according to temperature changes in the drying process.

"3. Since the fresh green alfalfa is reduced in particle size before going into the drying chamber, the hot gases serve as a conveyor easily carrying the alfalfa through the drying operation fast. Proper preparation makes better drying because it allows the dryer to operate at lower temperatures and the alfalfa dries faster, thus retaining more carotene and vitamin A. While in the drying process, each particle of alfalfa is protected by vapor which is developed from the heat drawing the moisture out of the alfalfa.

"4. After drying and before grinding or pelleting, the alfalfa goes through a quick cooling process to remove any heat and moisture. Up to this time foreign materials are removed from the alfalfa at two points. These separations remove not only metal but wood, glass, stones, heavy stems, etc.

"5. From the cooling cycle the alfalfa goes to the grinding or pelleting steps. Before these operations the material must go over the magnet to remove any remaining metal. Grinding in large capacity grinders with ample screen area helps to reduce friction heat that would normally be impregnated into the dehydrated alfalfa which would reduce carotene and vitamin A.

"6. The cooling step is more important for quality in processing as this operation lowers the temperature of the product quickly to where it will retain most of its carotene and vitamin A" (28).

Some operators perform additional operations, such as greasing or pelleting These processes have a bearing on quality, but in a manner not necessarily connected with nutritional value.

Manufacturers of mixed feeds like a product that is fairly free from dust (33). From their standpoint, then, a reduction in dustiness is an improvement in quality. Greasing, or the addition of fat to the meal, is a method of reducing dustiness in dehydrated alfalfa. The process also has other benefits, such as serving as an antioxidant carrier and aiding in pelleting.

The operator should give attention to at least two details with respect to greasing. One is the even dispersion of the fat in the meal, and the other is the relative stability of the fat used. The presence of fat lumps in the meal constitutes a problem for the feed manufacturer (33). It also makes dust control more difficult.

The addition of rancid fat can have a deleterious effect upon the meal. It will greatly accelerate the destruction of vitamin A (10). This is because rancidification increases oxidation, which is, of course, one of the things that must be controlled if carotene is to be retained.

There appears to be no conclusive evidence that dehydrated alfalfa pellets conserve carotene better than meal. Quality in pelleting is not considered in regard to nutrients, but rather in regard to handling and appearance.

Good pelleting stems from several factors, e.g., fineness of grind, moisture content, temperature, and a proper proportion of stems to leaf meal (14). Pelleting makes possible bulk storage, less storage space per ton, less dust, and greater utilization of feed by livestock.

Conservation of Quality in Storage

The successful storage of dehydrated alfalfa is accomplished under a relatively narrow range of conditions and with specialized facilities. Retention of carotene is the principal concern. This involves, primarily, control of oxidation.

Oxidation is a chemical reaction in which oxygen is the active agent. The process destroys carotene. Control is effected through two general methods: (1) Inhibiting the oxidation rate while oxygen is present, or (2) excluding active oxygen from the storage atmosphere.

It has been known for some time that oxidation rate is a function of temperature and time. The relationship as it affects carotene loss is indicated in figure 7. In this case, the percentages of carotene loss at 4-week intervals from dehydrated alfalfa stored under ordinary warehouse conditions at 80° and 90° F. are shown (3). The loss is, of course, greater at the higher temperature. Several observers have noted the difference between carotene losses in summer and those in winter (13, 32).

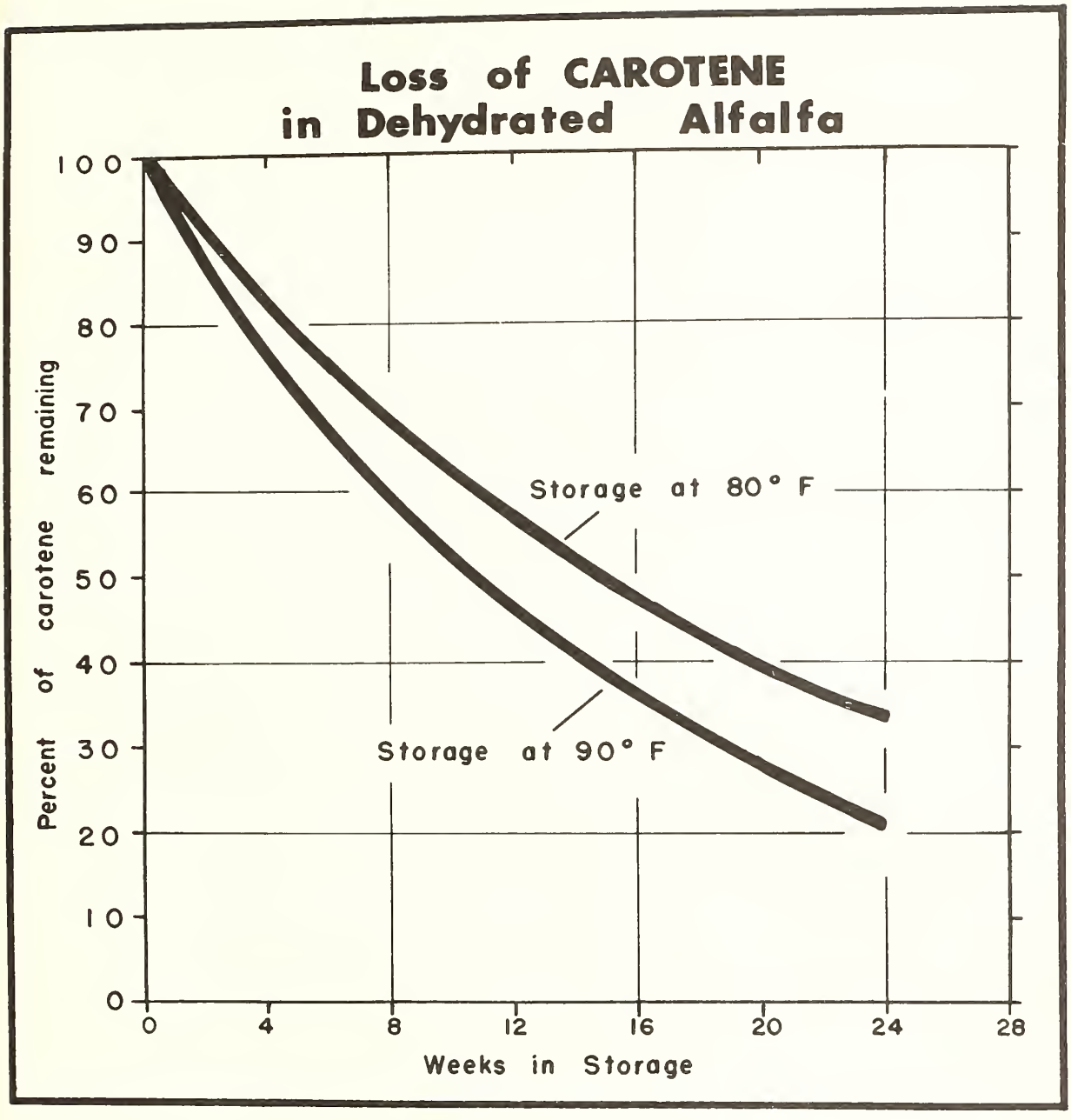
The knowledge that low temperature stabilized carotene in dehydrated alfalfa led to the practice of storing the product under refrigeration. This was the first method employed to inhibit oxidation. It has proved successful, but of course, when the meal is removed from such storage it loses carotene as it assumes the temperature of its surroundings.

Several experiments have been directed at providing storage for dehydrated alfalfa in an oxygen-free atmosphere. An early test showed that dried alfalfa meal was relatively stable when it was stored in sealed tin cans in vacuum at room temperature (34).

Other tests have shown that high-moisture meal may provide the oxygen-free environment. When the dehydrated material was stored in sealed containers at 12 to 17 percent moisture, the carotene was completely preserved for 3 months at room temperature (29). Under conditions of sealed storage with minimum head space, it is preferable not to increase moisture above about 8 percent; at this level only slightly more carotene is lost than at higher levels, less green color is lost, and loss after the seal is broken is at a minimum (2). Other investigations have been reported in this area, but interest in the method died and it has not been used commercially.

Storage of dehydrated alfalfa in inert gas has proved to be successful and commercially feasible. In essence, the process consists of replacing the regular storage air by gases that inhibit oxidation. The most popular of these gases are nitrogen and carbon dioxide (24). Special airtight storing tanks are required, also special gas-producing equipment. At present the trend is toward increasing use of inert gas to conserve oxidizable vitamins during storage.

The use of chemical antioxidants to conserve carotene and other vitamins has been the subject of much investigation lately. This method promises to be an economical and efficient means of retaining quality in dehydrated alfalfa. The principal difficulty with respect to chemical antioxidants is that many of them are toxic to some animals. No completely satisfactory antioxidant has been found.



U. S. DEPARTMENT OF AGRICULTURE NEG. 6073-58 (4) AGRICULTURAL MARKETING SERVICE

Figure 7

Discovery of a satisfactory chemical for inhibiting oxidation would benefit the industry as a whole. With the present means of storage--refrigeration or inert gas--vitamins are conserved while the product is stored. Once it is removed from storage, oxidation losses begin again. Chemical methods of preservation are expected to hold nutrients in the dehydrated alfalfa to the point of utilization by animals in the feed lot.

Control of Quality During Transportation

The quality of dehydrated alfalfa received by the feed manufacturer is affected by several details connected with transportation. One of these is the problem of heated meal (33). When hot meal is loaded, there is no opportunity for it to cool off in a steel boxcar during the summer. As high temperatures accelerate the rate of carotene loss, quality may deteriorate considerably. The solution is, of course, to cool the dehydrated alfalfa as much as possible before loading.

Another problem for feed manufacturers is that of varying quality between cars or within a car (33). That a car (or several cars) average out to a guaranteed analysis is not enough. Uniformity is desirable. It is attained by the proper blending of meals of varying analysis to obtain a material of one uniform analysis. A necessary step in controlling the quality of outbound cars is the establishment of good sampling practices (5).

MARKETING

Sellers and Sales

Methods of pricing.--For the United States as a whole, 37 percent of dehydrated alfalfa shipments in 1954 were priced f.o.b. plant, 47 percent f.o.b. basing point, and 16 percent f.o.b. destination (table 17). In each of the 4 regions, shipments by single-drum plants were more often priced f.o.b. plant than shipments by larger plants. The Southwest had the highest percentages of shipments priced f.o.b. plant--96 percent and 86 percent of all shipments by single-drum and multiple-drum plants, respectively. The North Central region had the lowest percentages--23 percent for single-drum plants and 6 percent for multiple drum plants.

Pricing f.o.b. basing point is practiced more by the larger plants. The North Central region led with 82 percent of shipments by multiple-drum plants and 40 percent of shipments by single-drum plants. In the Southwest, no shipments by the small plants and only 8 percent of shipments by the large ones were priced f.o.b. basing point. The points used for basing were Omaha, Kansas City, Chicago, and Boston.

Pricing f.o.b. destination was not as common as the other methods. Variations among the different regions were considerable, although the national averages for shipments by single-drum and multiple-drum plants were about the same--17 percent and 15 percent, respectively.

Table 17.--Basis of pricing dehydrated alfalfa, by region and type of plant, 1954

Region and type of plant	Plants in region	Plant		Basing point		Destination	
		Number of plants	Percentage of total shipments	Number of plants	Percentage of total shipments	Number of plants	Percentage of total shipments
	Number	Number	Percent	Number	Percent	Number	Percent
Northeast:							
Single drum	11	7	40	7	56	3	4
Multiple drum	3	2	28	3	70	1	2
All plants	14	9	36	10	61	4	3
North Central:							
Single drum	11	6	23	5	40	4	37
Multiple drum	9	3	6	7	82	1	12
All plants	20	9	11	12	69	5	20
South Central:							
Single drum	14	11	48	6	40	2	12
Multiple drum	7	5	24	4	40	2	36
All plants	21	16	35	10	40	4	25
Southwest:							
Single drum	5	5	96	0	--	2	4
Multiple drum	7	6	86	1	8	2	6
All plants	12	11	87	1	7	4	6
United States:							
Single drum	41	29	42	18	41	11	17
Multiple drum	26	16	34	15	51	6	15
All plants	67	45	37	33	47	17	16

Terms of sales.--Almost all sales of dehydrated alfalfa during 1954 were cash sales. Only 2 of the operators interviewed indicated that credit assumed any importance at all. One of these stated that about 25 percent of his sales were credit transactions; the other, about 20 percent. A third operator said that approximately 1 percent of his sales were for credit. All other operators said that they sold only for cash.

Sales for future delivery.--Approximately one-fourth of the dehydrated alfalfa produced in 1954 was sold for future delivery. Some of this was sold at a fixed price, but most of it was sold on the basis of a price at date of shipment (PDS). On PDS sales, the price is determined mutually by the buyer and seller on the date of shipment. Table 18 shows sales of dehydrated alfalfa for future delivery as percentages of total production.

Table 18.--Sales of dehydrated alfalfa for future delivery, by region and type of plant, 1954

Region and type of plant	Total plants in region	Sales for future delivery	
		Plants	Percentage of total production
	Number	Number	Percent
Northeast:			
Single drum	11	5	28
Multiple drum	3	1	7
All plants	14	6	20
North Central:			
Single drum	11	6	46
Multiple	9	3	20
All plants	20	9	26
South Central:			
Single drum	15	5	17
Multiple drum	7	6	60
All plants	22	11	39
Southwest:			
Single drum	5	2	46
Multiple drum	5	1	4
All plants	10	3	10

Thirty-three of the 69 operators interviewed stated that some or all of their sales were on a PDS basis. Percentages of PDS sales in relation to total sales by individual firms were:

Percentage of sales for future delivery relative to total sales	Number of firms
10 percent or less	5
11-20 percent	2
21-30 percent	8
31-40 percent	2
41-50 percent	9
51-60 percent	1
61-70 percent	0
71-80 percent	0
81-90 percent	0
91-100 percent	6
Total	33

Sales organization.--Most selling of dehydrated alfalfa is done by brokers. Only 31 of the plants in the survey gave indications that they had some kind of sales organization. Not all of these constituted a separation of functions by personnel. Fifteen plants were representatives of national firms and had sales organizations at their central office. In 4 firms a separate sales organization had been set up to handle the output of a group of plants. Four other firms had 1 or 2 full-time salesmen; most of these firms had more than 1 plant. In the remaining 8 plants, someone in the office handled the sales. Some plant owners and managers devoted part of their time to selling, especially during slack periods and when the plants were not operating.

Pricing policies.--Operators were asked what factors they considered in determining the selling price of their product. The answers indicate that, in general, a pricing problem as such does not exist for them. Only 2 of the 69 in the survey made no response to the question. Fifty-three mentioned the current condition of the market or of demand and supply as their guide. Most operators individually appeared to have little or no influence, the price being determined in pure competition.

Three operators stated that their price was established by other dehydrating firms which sold their meal for them. Three thought that brokers set the price for their product. Thus, at least 59 operators suggested that establishment of prices was out of their hands.

Among other factors considered, 1 operator included crop outlook, and 4 said that they took into account the price of other feeds. Four said that anticipated prices entered into their calculations.

Cost of production was mentioned by 13 operators, most of whom considered it less in relation to prices than in relation to policies on selling and storing. Some operators were emphatic in stating that there was no connection between the cost of production and the price of meal.

Buyers and Buying

Channels of distribution.--The channels through which dehydrated alfalfa moves are not numerous (fig. 8 and table 19). In general, they may be described as follows:

1. Direct sales to feed manufacturers. This channel involves no intermediate agents, unless the feed manufacturer is so considered. Essentially, however, dehydrated alfalfa loses its identity as a distinct product when it is commingled with other ingredients. From this standpoint, incorporation of dehydrated alfalfa in the feed formula constitutes the point of utilization. For the United States in 1954, these sales represented 44 percent of the total sales by dehydrators. Single-drum firms had a tendency to use this channel somewhat more than multiple-drum firms. This varied considerably among areas of the country (table 19).

2. Sales through brokers. This channel utilizes the services of an agent between buyer and seller, who does not take title to the product. More dehydrated alfalfa (36 percent) was sold through brokers than in any other way except directly to feed manufacturers. In the Northeast and Southwest more than one-half of the sales moved through this channel, but in the North Central and South Central regions only about one-quarter was sold through brokers. Multiple-drum firms tended to use this channel more than single-drum firms.

3. Sales through commissionmen. This channel also involves an agent, but he takes title to the dehydrated alfalfa before passing it on to the user. Some commissionmen also act as brokers. Firms located in the Northeast and Southwest indicated that they made no sales through commissionmen. However, about 20 percent of the total dehydrated alfalfa sales in the North Central region moved through this channel.

4. Direct sales at the dehydrating plant to livestock feeders in the local area. Only 7 percent of the alfalfa was sold in this way, most of it in the South Central region where 18 percent of the total used this channel.

5. Sales in mixed feeds produced by the dehydrator operators. In 1954 only 3 percent of the dehydrated alfalfa was sold in this way. Most of these sales were made in the Northeast and Southwest regions by single-drum firms.

6. Sales to others, including other dehydrating firms and other industries, were a minor proportion of the total in all types of firms and all areas of the country.

Buyers' practices.--Operators were asked whether buyers followed any practices which influenced the price received for their product. To this question there was a variety of answers. The responses in summary form were:

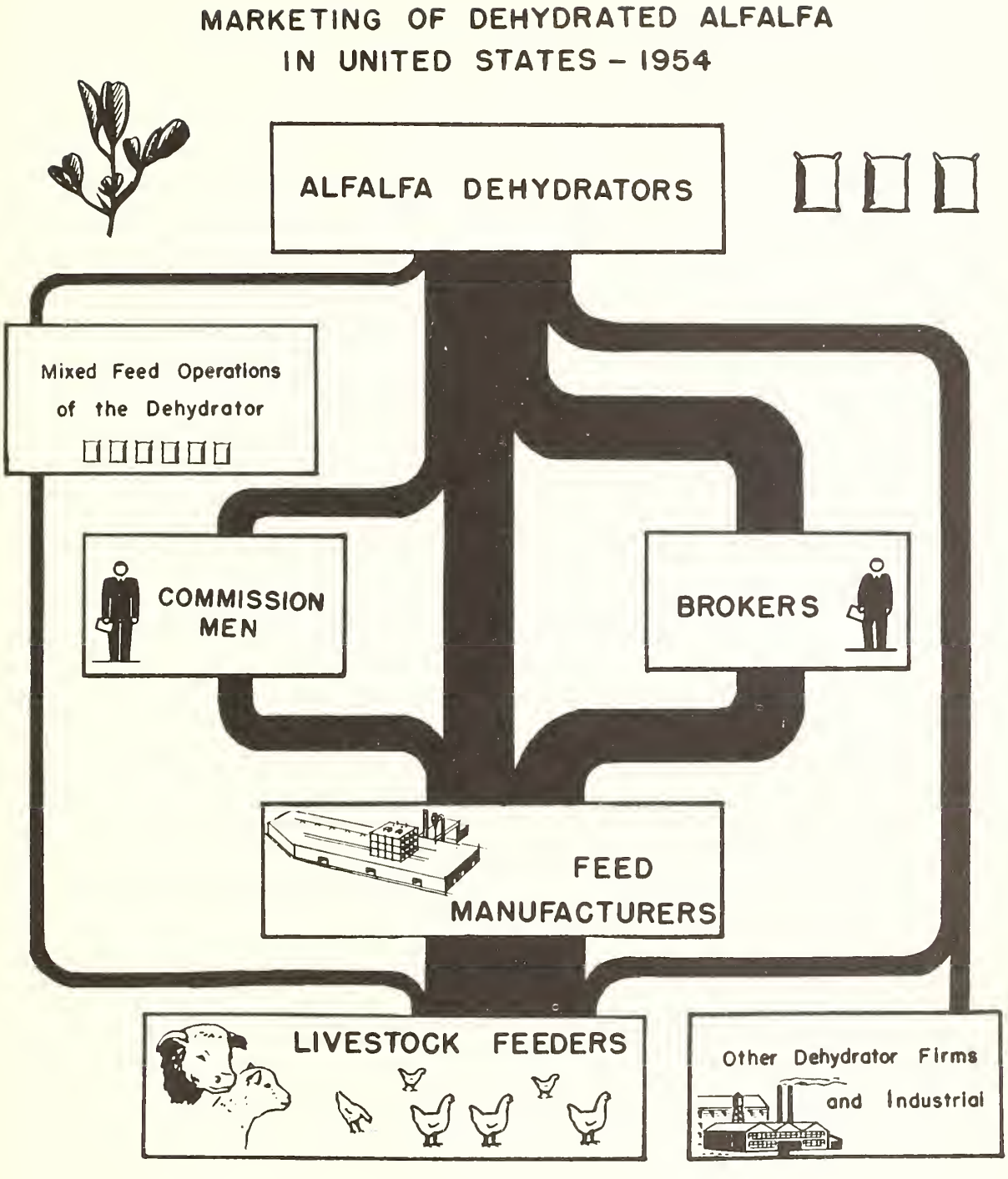


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Figure 8

Table 19.--Channels of distribution used in selling dehydrated alfalfa, by region and by type of plant, 1954

Region and type of plant	Total plants in region	Commission-men		Brokers		Direct to feed manufacturers		Used in production of mixed feed by own organization		Direct to livestock feeders		Direct to others	
		Number of plants	Percentage of total sales	Number of plants	Percentage of total sales	Number of plants	Percentage of total sales	Number of plants	Percentage of total sales	Number of plants	Percentage of total sales	Number of plants	Percentage of total sales
	Number	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent
Northeast:													
Single drum	11	--	--	7	36	9	49	2	13	3	1	2	1
Multiple drum	3	--	--	3	85	2	15	--	--	--	--	--	--
All plants	14	--	--	10	54	11	36	2	8	3	1	2	1
North Central:													
Single drum	11	5	11	9	19	10	62	--	--	8	7	1	1
Multiple drum	10	5	24	8	31	8	40	1	1/	7	5	--	--
All plants	21	10	20	17	28	18	46	1	1/	15	6	1	1/
South Central:													
Single drum	15	3	10	8	31	10	34	1	4	5	21	--	--
Multiple drum	7	2	3	6	22	7	56	1	2	5	15	2	2
All plants	22	5	7	14	26	17	45	2	3	10	18	2	1
Southwest:													
Single drum	5	--	--	5	45	5	43	3	11	3	1	--	--
Multiple drum	7	--	--	6	52	6	44	1	4	1	1/	--	--
All plants	12	--	--	11	51	11	44	4	5	4	1/	--	--
United States:													
Single drum	42	8	7	29	30	34	47	6	6	19	10	3	1/
Multiple drum	27	7	11	23	40	23	43	3	1	13	5	2	1/
All plants	69	15	10	52	36	57	44	9	3	32	7	5	1/

1/ Less than 0.5 percent.

Response	Number of operators giving the response
Buyers do not influence price	48
Buyers force the price down through brokers	5
Buyers pay a premium for good quality	2
Buyers are organized, set price by agreement among themselves	2
Commissionmen influence price	1
Buyers pay a premium for dehydrated alfalfa to store for winter	1
Large companies force price down on early market	1
Brokers favor large feed manufacturers	1
Buyer bids $1.00 less than offering price	1
Chain dehydrators influence price (no indication in what direction)	1
Respondents did not understand question	6
	69

Not all of the responses dealt specifically with buyers' practices. The general feeling appeared to be, however, that there was little influence exerted on price from any quarter.

Intermediate agents.--Twenty agents were interviewed, 5 in each of the 4 areas. Six were commissionmen who took title and possession of the goods they sold, and 14 were brokers who neither handled nor took title to the dehydrated alfalfa. A few acted as both commissionman and broker.

Only 1 of the brokers indicated that dehydrated alfalfa constituted 100 percent of total sales. Others reported percentages from 5 to 90. Sales of dehydrated alfalfa as a percentage of total sales by these 20 agents break down as follows:

Percent	Number of agents
5	5
10	5
15	2
20	1
25	1
30	1
40	1
50	2
90	1
100	1
	20

For half the agents, sales of dehydrated alfalfa constituted not more than one-tenth of their total sales. Most of the agents handled rather small amounts of dehydrated alfalfa. Generally, the higher percentages indicate larger volumes of the goods handled by the agent.

An agent whose sales of dehydrated alfalfa constitute only 10 percent of his total sales volume may not push the product with the same zeal as one who handles nothing but dehydrated alfalfa. Only 2 of the middlemen appear to specialize in this commodity. Two others may be considered as being on the borderline. The other 16 apparently devote less than half their efforts to selling dehydrated alfalfa.

Total volume of dehydrated alfalfa handled ranged from 750 tons to a possible 100,000 tons in 1954. However, volume figures were not obtained from all of the agents. For the 16 who gave specific figures, the average was about 12,000 tons.

The agents indicated that their average markup or charge for services was in the neighborhood of 75 cents to $1.00 per ton. Eight charged an average of $1.00 per ton, and 10 charged 75 cents. One broker charged $1.15. Three of those charging 75 cents increased their rate to $1.00 per ton for truck movements, and 1 increased his rate to $1.00 for handling meal produced in the West.

All but 2 of the agents said that their charges were the same in 1954 as in 1953. These 2 said that their charge of $1.00 per ton in 1954 was less than in 1953.

The 6 agents who purchased dehydrated alfalfa generally bought directly from dehydrators. Four of them bought all their dehydrated alfalfa directly; the other 2 bought 75 percent of theirs directly, and 25 percent from other agents. In volume, 46,337 tons came directly from dehydrator operators and 2,063 tons came through other agents. The 6 men made all their purchases, regardless of source, by cash.

None of the 6 commissionmen did any processing, except that 1 controlled another firm in which 200 tons of dehydrated alfalfa was used for feed manufacturing.

The 6 commissionmen guaranteed carotene content to varying degrees and in varying quantities--25 to 100 percent--of the alfalfa they handled. In volume, out of the total 50,250 tons handled, carotene content was guaranteed on 40,650 tons.

Four of the 6 commissionmen took actual possession of the dehydrated alfalfa they bought. This included a total of 37,250 tons. Out of this total, they received 30,762 tons by rail and 6,488 tons by truck. They shipped out exactly the same quantities in the same ways.

These 4 commissionmen appear to have only limited storage facilities. One of the men uses commercial storage. Generally, the 4 men shipped dehydrated alfalfa without storing. Only 1 indicated any storing at all; he stored 3 percent of what he handled, and for less than 3 months. This means that, of the 37,250 tons handled by these men, only 120 tons were stored before shipment.

Seventeen of the 20 men interviewed performed the service of locatig both buyers and sellers of dehydrated alfalfa, as well as negotiating prices for their principals. Twelve of the middlemen also performed the service of scheduling shipments. Only 1 indicated that he did any arranging of credit. One provided traffic service, and 1 provided quality control and fiscal planning for his client.

The brokers received their supplies primarily from dehydrator operators. Eight brokers indicated that they obtained from 1 to 30 percent of their supply from other middlemen. Some did not give the volume of dehydrated alfalfa they handled.

Competitive Positions of Sellers and Buyers

Comparison between formula feeds industry and dehydrated alfalfa industry.--Almost all the dehydrated alfalfa produced in the United States goes into the manufacture of formula feeds. This means that the feed manufacturing industry is the only effective outlet for the dehydrator operators. The relation between the dehydrating industry as seller and the feed industry as buyer has been indicated in several ways. A brief discussion of their competitive position follows.

In 1954, 35,067,600 tons of formula feed was produced in the United States, by about 6,250 firms. Of these, 1,250 manufacturers each produced more than 5,000 tons of feed, or 80 percent of the total. About 5,000 firms produced the remaining 20 percent. The 12 largest firms produced about 30 percent of the total. There were 70 companies, controlling about 275 plants, which produced more than 100,000 tons annually (8).

The alfalfa dehydrating industry, on the other hand, is composed of about 350 plants. These produced a total of 1,067,000 tons of dehydrated alfalfa meal during the 1954-55 production year. The largest individual plant in the United States accounted for only a little more than $2\frac{1}{2}$ percent of total production. The largest chain company operated 12 percent of the plants. Another comparatively large company controlled about 8 percent of the plants. Possibly 5 other companies each controlled 5 or more plants. These 7 companies controlled not more than 30 percent of the dehydrating plants in the United States. The size of plants operated by these companies is about the same as that of individually managed plants.

A comparison of the two industries reveals the competitive strength of each. The feed manufacturing industry is larger and more concentrated in its structure. The feed manufacturing industry has alternative sources of feed ingredients, including vitamin A, but the dehydrated alfalfa industry can count on only the formula feed manufacturers to buy the bulk of its production. And most of this production comes from small firms.

Advantages in freight differentials.--The method of pricing for shipments furnishes further evidence of the relative bargaining strength between the two

industries (fig. 9). The center of dehydrated alfalfa production lies in the Middle West, especially Nebraska and Kansas. The center of feed production lies to the east of these 2 States. As can be seen from the map, most of the dehydrator operators in Nebraska and Kansas ship their meal f.o.b. basing point, which for these States is Omaha or Kansas City. As sellers, these operators must absorb the freight from their plant to the basing point. Some plants in the 2 States sell f.o.b. destination. All of these are members of a chain company. East of Omaha and Kansas City, dehydrating plants sell mostly on an f.o.b. plant basis, because the plants are closer to feed manufacturing centers than the basing points are.

The dehydrator operators in Ohio that sell f.o.b. basing point do not present quite so clear a picture. Their basing point is primarily Boston, although a few also mentioned Kansas City. Some of them indicated sales f.o.b. plant or destination as well as basing point. But without knowledge as to where their shipments go under each system of pricing, there is no way to determine who receives the benefits of freight differentials.

Three dehydrating plants in Colorado sell principally f.o.b. plant and mainly to local livestock feeders. The other 2 sell f.o.b. basing point.

PHYSICAL HANDLING

Type of Carrier Used for Shipments in 1954

More shipments were made by rail than by truck in 1954 (table 20). In every region, and especially in the North Central region, the larger plants were heavier users of rail facilities than the small plants.

Trucks were used more than rail carriers in the Southwest, and only a little less than rail carriers in the Northeast.

Forms in Which Dehydrated Alfalfa Is Marketed

Almost 85 percent of dehydrated alfalfa was marketed as meal in 1954, and about 12 percent as pellets (table 21). The small amounts remaining were sold as granules, or in feeds mixed at the dehydrating plant and in other forms. The North Central and South Central regions were the heaviest producers of pellets.

Multiple-drum plants in the South Central area and single-drum plants in the North Central area were the only ones that marketed significant quantities of granules.

Shipments in Bulk and in Bags

Most of the dehydrated alfalfa shipped in 1954 was in bags (table 22). In only one area, the North Central, multiple-drum plants shipped more alfalfa in

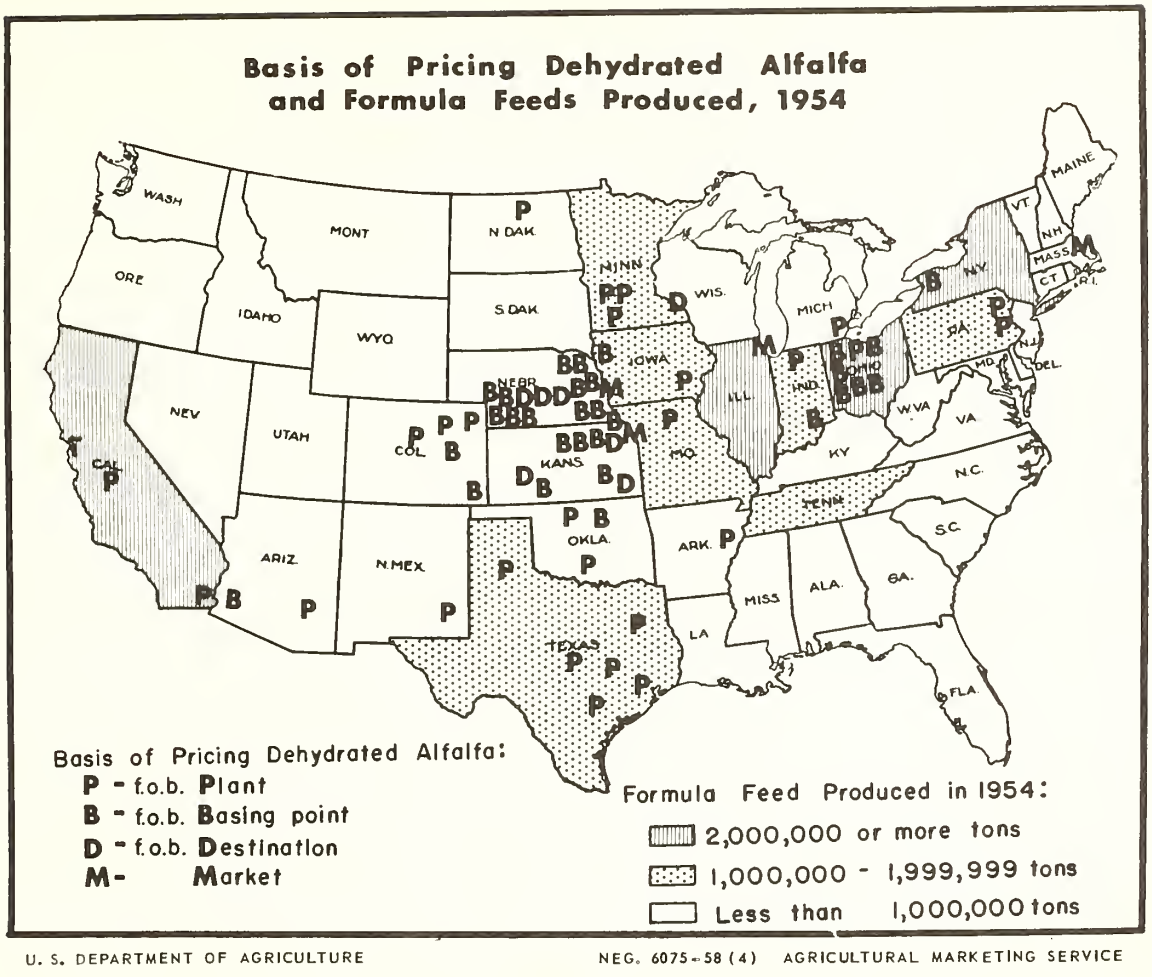

Figure 9

bulk than in bags. In this region, however, single-drum and multiple-drum plants together shipped more in bags than in bulk.

Bulk shipments were notably small in the Southwest and the Northeast.

Burlap or cloth bags are popular in the South Central and Southwest regions. They are used more by single-drum plants than by multiple-drum plants in both regions.

Time in Storage

In 1954, the plants in the survey shipped 56 percent of their product as soon as it was processed, without storing it at all (table 23). The remaining 44 percent was stored for various periods of time. As indicated by the table, 21 percent of processed alfalfa was stored less than 3 months, 18 percent from 3 to 6 months, and 5 percent for more than 6 months. Thus 77 percent was stored not at all or for less than 3 months by the producing plants.

Table 20.--Type of carrier used in shipping dehydrated alfalfa, by region and by type of plant, 1954

Region and type of plant	Total plants in region	Rail		Truck	
		Plants	Percentage of total shipments	Plants	Percentage of total shipments
	Number	Number	Percent	Number	Percent
Northeast:					
Single drum	11	8	43	11	57
Multiple drum	3	3	75	3	25
All plants	14	11	55	14	45
North Central:					
Single drum	11	8	64	8	36
Multiple drum	10	10	86	9	14
All plants	21	18	80	17	20
South Central:					
Single drum	14	14	69	13	31
Multiple drum	7	7	83	6	17
All plants	21	21	76	19	24
Southwest:					
Single drum	5	5	24	5	76
Multiple drum	7	7	46	5	54
All plants	12	12	43	10	57
United States:					
Single drum	41	35	57	37	43
Multiple drum	27	27	74	23	26
All plants	68	62	68	60	32

Some differences occur between sizes of plants and among regions with respect to shipments at the time of processing and time in storage. The differences are not great, however, and show a rather consistent pattern of practice, with one exception. This exception occurs in the South Central area, where only 42 percent of the product of multiple-drum units is shipped as it is manufactured.

In each region, shipments were larger during the production season than at any other time of the year. Table 24 shows the relative sizes of monthly shipments made during 1952, 1953, and 1954 by all plants covered in the survey. The increase in shipments during the processing season is especially large in the Northeast, North Central, and South Central areas. In general, June, July, and August show the highest percentages of shipments in the Northeast. The

Table 21.--Form in which dehydrated alfalfa was marketed, by region and by type of plant, 1954

Region and type of plant	Average production per plant	Meal	Pellets	Granules	Mixed feeds	Other forms
	Tons	Percent	Percent	Percent	Percent	Percent
Northeast:						
Single drum	2,499.18	87	--	--	13	--
Multiple drum	5,391.42	100	--	--	--	--
All plants	3,118.94	92	--	--	8	--
North Central:						
Single drum	2,845.27	94	2	4	--	1/
Multiple drum	7,846.12	83	16	1	--	1/
All plants	5,226.61	86	12	2	--	1/
South Central:						
Single drum	2,439.65	73	26	1	--	1/
Multiple drum	5,554.13	68	28	4	--	1/
All plants	4,439.64	70	27	33	--	1/
Southwest:						
Single drum	1,686.00	86	5	--	3	6
Multiple drum	7,118.39	98	1	1	--	--
All plants	4,854.60	96	2	1	1/	1
United States:						
All plants	287,156.85	85	12	2	1	1/

1/ Less than 0.51 percent.

principal shipping months are June to September in the North Central region. As a large number of plants in the North Central area are located in its southernmost part, the added month is indicative of a longer growing season for alfalfa. In line with this, in the South Central area, the months of largest shipments are June to October.

The Southwest exhibits a somewhat erratic pattern. In much of this area there are season-to-season variations in crop production, coupled with a longer growing season. A higher percentage of dehydrated alfalfa is shipped at the time of processing in the Southwest than in any of the other areas (table 23).

The pattern of shipments of dehydrated alfalfa shows some relationship to the pattern of production of formula feeds. William T. Diamond, speaking to the Dehydrators Production School, said, "As a matter of fact, in the month

Table 22.--Manner of shipping dehydrated alfalfa, by region and by type of plant, 1954

Region and type of plant	Total plants in region	Bulk		Burlap or cloth bags		Paper bags	
		Plants	Percentage of total shipments	Plants	Percentage of total shipments	Plants	Percentage of total shipments
	Number	Number	Percent	Number	Percent	Number	Percent
Northeast:							
Single drum	11	1	9	6	37	8	54
Multiple drum	3	1	1	3	50	2	49
All plants	14	2	6	9	42	10	52
North Central:							
Single drum	11	4	28	5	18	9	54
Multiple drum	10	7	41	6	27	7	32
All plants	21	11	37	11	25	16	38
South Central:							
Single drum	14	5	40	12	56	3	4
Multiple drum	7	4	33	7	46	5	21
All plants	21	9	36	19	51	8	13
Southwest:							
Single drum	5	1	3	5	97	0	0
Multiple drum	7	0	0	7	80	2	20
All plants	12	1	1/	12	83	2	17
United States:							
Single drum	41	11	25	28	43	20	32
Multiple drum	27	12	25	23	48	16	27
All plants	68	23	25	51	46	36	29

1/ Less than 0.51 percent.

Table 23.--Relative percentages of dehydrated alfalfa shipped at time of processing and after various periods in storage, by region and type of plant, 1954

Region and type of plant	Percentage shipped at time of processing	Percentage stored		
		Less than 3 months	3 to 6 months	More than 6 months
	Percent	Percent	Percent	Percent
Northeast:				
Single drum	52	19	25	4
Multiple drum	60	15	15	10
All plants	55	18	21	6
North Central:				
Single drum	53	20	21	6
Multiple drum	60	24	14	2
All plants	58	23	16	3
South Central:				
Single drum	71	16	11	2
Multiple drum	42	31	20	7
All plants	54	25	16	5
Southwest:				
Single drum	62	24	9	5
Multiple drum	59	16	19	6
All plants	59	17	18	6
United States:				
Single drum	58	19	19	4
Multiple drum	56	22	17	5
All plants	56	21	18	5

when we turn out our greatest amount of feed, we are putting out about 9 percent of the annual output, and in the month when we turn out the least amount of feed, we are putting out about $7\frac{1}{2}$ percent" (8). However, seasonal variations occur in production of certain types of feeds, and in production at certain plants. Poultry feeds, among others, are seasonal, and as these are the types in which dehydrated alfalfa is most heavily used, the demand for dehydrated alfalfa varies accordingly.

Table 24.--Percentage of annual production of dehydrated alfalfa shipped monthly by 69 plants, by regions, 1954

Month	Northeast			North Central			South Central			Southwest		
	1952	1953	1954	1952	1953	1954	1952	1953	1954	1952	1953	1954
April	7.80	7.30	6.51	4.04	4.82	4.31	6.65	9.32	9.47	8.38	5.66	10.07
May	6.07	8.07	6.92	7.29	5.21	6.37	9.47	8.91	7.30	5.55	8.53	7.37
June	11.09	11.23	8.94	14.58	12.66	12.65	12.61	11.44	10.08	6.52	8.55	7.89
July	9.23	9.05	10.71	14.14	15.93	13.80	12.35	9.89	11.52	8.16	9.83	9.08
August	11.01	7.73	9.24	11.40	9.68	10.43	10.95	6.73	7.38	10.54	8.46	7.90
September	7.99	7.05	7.77	9.60	8.91	11.50	9.28	6.46	6.88	10.39	8.81	7.15
October	7.89	8.86	10.00	7.70	8.16	8.48	9.16	10.15	8.71	13.43	10.28	7.07
November	7.94	6.63	6.17	6.30	6.76	6.87	6.25	8.50	8.07	8.82	11.43	7.10
December	7.55	7.61	8.10	7.47	8.16	8.28	5.23	8.41	7.30	4.91	10.85	7.90
January	8.12	10.00	7.89	7.31	8.69	6.13	6.65	7.27	8.31	5.24	6.58	8.84
February	6.41	7.65	7.76	5.77	6.22	5.28	7.12	6.48	7.65	6.77	5.76	8.80
March	8.90	8.82	9.99	4.34	4.80	5.90	4.28	6.44	7.33	11.28	5.26	10.83
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

STANDARDIZATION AND SIMPLIFICATION

Grade Designations

Standardization is something of a problem in the marketing of dehydrated alfalfa. The following pertinent material was obtained from the Kansas City Grain Market Review of the Kansas City (Mo.) Board of Trade.

During the 23 years from 1930 to 1952 there were more than 50 different market grade designations of alfalfa meal, including both sun-cured and dehydrated. In 1930, five grades were listed: Alfalfa meal, choice; No. 1, No. 2; brown; and alfalfa molasses feed. During 1931, No. 1 and No. 2 were changed to read No. 1 fine and No. 2 fine. No. 1 medium, No. 2 medium, and No. 1 stem meal were added, making 7 different grades in that year. No new grades were added until 1934, when the No. 1 stem meal was changed to alfalfa stem meal. Alfalfa leaf meal was added as a grade designation. In 1935, only 3 of the grades previously named were being used. These were No. 1 fine, No. 1 medium, and alfalfa leaf meal.

In June 1936, the alfalfa leaf meal was broken down into sun-cured leaf meal and dehydrated leaf meal. The dehydrated leaf meal was used until the latter part of 1937, then was dropped until the latter part of 1939. The 4 grades listed for 1936, except for the temporary dropping of dehydrated leaf meal, were used until 1940. In 1940 the protein content was included in the grade designation. Dehydrated alfalfa as such was first used in 1936, continued to the latter part of 1937, and then dropped. When quotation of it resumed again in September 1939, it was quoted as dehydrated alfalfa meal, 20 percent protein.

From 1940 through 1944 the grades quoted were about the same, with alfalfa meal, No. 1 fine ground, No. 1 medium, No. 2 medium, No. 1 stem meal; alfalfa leaf meal, sun-cured, 20 percent protein; and dehydrated meal, 20 percent protein, 17 percent protein, and 13 percent protein. From September 1943, there were 3 additional grades listed: Sun-cured 20 percent protein choice leaf meal, 20 percent protein standard leaf meal, and 15 percent dehydrated leaf meal. From 1944 to 1948 there were 12 to 16 different grades of alfalfa meal listed. These consisted of leaf and stem meals with the differences in grade and fineness, and with protein percentages ranging from 13 percent to 20 percent. Dehydrated alfalfa leaf meal with guaranteed protein and vitamin A (carotene) grades were first quoted in December 1948. From 1948 to 1952 there were 8 different grades of dehydrated alfalfa quoted at one time or another. Over the years the dehydrating industry has fairly well standardized the grades being produced.

In 1952 the Kansas City Grain Market Review quoted the following grades: Alfalfa meal sun-cured, $\frac{1}{4}$ inch Nebraska, Colorado fine ground, dehydrated alfalfa meal, sacked 17 percent protein guaranteed 100,000 A, and nonguaranteed A. The May 4, 1956, Grain Market Review gives the following quotations: Alfalfa meal, sun-cured, fine ground; dehydrated alfalfa meal, sacked, 17

percent protein, guaranteed 100,000 A; nonguaranteed A; 15 percent protein. The standard grade of dehydrated alfalfa quoted on the market now is the 17 percent protein with a guaranteed 100,000 vitamin A content. Dehydrators sell alfalfa meal with higher and lower guaranteed contents of protein and carotene.

Guaranteed Carotene Content

Of the total marketed dehydrated alfalfa, 87 percent was guaranteed as to carotene content and 13 percent was not (table 25). On an average, larger firms guaranteed more of their product than small firms, the percentages being 93 and 77, respectively.

This general picture was also true in each of the four areas covered. The highest percentage of guaranteed meal existed in the Southwest among multiple-drum plants, where 99 percent of marketed dehydrated alfalfa was guaranteed. The smallest percentage occurred in the Northeast among single-drum units, where 70 percent was guaranteed. On an average for all plants regardless of size, the regions ranked as follows: Southwest, 97 percent; North Central, 88 percent; South Central, 84 percent; and Northeast, 80 percent.

Financing and Risk Bearing

Thirty-eight of the dehydrator operators had to borrow in order to carry their 1954 inventory. Several among these 38 indicated that they obtained loans easily from stockholders or partners who were bankers. Twenty-nine stated that they did not borrow to carry the 1954 inventory. Of these 29 operators 2 could not obtain loans because their bankers thought that loans on dehydrated alfalfa involved too great a risk. Two operators gave no information at all concerning their borrowing activities.

Only 3 of the 38 operators who borrowed thought that creditors influenced their marketing activities. These 3 had to sell their meal at a time of low prices in order to pay back their loan.

On the question whether the lack of investment and working capital influenced the marketing of dehydrated alfalfa, responses varied. Fifteen stated that this was a definite problem with them. Out of this group, 10 said that their primary need was for more storage. One operator said he needed more equipment. Four operators said that they were pinched for operating expenses. Both lack of storage space and lack of operating capital necessitated the early sale of meal, on the one hand because it could not be stored, on the other because current operating expenses had to be met.

The dehydrated alfalfa industry is confronted with many risks. Among these are uncertainties of supply, of price, and of quality. There are also other risks, among them exposure to greater fire hazards than exist in other industries.

Table 25.--Percentage of marketed dehydrated alfalfa guaranteed as to carotene content, by region and type of plant, 1954

Region and type of plant	Guaranteed		Not guaranteed	
	Number of plants	Percentage of total marketing	Number of plants	Percentage of total marketing
	Number	Percent	Number	Percent
Northeast:				
Single drum	9	70	9	30
Multiple drum	3	95	2	5
All plants	12	80	11	20
North Central:				
Single drum	10	81	5	19
Multiple drum	9	91	3	9
All plants	19	88	8	12
South Central:				
Single drum	14	79	5	21
Multiple drum	7	88	2	12
All plants	21	84	7	16
Southwest:				
Single drum	5	82	3	18
Multiple drum	7	99	2	1
All plants	12	97	5	3
United States:				
Single drum	38	77	22	23
Multiple drum	26	93	9	7
All plants	64	87	31	13

An uncertain supply of alfalfa for dehydrating results in instability of production. During some years, a few plants do not operate because there is no raw material available. Reduced production or complete lack of it in any one season works a hardship on dehydrating firms because of the necessity to meet fixed costs.

Price uncertainties bear heavily upon dehydrator operators. There is no futures market to provide hedging opportunities and it does not appear that a bona fide futures market could function in the industry.

The factor of quality arises as a risk in several ways. The growing alfalfa may be of poor quality for several reasons, such as unusually wet weather, and protein and carotene requirements for standard meal may be hard

to obtain. After dehydration there is always the danger of deterioration. Because feed manufacturers do not stockpile their raw materials for more than several weeks ahead of current needs, deterioration as a risk falls primarily upon the dehydrator operators.

Market information

Market information in the form of price quotations is available to dehydrator operators through newspapers and trade journals. These quotations are based principally upon a standard of 17 percent protein and 100,000 guaranteed units of vitamin A. In some cases, differences in protein or vitamin A or both may form the basis for a different quoted price.

Newspapers in the principal dehydrated alfalfa markets publish daily price quotations. As an example, the Kansas City Star quotes prices for dehydrated alfalfa meal, 17 percent, 100,000 A. It also gives prices for No. 1 fine sun-cured meal. The Wall Street Journal also quotes dehydrated alfalfa meal on its commodity page. The price information quoted in this paper for 17-percent protein meal usually varies according to whether it is bagged in burlap or paper and whether or not vitamin A content is guaranteed.

Feedstuffs, a weekly newspaper for the feed manufacturing industry, gives analyses of demand, supply, and trend, as well as prices, on its Feed Markets pages. About 16 market centers are covered in this paper for processed alfalfa and other feed ingredients. Price quotations for dehydrated alfalfa for the 16 cities do not show much uniformity in grade designations. The following 16 standards were used in the issue of May 12, 1956:

Grade designation	Number of times used
17 percent, northern origin, 100,000 A	1
20 percent, 150,000 A, California origin	1
17 percent, 100,000 A	9
17 percent, nonguaranteed	4
15 percent	1
17 percent	3
20 percent	1
Granules or oil treated (17 percent, 100,000 A)	1
18 percent, 125,000 A	1
Granules or oil treated (18 percent, 125,000 A)	1
136,000 A	1
Straight grades	1
California (origin)	1
20 percent, 150,000 A	1
Alfalfa pellets, 17 percent, 100,000 A	2
No grade designation	1

The list suggests the need for further simplification in grade designation.

The Agricultural Marketing Service, Grain Division, of the United States Department of Agriculture publishes a monthly report of production of alfalfa meal. This report covers the production of both sun-cured and dehydrated meal for the 2 months before its issue date, as well as seasonal totals (from April to 1 month before issue date), and similar figures for the same periods 1 year earlier.

Also included in the monthly report are figures on stocks of alfalfa meal at producing plants for the 2 months before issue date. Comparison is also given between the latest month reported and the same month 1 year earlier.

From time to time the American Dehydrators Association computes and publishes, from the USDA production reports, disappearance rates by months for the current year and similar months for the preceding year.

The American Dehydrators Association also publishes a weekly bulletin which contains the latest information on crop conditions and expectations in various parts of the country.

COMPETITION AND PRICE DETERMINATION

Competition

The dehydrated alfalfa industry has few sellers and few buyers. This represents a situation in which an individual can influence market price. The action of each seller or buyer determines, and is determined by, what other sellers or buyers do. The decision of one dehydrator operator, for example, to reduce prices must be made in consideration of the possibility that other operators will follow suit, either in retaliation or as a means of assuring them their share of the market.

The use of the basing-point system of pricing places some dehydrator operators in a position of advantage over others. Advertising, brands, and trade marks are indicative of product differentiation. All these are means by which some sellers can achieve preferential treatment from buyers.

Price Determination

A few of the persons interviewed for this study stated that they supply regular customers at the current price, but if that price is low they store any meal left over. This is one way of saying that, at any given time, these sellers have more than one price at which they are willing to sell various quantities of their product; the higher the price, the greater the quantity of dehydrated alfalfa they are willing to sell.

The relationship between price and quantity differs among various sellers at any given time. Although no actual supply schedules were obtained in the survey, some evidence of how dehydrator operators react to various prices was

provided in their answers to questions on sales and storage policies. These reactions are indicated in the hypothetical data given in table 26.

Table 26.--Tons of dehydrated alfalfa that various operators will supply at different prices (assumed data)

Price per ton	Operator A	Operator B	Operator C	Operator D
	Tons	Tons	Tons	Tons
$ 30	500	500	0	500
$ 40	1,500	700	1,000	500
$ 50	3,000	1,000	2,000	500

These different reactions to price may be explained in terms of individual reactions:

Operator A is induced to sell considerable additional quantities of meal as price increases--that is, he is responsive to price changes.

Operator B is not very responsive to price changes.

Operator C will sell nothing at $30, but is relatively responsive at higher prices.

Operator D sells the same amount at all prices. He may be the type of seller who could be induced to additional sales only if the price exceeds $50, or he may sell all his meal regardless of how low the price falls because he has no alternative but to sell.

Many factors may be involved in the different responses to price changes among individual sellers of dehydrated alfalfa. Four principle ones, however, were either explicit or could be inferred from interviews with operators. These were (1) differences in outlook with respect to future prices, (2) differences in production costs and/or knowledge of those costs, (3) differences in availability of storage space, and (4) differences among operators in their need for ready cash.

Not only do sellers of dehydrated alfalfa differ from each other in their responsiveness to price change, but any individual seller will exhibit a different response from one time to another. This change over time may be shown by letting the supply condition of operator A in table 26 represent his attitude in the summer during the processing season, and then setting up a new schedule to represent his supply condition during a winter month (table 27).

Table 27.--Tons of dehydrated alfalfa supplied by operator A during a summer month and a winter month (assumed data)

Price per ton	Summer supply	Winter supply
	Tons	Tons
$ 30	500	0
$ 40	1,500	0
$ 50	3,000	500
$ 60	4,500	700

The changed price-quantity relationship may be explained as follows:

Summer: The dehydrator operator's production costs per unit are lowest during the processing season, hence he can accept a lower price for his meal than at other times during the year. Also, during the production season, prices in the next month or so may not be promising, therefore he is likely to be responsive to price changes.

Winter: The dehydrator operator must receive higher prices during the winter months because costs, especially for storage, have accumulated against his product. Moreover, winter sales are mostly from stored inventories, which means that stocks are diminishing. In this situation, prices in the immediate future are likely to be promising, and the result is that the seller becomes less responsive to price changes than when sales are made largely from current production.

Demand also varies as price varies, with the price-quantity relationship being an inverse one. Amounts that individuals are willing to buy at various prices differ among buyers and change for any one buyer over time. No exact data pertaining to demand for dehydrated alfalfa were obtained in the study. However, enough information was given by the persons contacted to indicate the response of buyers to price changes, and the manner in which demand changes for the individual buyer from one time to another.

Members of the Nutritional Council of the American Feed Manufacturers Association expressed the view that dehydrated alfalfa constitutes an essential ingredient in most poultry formulas and is useful in some other mixes. In their estimation, the price of dehydrated alfalfa (within limits) was not an important determinant of the quantity used in poultry feeds, except for the mixes in which dehydrated alfalfa was considered desirable but not essential.

As some differences did exist among the nutritionists with respect to the relative essentiality of dehydrated alfalfa in poultry and other feed formulas, some variations among them would be indicated also for price-quantity relationships. The hypothetical data given in table 28 are designed to emphasize that these differences do occur.

Table 28.--Tons of dehydrated alfalfa demanded at different prices by various buyers (assumed data)

Price per ton	Buyer A	Buyer B	Buyer C
	Tons	Tons	Tons
$ 30	1,100	1,200	1,000
$ 40	1,000	1,000	700
$ 50	900	800	400
$ 60	800	500	0

The differences in response to price changes may be explained as follows:

Buyer A is not very responsive to price changes. This means that he considers dehydrated alfalfa to be an essential ingredient in his formula and price is not a decisive factor in his use of it.

Buyer B is more responsive to price changes than buyer A. He may not consider dehydrated alfalfa as essential as A does, and he may also have substitutes for dehydrated alfalfa more readily available than A has.

Buyer C is the most responsive to price changes. At least three factors could account for the differences: (1) He may not consider dehydrated alfalfa as very essential in any of the formulas he produces, hence price becomes a determinant in his use of it; (2) he may have substitutes for dehydrated alfalfa available more readily than either A or B; and/or (3) the ratio of feeds produced in which dehydrated alfalfa is considered an essential ingredient to those produced in which dehydrated alfalfa is considered as merely useful may be lower than the corresponding ratio for A or B.

An individual buyer's demand for dehydrated alfalfa changes from one time to another. If the schedule for buyer A in table 28 is assumed to represent his demand during a summer month, additional data assumed to represent his demand during a winter month will illustrate the change (table 29).

Table 29.--Tons of dehydrated alfalfa demanded by buyer A at various prices during a summer month and a winter month (assumed data)

Price per ton	Summer demand	Winter demand
	Tons	Tons
$ 30	1,100	900
$ 40	1,000	600
$ 50	900	400
$ 60	800	250

The explanation for the change in demand from one time to another can be illustrated as follows:

Summer: Buyer A is not very responsive to price changes in summer, and so must be producing a high proportion of mixed feed in which he considers dehydrated alfalfa to be an essential ingredient. He may be a producer of poultry feeds; not only is dehydrated alfalfa considered to be essential in poultry formulas, but also the production of poultry feeds is somewhat concentrated in the summer months. The production of some other types of feeds is smaller during the summer than during winter. Thus the ratio of poultry feeds to nonpoultry feeds may be relatively high during the summer months.

Winter: Buyer A will buy smaller amounts of dehydrated alfalfa at all possible prices in winter because he is producing less poultry feed at that time. Moreover, he will be more responsive to price changes in winter because he is producing more feed in which dehydrated alfalfa is not considered an essential ingredient.

Industry supply is obtained by adding together all the supply schedules of individual dehydrator operators. Thus, if the amounts of dehydrated alfalfa which operators A, B, C, and D are willing to sell are combined with similar schedules for all other sellers of the product, the industry supply schedule results. The total schedule would take on the characteristics which are predominant among individuals.

In a similar manner, the industry demand schedule may also be obtained. It would take on the characteristics which dominate most buyers. Just as both the individual supply schedule and the individual demand schedule represent attitudes as of a given time, the corresponding industry schedules represent aggregated attitudes as of a given time. The industry schedules are also subject to change over time.

Analysis of sales, storage, and purchasing policies indicate that these industry supply and demand schedules have the following tendencies:

1. Suppliers are more responsive to price changes in summer than in winter.

2. Buyers are more responsive to price changes in winter than in summer.

3. Suppliers of dehydrated alfalfa are more responsive to price changes in the summer than buyers are.

4. Buyers are more responsive to price changes in the winter than suppliers are.

The relationships between buyers and sellers change gradually from summer to winter and back again. Price and quantity relationships for intermediate periods would fall somewhere between these extremes. Hence, there is a seasonal swing of prices back and forth between summer low prices and winter high prices. Since there are relatively few buyers and sellers represented in the dehydrating industry, it is always possible for individual buyers or sellers to influence market price.

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Appendix A. Questionnaires and Surveys

Replies were received from 325 dehydrator operators who were asked to report their type of business organization, 24-hour dehydrating capacity, production volume for the producing periods of 1953-54 and 1954-55, channels of distribution, form in which their produce was marketed (meal, pellets, etc.), whether shipments were made in bulk or in bags, and storage facilities available.

A detailed schedule was devised for personal interviews. This survey was conducted on a sample basis. In essence, rather exhaustive information was sought on the processing and marketing activities of the individual plant. A skeletonized form of the schedule follows:

A. General information

1. Location of plant
2. By whom plant owned
3. By whom plant operated
4. Name of individual in charge of plant
5. Crops dehydrated at the plant
   a. Tons dry weight produced for crop years of 1952, 1953, and 1954
6. Twenty-four hour dehydrating capacity in tons

B. Procurement of alfalfa for processing

1. Percentage of alfalfa purchased in 1954 on contract
2. Terms of contract relating to quality, price, delivery date, etc.
3. How the price to be paid for alfalfa is determined
4. Amount of alfalfa obtained from acres owned by firm, leased by by firm or from other sources in 1954
5. Percent of alfalfa supply bought by acre or by ton in 1954
6. Distance of alfalfa supply from plant
7. Whether plant does or does not operate equipment for harvesting alfalfa
8. Percent of Alfalfa supply harvested by the firm in 1954
9. Harvesting equipment used (itemized)

C. Processing of dehydrated alfalfa

1. Processing facilities and equipment (itemized)
2. Type of fuel used for dehydration
3. Number of employees at maximum production in 1954, with specifications as to direct operations, supervisory and administrative, and sales

D. Storage of dehydrated alfalfa

1. Facilities available
2. Amount of dehydrated alfalfa in storage on September 30, 1954
3. Relative time of dehydrated alfalfa in storage prior to shipment
4. How quantity and time to store dehydrated alfalfa is determined
5. Whether firm did or did not borrow to carry 1954 inventory
6. If plant did borrow, were terms of loan such that creditor influenced time of sale of processed alfalfa?

E. Sale and shipment of dehydrated alfalfa

1. Percent of dehydrated alfalfa processed in 1954 marketed as meal, pellets, granules, in mixed feeds or in other forms
2. Percent marketed in bulk, burlap or cloth bags or in paper bags
3. Percent of dehydrated alfalfa processed in 1954 sold through commissionmen, brokers, direct to feed manufacturers, direct to livestock feeders or direct to others
4. Percent of 1954 production used in firms own feed mix
5. Percent of 1954 production shipped by rail or truck
6. Guarantee of carotene content and on what percent of 1954 shipments such guarantee made
7. Carotene tests made by own laboratory or by a commercial laboratory
8. Tests for protein content, moisture content and fiber content
9. Percent of 1954 sales priced f.o.b. plant, destination or basing point
10. Percent of 1954 production sold for cash or on credit
11. Percent of 1954 production sold for future delivery
12. Distribution of shipments of processed alfalfa for 1952, 1953, and 1954, broken down by month from May through April
13. Percent of gross sales in 1953 spent for sales promotion
14. Manner in which sales promotion expenditures were distributed, i.e., newspapers, radio, magazines and trade journals or other media
15. Brief description of own sales organization, if any
16. Factors considered in establishing selling prices for dehydrated alfalfa products
17. Practices followed by buyers which influence the price received for the firm's products
18. Influence of each investment or working capital on the marketing of dehydrated alfalfa.

A detailed schedule was also developed to serve as a guide in interviewing middlemen. In brief outline the schedule follows:

A. General information

1. Firm name and location
2. Location of home office

3. Location of other branch offices
4. Percent dehydrated alfalfa sales are of total sales
5. How many tons of dehydrated alfalfa were handled during 1954
6. Average markup on dehydrated alfalfa during 1954 in dollars per ton
7. Comparison of 1954 markup with previous year--greater, less or same

B. Services performed

1. Whether dehydrated alfalfa is or is not purchased
2. Percentage purchased in 1954 directly from dehydrators, from other middlemen, or from other sources
3. Percentage of dehydrated alfalfa purchased in 1954 for cash or on credit
4. How the price is determined for dehydrated alfalfa products
5. Percentage of dehydrated alfalfa purchased in 1954 received by rail, by truck, or by other means
6. Percentage of dehydrated alfalfa in 1954 used in feed mixing, blending, pelleting, or given over to other uses
7. If storage facilities are operated is this principally for own inventory, other processors, or others?
8. Type of storage facilities operated
9. Percentage of dehydrated alfalfa handled during 1954 shipped without storing, stored less than 3 months, stored 3 to 6 months, or stored 6 months or more
10. Percentage of total sales of dehydrated alfalfa in 1954 sold to feed manufacturers, to other middlemen, to livestock feeders, or to others
11. Factors considered in establishing the selling price for dehydrated alfalfa products
12. Percentage of dehydrated alfalfa sales during 1954 shipped by rail, by truck, or by other means
13. Percentage of dehydrated alfalfa sold during 1954 guaranteed as to carotene content
14. Services performed for the seller and/or buyer, locate supplier, provide credit, arrange credit, schedule shipments, negotiate price, etc.
15. Percentage of suppliers of dehydrated alfalfa during 1954 who were dehydrators, other middlemen, or other (specified)
16. Percentage of buyers of dehydrated alfalfa during 1954 who were feed mixers, livestock feeders, other middlemen, or others (specified)

Appendix B. Index of seasonal variation: Feedstuffs, production in United States, 1944-1954 1/

Commodity	January	February	March	April	May	June	July	August	September	October	November	December
Dehydrated alfalfa meal	7.75	11.41	22.12	44.64	134.56	226.32	234.38	205.07	163.56	111.46	27.83	10.92
Sun-cured alfalfa meal	120.90	106.20	90.50	76.20	66.70	93.60	103.10	102.80	99.60	107.20	117.00	116.40
Wheat millfeeds	109.46	97.87	98.20	90.01	91.39	93.50	96.78	102.98	103.17	111.95	103.06	101.60
Corn gluten feed and meal	102.60	93.30	107.10	99.50	99.40	98.70	94.10	97.70	97.40	105.10	104.90	100.30
Brewers' dried grains	87.20	83.60	95.90	95.50	105.20	114.00	120.60	121.00	106.40	100.00	85.70	85.70
Distillers' dried grains	110.90	115.50	128.00	109.70	106.40	79.80	79.60	82.90	86.70	107.10	89.00	104.20
Soybean cake and meal	116.60	107.80	116.50	104.40	101.90	89.70	90.00	87.50	74.40	95.10	109.00	107.20
Cottonseed cake and meal	155.20	118.60	94.80	64.20	47.20	34.40	26.90	39.60	104.40	178.90	179.80	156.00
Linseed cake and meal	101.10	93.50	91.70	79.00	79.70	94.30	104.00	104.90	113.00	117.50	115.20	105.90
Dry or powdered skim milk	69.00	70.40	102.00	135.00	176.90	185.00	128.80	106.70	74.10	56.80	44.00	52.50
Tankage	114.30	105.60	98.20	87.70	89.70	92.70	90.70	97.00	89.10	99.00	117.60	118.80
Meat scraps	104.90	94.00	98.30	98.00	100.50	99.10	96.10	101.30	95.90	104.80	103.40	103.30

1/ A 13-month moving average was used to compute the seasonal variations.

Computed from Grain and Feed Statistics Through 1954, U. S. Dept. Agr., Stat. Bul. No. 159, pp. 66-73, March 1955.

Appendix C. Index of seasonal variation: Feedstuffs, wholesale price per ton at Kansas City, Mo., 1938-1955 1/

Commodity	January	February	March	April	May	June	July	August	September	October	November	December
Dehydrated alfalfa meal	110.28	109.65	104.34	100.00	89.65	86.01	88.00	93.02	98.65	104.59	107.39	108.50
Sun-cured alfalfa meal	104.89	102.43	99.05	97.35	95.89	92.37	93.98	97.20	102.07	104.07	105.37	105.27
Bran	103.06	99.79	106.04	110.60	104.99	97.95	98.55	92.60	94.54	93.84	98.19	100.07
Wheat shorts	98.04	96.30	103.00	105.64	106.37	104.85	98.60	94.19	99.00	98.76	99.01	96.19
Soybean meal	100.18	97.11	96.42	97.92	97.39	98.55	104.83	103.43	102.20	98.22	101.72	102.07
Cottonseed meal	103.08	97.83	98.19	97.83	96.44	96.06	101.26	102.24	98.96	99.46	104.02	104.60
Linseed meal	107.04	103.29	100.19	99.43	97.98	94.73	96.96	96.87	96.90	98.82	102.72	105.02
Gluten feed	104.63	102.87	100.43	98.71	98.59	96.76	98.70	98.31	98.39	98.92	99.90	103.78
Tankage	104.36	100.88	99.00	97.94	95.60	93.65	98.84	100.40	100.71	102.51	102.86	103.27
Meat scraps	100.18	98.11	97.92	98.14	97.41	97.64	103.56	105.39	102.25	99.36	100.12	99.95
Fish meal (Buffalo, N. Y.)	103.92	104.10	103.03	102.93	100.05	98.10	96.00	95.56	95.96	97.94	100.12	102.30

1/ A 13-month moving average was used to compute the seasonal variations.

Computed from Alfalfa Meal, U. S. Dept. Agr., Agr. Mktg. Serv., Kansas City, Mo., Apr. 1955 (processed), and Kansas City Grain Market Review, Board of Trade, Kansas City, Mo. (monthly average of daily top carlot price per ton, nominal quotations).