THE EFFECTS OF THE PRODUCTION OF HAY ON ITS SEASONAL PRICE AND SEASONAL MARKETING MOVEMENT IN KANSAS

by

John Richard Unger

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INTRODUCTION

It is generally the goal of every business to carry out its marketing activities in such a way that it can make the largest gain or return. Farming is no exception as long as this does not adversely affect future profits. It is important for any individual buying or selling agricultural commodities to study production and prices if he is to conduct his business successfully.

Hay is a commodity which displays wide fluctuations in production and price. The wide fluctuations in the production of hay makes it possible to place each year into a type of roughage production period according to the relative size of the crop. The seasonal price movements during these periods can then be calculated and shown.

Whether individuals buying or selling hay consider the production figures and price movements is not known. But a study of the seasonal price analysis of hay and its supply is important in order to market intelligently.

Hay is an important feed for livestock in Kansas. Many farmers rely upon hay to carry their livestock through the winter months. Roughages other than hay are also used, but marketing activities and price quotations are not adequately available for these other roughages, so only the price activities of alfalfa and prairie hay are analyzed in this study.

BACKGROUND AND PROBLEM

The hay and roughage supply in Kansas is highly variable from year to year because of several factors. Some of these factors are weather, insects, and government policies. The variation from one year to the next of hay and other roughage production in Kansas is probably more dependent upon weather than upon any other factor. The fluctuation of the hay supply creates for both the producer and the consumer the problem of when to buy or sell hay so as to make the most profit or to suffer the smallest loss. This is partly because of the difference in the seasonal price movements of hay.

The changing from year to year of the seasonal price movements of hay has suggested dividing the years into the different type roughage production periods in accordance with the quantity produced. These seasonal price movements could then show the way prices might be expected to behave during any year corresponding to one of these different type production periods.

Individuals relying upon a supply of hay produced by others must be prepared to make decisions concerning whether or not to buy, and when to buy. A different seasonal price movement of hay in each of the different type production periods complicates the problem of price prediction. For the buyer, it is a problem of when during each type production period is the best time to buy so as to reduce costs. For the seller, the similar problem is in what month during each year can he get the highest return for his hay crop.

The central problem investigated in this study was the analysis of relationships which exist between the seasonal price movements of hay and the variation in volume of roughage production in Kansas. Some subsidiary questions are important in an analysis of the central problem. These are: (1) How do hay and roughage crops compare in importance to the feed grains as a

feed for livestock? (2) What is the degree of fluctuation of the production of hay and other roughage crops from year to year in Kansas? (3) What is the relationship between the numbers of various types of livestock in Kansas and the roughage supply? (4) What is the difference between the seasonal price movements of hay for the different types of roughage production years in Kansas? (5) What time of the year is most of the hay marketed as indicated by the percentage marketed by months in Kansas?

FIELD OF STUDY

This particular study is confined almost entirely to the roughage crops of alfalfa and prairie hay. Sorghums are important as a roughage crop and contribute a significant part of the total roughage supply, but their price movements were not studied for lack of adequate price information.

In order to investigate the central problem, several other questions and problems were investigated. First, the importance of hay and other roughages in Kansas was compared with the feed grains as a feed for livestock over the past 25 year period.

Second, after the importance of hay and other roughages was considered, it was shown how the fluctuations in roughage supplies from year to year cause problems of uncertainty. Such uncertainty may influence operating profit.

Next, the relationship of numbers of different types of livestock to the total roughage supply in Kansas was analyzed to show the response of livestock numbers to the roughage supply. This would help to indicate the relative need for hay and other roughages for livestock in the different roughage production years.

Then, the spread in the seasonal prices of hay was calculated to show the effect different type roughage production periods had upon prices of hay.

Last, the percentage of hay marketed in Kansas during the various months was calculated for the different type roughage production periods. This would help to show the time hay was marketed when there was a difference in the hay and other roughage supply.

PURPOSE AND OBJECTIVE

The primary purpose and objective of this study was to analyze trends, relationships, and production fluctuations of hay and the influence such factors have had on seasonal price and seasonal marketing movements of hay in Kansas.

METHOD OF PROCEDURE

The following steps were followed in analyzing the problem of this thesis.

First, production trends were calculated in order to present the importance of roughage crops in Kansas. Trends were found for the feed grains and the roughage crops both individually and combined. A measure of the fluctuations in supply of hay and other roughages from year to year may help explain why there is the degree of difference in the seasonal price movements of hay that there is in Kansas.

Second, several correlations were calculated to test various relationships in regard to roughages. Correlations were run for example between the feed-grain supply and the number of grain-consuming livestock, and between the roughage supply and the numbers of different types of livestock. Several

other correlations were run to discover relationships that may be actually present in regard to the buying and selling of hay.

Third, seasonal price movements were analyzed for different types of roughage production periods. The production periods were divided into three types (small, average, and large) in accordance with the size of the crop. These three periods were divided according to the standard deviations from the adjusted mean of the roughage production in Kansas and the Flint-Hills area.[1] Marginal monthly prices were also calculated in order to determine the change in price of hay from month to month in the different type production periods. Prices of beef cattle in relation to the types of roughage production years were examined to demonstrate the economic pressure that roughage supply has exerted on cattle numbers.

Fourth, to discover when individuals do actually purchase and sell hay, the percentage marketing of hay in Kansas during the various months was calculated for the different type roughage production periods.

The material and data used in this study were taken from the Farm Facts and the Weekly Hay Market Review for those years used.[2] and [3]

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[1]Adjusted mean is the calculated mean for the data after the trend during that time period had been removed.

[2]Farm Facts, Kansas State Board of Agriculture, 1930-54.

[3]Weekly Hay Market Review, U.S.D.A., Agricultural Marketing Service; Crop years 1941-42, 1949-50, 1950-51, 1951-52, 1952-53, and 1954-55.

LIMITATIONS AND ASSUMPTIONS

The findings of this analysis are useful only in the making of economic decisions. In certain individual cases, in regard to the marketing activities at certain times, the individual may make decisions that are not economically sound because of lack of knowledge, cash or credit, or because he just puts off a decision hoping that circumstances will turn out with no adverse effects. Other reasons may also alter his decisions.

It is assumed that any individual can buy his alfalfa or prairie hay at any time period or sell at any time period at the existing price. This, however, may in some instances not be the case.

It is further assumed that the buyer generally knows with some degree of accuracy what his need for alfalfa and prairie hay for the year will be by early summer, and also that he is able to acquire information from some source of the expected year's roughage production and can closely determine the type of roughage production year the area is having.[1] The need for hay is not always known, depending upon how much the winter feed supply is dependent upon alfalfa and prairie hay. In these cases the decision is harder to make and more uncertainty in the estimate can be expected. It is, in addition, assumed that the seller of alfalfa and prairie hay knows with an equal degree of accuracy early in the summer how much he can and will sell for that year. This, likewise, may not always be the case.

It is assumed that the seasonal price movement of alfalfa and prairie hay in the different type roughage production periods was characteristic of their

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[1] Reliability of crop reports given in Appendix A.

period and decisions could be made from them; however, seasonal price variations may be so large as to make this difficult.[1]

It is realized that the moisture content of hay at harvest time is higher than it would be in the winter months. The moisture content of hay, when properly cured, is normally not higher than 25 percent when put in the bale, but can vary widely if not handled properly.[2] The moisture content of barn-dried alfalfa hay is about 17 percent.[3] This would indicate that hay may lose normally about 8 to 10 percent in moisture content from the time it is put in the bale until January. A large share of this loss of moisture occurs during the first few weeks after baling. The moisture loss has to be considered when judging the price to pay for hay just baled and the price to be paid later when most of the moisture has been lost.

TRENDS IN ACREAGE OF ROUGHAGES AND FEED GRAINS IN KANSAS

Trends are computed to determine the average rate at which a set of data is increasing or decreasing in magnitude. It does not consider the variability of the data and this may be so large at times as to make the trend insignificant. It is this trend or average increase or decrease of the data which was measured here, but the data also has a variability that is quite large.

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[1] Seasonal variation analysis given in Appendix B.

[2] Burcalow, F. V., "Know Moisture Content of Hay", Hoard's Dairyman, Vol. 101, p. 648, June 25, 1956.

[3] Ball, C. E., and G. R. Shier, "Drying Hay with Forced ventilation", Agricultural Engineering, Vol. 29, p. 299, July 1948.

To discover the importance of hay and other roughages in Kansas, their acreage and trends were compared with the feed grains. This would give an indication if the hay and roughages in Kansas were increasing or decreasing and would also show their importance as a feed for livestock in this area as compared with the feed grains.

The acreage harvested of only one of the feed grains, grain sorghum, has had an increasing trend over the past 26 years in Kansas. In 1930, there were 983 thousand acres of grain sorghums harvested and in 1955 there were 2,722 thousand harvested acres. It had decreased slightly for the past two years. This is shown in Table 1.

Corn has shown a distinct drop in acreage in Kansas during this period. In 1930 there were 6,776 thousand harvested acres of corn and in 1955 the acreage had dropped to 1,624 thousand harvested acres. This was a drop of 5,152 thousand acres or close to 80 percent.

The acreage trend for oats and barley has remained steady during this time period with no significant increasing or decreasing trend being shown.

In regard to roughage crops, the acreage harvested of sorghum silage and alfalfa hay have both been on an upward trend during the time period of this study. In 1939, sorghum silage was harvested from 278 thousand acres and in 1955 it was harvested from 785 thousand acres. Alfalfa acreage harvested for Kansas in 1930 was 642 thousand acres and in 1955 it was 1,538 thousand acres. The harvested acres of roughage crops are shown in Table 2.

The acreage harvested of sorghum for forage had shown a definite downward trend through years 1940 to 1952, but from 1952 to 1955 the harvested acres have increased quite significantly.

Table 1. Harvested acres of various feed grains (corn, oats, barley, grain sorghum) in Kansas, 1930-55.

Year	Corn	Oats	Barley	Grain sorghum	Total
			(000 omitted)		
1930	6,776	1,357	608	988	9,729
1931	6,573	1,561	564	1,107	9,805
1932	7,362	1,577	792	1,328	11,059
1933	6,994	1,528	1,067	1,607	11,196
1934	3,777	1,272	593	1,195	6,837
1935	4,380	1,540	544	1,760	8,224
1936	2,759	1,694	557	1,214	6,224
1937	2,456	1,474	298	1,370	5,598
1938	2,260	1,518	393	1,343	5,514
1939	2,757	1,267	647	853	5,524
1940	2,647	1,495	1,136	1,885	7,163
1941	2,488	1,619	1,326	1,275	6,708
1942	3,110	1,813	1,233	1,173	7,329
1943	3,514	1,976	1,110	1,161	7,761
1944	3,549	1,561	722	2,229	8,061
1945	2,981	968	383	1,149	5,481
1946	3,011	1,423	287	851	5,572
1947	2,379	1,395	290	754	4,818
1948	2,427	1,144	362	1,339	5,272
1949	2,524	881	221	1,392	5,018
1950	2,625	960	254	1,943	5,782
1951	2,429	797	119	2,605	5,950
1952	2,720	885	86	1,324	5,015
1953	2,366	1,062	112	3,419	6,959
1954	2,082	1,115	459	3,217	6,873
1955	1,624	1,171	688	2,772	6,255

Source: Compiled from data taken from Farm Facts, Kansas State Board of Agriculture.

Table 2. Harvested acres of various roughage crops (sorghum for forage and silage, alfalfa, wild hay) in Kansas, 1930-55.

Year	Sorghum silage	Sorghum forage	Wild hay	Alfalfa hay	Total
			(000 omitted)		
1930			824	642	
1931			772	719	
1932			770	705	
1933			773	705	
1934			788	749	
1935			796	854	
1936			751	777	
1937			645	606	
1938			697	394	
1939	278	1,466	585	380	2,709
1940	286	1,937	585	490	3,298
1941	452	1,585	573	642	3,252
1942	325	1,359	590	802	3,076
1943	458	1,539	673	810	3,480
1944	412	1,125	693	827	3,057
1945	342	1,386	638	852	3,218
1946	350	1,302	638	826	3,116
1947	409	989	702	1,016	3,116
1948	367	792	632	1,036	2,827
1949	375	749	657	1,026	2,807
1950	408	860	604	995	2,867
1951	553	790	693	985	3,021
1952	409	675	665	906	2,655
1953	581	923	679	1,114	3,297
1954	628	1,181	678	1,381	3,868
1955	785	1,674	607	1,538	4,604

Source: Compiled from data taken from Farm Facts, Kansas State Board of Agriculture.

Wild hay, including wild and prairie grasses, throughout the 26-year period has shown a trend having a slight decline in acreage harvested in Kansas. Wild hay and prairie hay have been used interchangeably in Kansas crop reports and it is assumed both terms apply to a given kind of roughage.

The reason figures are not shown for years 1930-38, inclusive, for sorghum silage and forage is because comparable figures could not be obtained. The composite figure for roughage crops is used only for years 1939-55 for this reason.

The trend for the composite acreage of roughage crops in Kansas for the years 1939-55, inclusive, has increased. The slope of the trend line of roughage crops in Kansas indicated there has been an average increase of about 34 thousand harvested acres per year over the 17-year period. They have increased substantially in total since 1952, but have also had quite a wide fluctuation throughout the period.

The larger acreage and the great need of roughages as a feed for livestock in Kansas, coupled with the production fluctuations of the roughage supply, makes having the proper amount of roughage feeds for livestock from year to year a problem.

TRENDS AND FLUCTUATION IN PRODUCTION OF ROUGHAGES AND FEED GRAINS IN KANSAS

To give an indication of the size of the production of hay and other roughages, compared again to the feed grains, total roughage figures and its trend were calculated. The wide degree of fluctuation of the roughage supply may cause the trend shown to be less significant than it is actually calculated to be. A measure of the fluctuation of the roughage supply was

found to help identify the different types of roughage production periods in Kansas.

There has been an upward trend present in the total roughage supply in Kansas for the period 1930-54, but there have been wide fluctuations from year to year. The total roughage supply in Kansas was made up of the hay production of the current year, the carry-over of hay, and the silage and fodder from corn and sorghums. The slope of the trend line indicated there had been an average increase of about 158 thousand tons of roughage supplied in Kansas during each year since 1930. This increase, however, cannot be depended upon each year, for the fluctuation from year to year is often quite large. The standard deviation for the total roughage supply in Kansas was found to be 1,038 thousand tons with a coefficient of variation equal to 18.3. This wide fluctuation of supply would indicate the presence of the different type roughage production periods. These relationships are shown in Fig. 1.

The total feed grain supply in Kansas for 1930-54 has shown a small downward trend with large fluctuations from year to year. The feed grain supply was made up of the current year's production of corn, grain sorghum, barley, and oats; the carry-over of these grains, and the cereal grains fed. The slope of the trend line indicated an average decrease of about 21 thousand tons of feed grain supplied each year. The standard deviation here was about 1,176 thousand tons. The coefficient of variation was 34.8.

The high degree of fluctuation of the roughage supply, disregarding the feed grains, is what causes the difference in the types of roughage production periods. This creates the situation of an area having first an abundance of hay and other roughage crops and perhaps the next year a shortage. The type of roughage production period may make the time of entering the market much

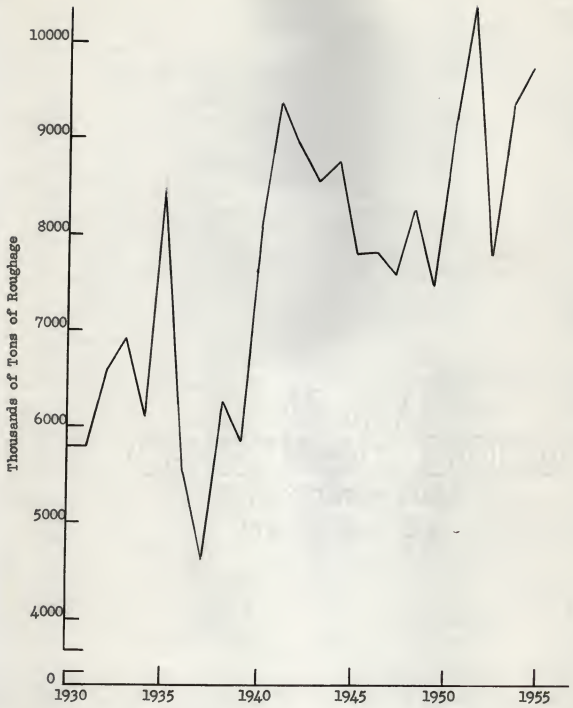

Fig. 1. Total available roughage supply in Kansas for years 1930-54 inclusive, consisting of current hay production, carryover of hay, and silage and fodder from corn and sorghums.

more important in any one year, during any one of these type production periods, than it may be in another. This may be better seen later in this study.

The trend for the roughage-consuming livestock in Kansas, during the period of 1930-54, has shown an average increase of over four and one-half thousand livestock units per year. This indicates there has been a corresponding average increase in both the roughage-consuming livestock and the roughage supply in Kansas. The increased numbers of livestock in Kansas, dependent to a large extent upon hay and other roughages which in turn fluctuate to a great extent, makes the amount of hay bought and sold in the market likely to be an ever increasing figure.

The trend for grain-consuming livestock in Kansas during the period of 1930-54 has shown an average decrease of about 97 thousand livestock units each year with also a rather high degree of fluctuation from year to year.

CORRELATION ANALYSIS BETWEEN LIVESTOCK AND FEED SUPPLIES

The relationship between numbers of different types of livestock in Kansas and the corresponding feed supplies would give an indication of the way individuals have adjusted their livestock to the existing feed supply. With an indication of this adjustment, the relative importance of hay and other roughages in the different roughage production periods could be seen. This may then help explain hay prices and show the importance of knowing these price movements in these different periods.

There is apparently some degree of relationship between the roughage-consuming livestock and the total roughage supply in Kansas, as shown in Fig. 2. The roughage-consuming livestock is made up of several different

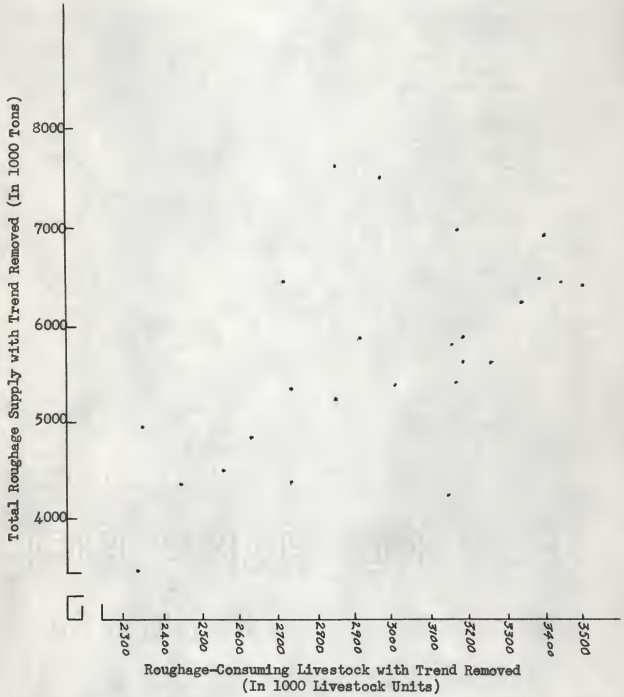

Fig. 2. Scatter diagram of relationship of total roughage supply to that of roughage-consuming livestock in Kansas, 1930-54.

types of livestock. The main proportion of the total roughage-consuming livestock is beef cattle and dairy cattle with smaller proportions of horses and sheep. Other livestock consume only minor amounts of roughage. The correlation coefficient between the roughage supply and the roughage-consuming livestock in Kansas was found to be 0.634.[1] In computing a "t" test,[2] to determine if there was any relationship between the two variables, it was found to be significant at the one percent level.[3] This indicated there was very likely some relationship or correlation between the roughage supply and the roughage-consuming livestock. However, as the correlation coefficient indicated, even though there appeared to be quite definitely some relationship between these variables, the degree of response in the number of the roughage-consuming livestock was not too greatly determined by the roughage supply. This indicates that the animal units fed are not too highly related to the roughage supply. Farmers may actually be adjusting their roughage supply to their animal units on many individual farms.

What it indicated was that as the roughage supply fluctuates the roughage-consuming livestock may well follow but not generally in the same proportion. The livestock numbers fluctuate generally in about the same way or perhaps by a time lag, as that of the roughage supply, but possibly not by the same amount. This may be partly due to the fact that many individuals

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[1]Correlation coefficient is a measure of the degree to which one factor or group of factors is associated with another factor.

[2]"t" test is the deviation of the estimated mean from that of the population, measured in terms of the sample standard deviation divided by the square-root as the unit. Definition taken from following source: G. W. Snedecor, Statistical Methods, fifth edition, p. 45.

[3]One percent level is a significance level for which there is less than one chance in a hundred of rejecting a true hypothesis. This is also found in source by Snedecor.

having a small roughage crop cannot afford to sell the livestock for which they do not have feed, but must generally maintain at least a large portion of their herd in order to remain in that business.

There is a rather high degree of relationship between the grain-consuming livestock and the total feed grain supply in Kansas. The grain-consuming livestock, as well as the roughage-consuming livestock, is made up of several kinds of livestock. The larger proportion of the grain-consuming livestock is made up of hogs, dairy and feeder cattle, and poultry. Smaller amounts are fed to other types of livestock such as sheep, and minor numbers of other farm animals. The correlation coefficient between the total feed grain supply and that of the grain-consuming livestock was found to be 0.832. The "t" test was used to test the hypothesis that there was no correlation. The "t" was found to be significant below the one percent level. There appeared to be a rather high degree of relationship between these two variables as shown in Fig. 3 and the correlation coefficient. This seems to indicate that as the feed grain supply fluctuates from year to year, which it does as was shown earlier in the study, the grain-consuming livestock fluctuates at very nearly the same time and also in nearly the same proportion. The number of this class of livestock appears to be quite dependent upon or at least has reacted very closely to that of the feed grain supply. This may indicate the possibility of being able to predict the number of grain-consuming livestock in Kansas by knowing the feed grain supply for any particular year.

By considering Fig. 2, it is seen that the relative importance of the hay supply used to feed the roughage consuming livestock in Kansas may very well be a problem. This is true because the hay portion of the total roughage supply has generally made up nearly 50 percent of the total supply. This is

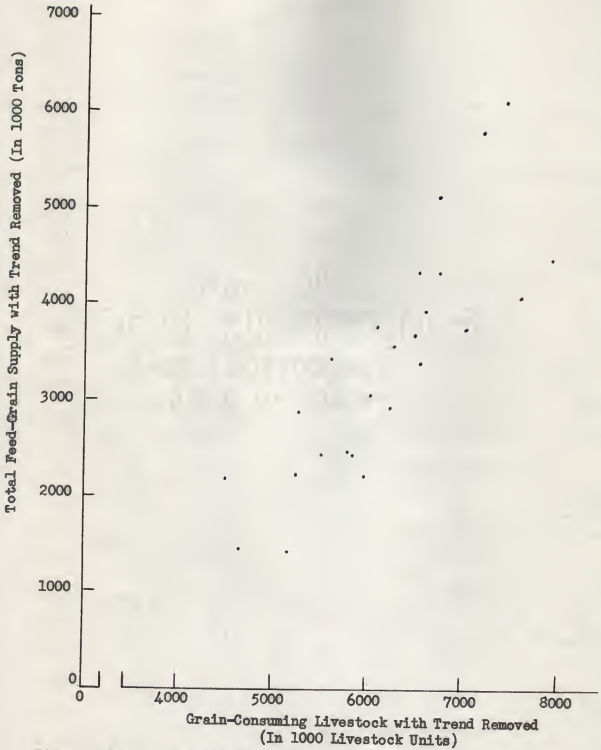

Fig. 3. Scatter diagram of relationship of total feed-grain supply to that of grain-consuming livestock in Kansas, 1930-54.

not to say that there is no problem concerning the relationship between feed grain supply and the number of grain-consuming livestock. It is to say there may be a greater and possibly a more important relative feed supply problem in the hay marketing sector of the Kansas economy.

This seems to indicate that due to the slow adjustment of the roughage-consuming livestock to the roughage supply, the relative available feed supply is more important in the small production years. Prices also become a very important consideration as their movements are related to the roughage supply.

Two other correlations were calculated in order to see the relationship existing between particular types of livestock, mainly roughage-consuming, and the roughage supply. The number of beef cattle and milk cows two years old and older was investigated. These two types of livestock have generally made up more than 50 percent of the total number of roughage-consuming livestock in Kansas. In 1954 there were 1,937 thousand animals in these two groups of cattle of the total of 3,286 thousand roughage-consuming livestock. During the period 1930-54, the number of beef cattle two years old and older has had an average increase of about 31 thousand head each year. Milk cows two years old and older have had an average decrease of about 14 thousand head each year. These trends indicate the increased importance of beef cow herds and the decline of milk cow herds in Kansas. In 1954, there were 1,392 thousand head in this class of beef cattle and 545 thousand milk cows two years old and older.

The correlation coefficient between the number of beef cattle two years old and older and the roughage supply was 0.274. The "t" was not found to be significant, indicating there was not any definite correlation or relationship that could be detected between them. This seems to indicate that beef

herds are not sold but rather feed is obtained when there is a small roughage supply. The supply of roughages in Kansas may not be a good indication of the number of animal units fed.

The correlation coefficient between the number of milk cows two years old and older and the roughage supply was 0.548. The "t" test was found to be significant at the one percent level, indicating there apparently was some relationship. The relationship is not, however, very high, meaning they do not follow each other too closely.

This high number of cattle that are at least two years old in these cow herds, both beef and milk, helps create the relative shortage of roughage supply in Kansas. The owners of these cow herds possibly cannot afford to sell their herds because there may have been a small hay and other roughage production year. If not, these individuals must acquire some feed for their livestock, and this may often consist of hay.

In all the correlation analyses used in this study between the various types feeds and the types of livestock, the trends during the period used have been removed.

CORRELATION ANALYSIS OF BEEF CATTLE PRICES AND ROUGHAGE SUPPLY

An investigation was made of the relationship between the total roughage supply in Kansas and the deflated price of beef cattle in Kansas. The correlation between these two variables was found to be 0.059. The "t" was non-significant at even the 50 percent level. This indicates there was no relationship, at least none that could be detected, between the total roughage supply and the deflated price of beef cattle, as illustrated in Fig. 4.

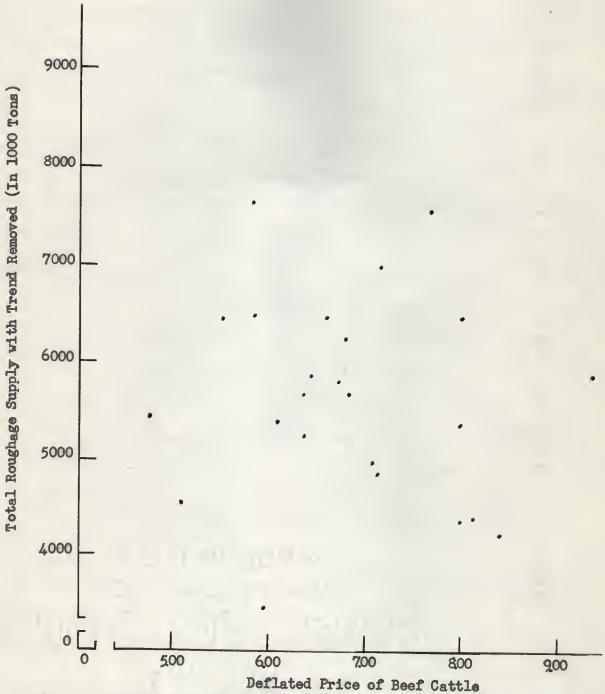

Fig. 4. Scatter diagram of relationship of total roughage supply to that of deflated price of beef cattle in Kansas, 1930-54.

The above relationship signifies that even if the total roughage supply is small, and thus the price of hay is likely to be high, the price of beef cattle will probably not be affected. Beef cattle prices are determined in a much larger market than Kansas, and the price or supply of roughage in Kansas has very little effect. This is what makes the price of roughages a very important cost item in feeding livestock.

A similar conclusion was drawn with a correlation analysis of the current yearly roughage supply in the Flint Hills area with the deflated price of beef cattle. The correlation coefficient here was about 0.0006. The figure was far from being significant. This again indicates that the supply and price of roughages seem to have no relationship to the price of beef cattle.

CORRELATION ANALYSIS OF DEFLATED ALFALFA AND PRAIRIE HAY PRICES WITH ALFALFA AND PRAIRIE HAY SUPPLY, RESPECTIVELY, IN KANSAS

There is quite definitely an inverse relationship between the alfalfa production for a particular year and the deflated price of alfalfa in Kansas, as shown in Fig. 5. When there is a shortage of production of alfalfa in Kansas the price is higher and visa-versa. These two variables show a correlation coefficient of about 0.584, which is significant at the one percent level based on the "t" test. The size of the correlation coefficient indicates that other factors also influence the price of alfalfa-- such as possibly the number of animal units fed. Other feeds that may not be as scarce or as high in price as alfalfa may be substituted for alfalfa when there is a shortage in its supply.

The prairie hay supply and the deflated price of prairie hay show a similar inverse relationship as displayed in Fig. 6. The correlation coefficient here is about 0.655. The "t" test shows this to be significant at the

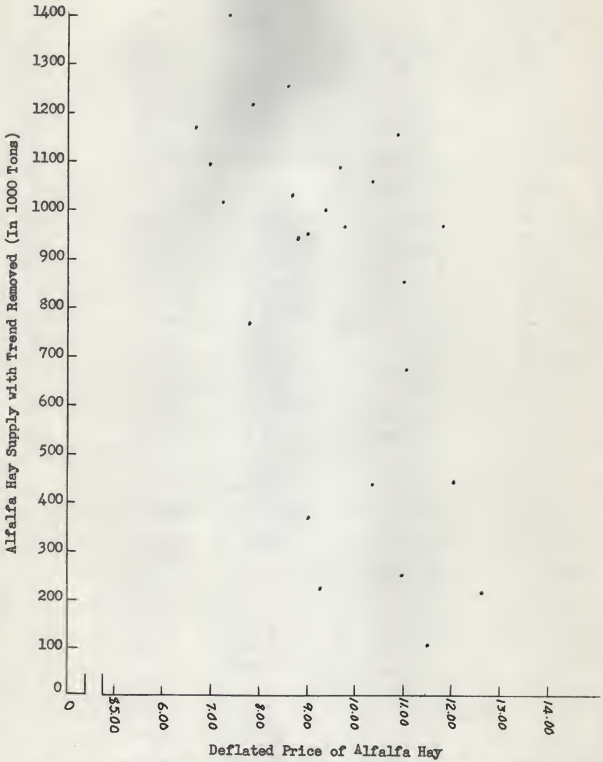

Fig. 5. Scatter diagram of relationship of alfalfa hay supply to that of deflated price of alfalfa in Kansas, 1930-54.

one percent level, indicating there is quite definitely a relationship between the variables. The situation involved with prairie hay is similar to that of alfalfa in regard to its price relationships.

The alfalfa and prairie hay prices were deflated by the index of prices received by farmers in the United States. The trends were also taken out of the supplies of alfalfa and prairie hay before calculating these correlations.

The production of alfalfa in Kansas, as well as the acreage shown earlier, during the period of 1930-54, has had an upward trend. In 1930 there was a production of 1,156 thousand tons, in 1954, 2,348 thousand tons. The average increase of alfalfa production in Kansas over this period was about 56 thousand tons each year. This indicates the increased importance of alfalfa. The standard deviation of the yearly production of alfalfa, with the trend removed, was about 375 thousand tons. The coefficient of variation was about 46.8. This indicates the high degree of fluctuation and uncertainty of the alfalfa supply from year to year.

The production of prairie hay in Kansas during this period has had a very slight downward trend. The trend has shown an average decrease in production of a little over one thousand tons each year. While the trend has remained almost insignificant, the fluctuation in yearly production has been rather large. The standard deviation of prairie hay from year to year, with the trend removed, was about 155 thousand tons. The coefficient of variation was about 23.3. This is not as high a variation as that of alfalfa, but there is still the same situation present, though possibly not in as high a degree.

The number of animal units fed with existing supplies of hay has very likely had an influence on the price of hay. However, the price of alfalfa and prairie hay has shown to have had a rather small effect upon the number of roughage-consuming animal units fed.

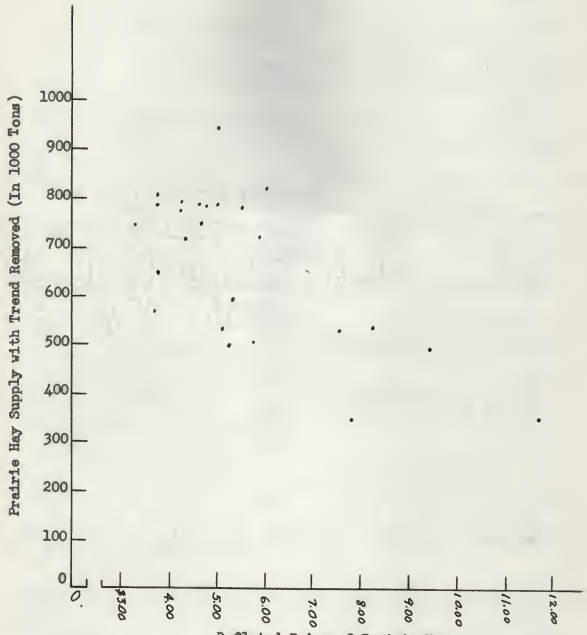

Fig. 6. Scatter diagram of relationship of prairie hay supply to that of deflated price of prairie hay in Kansas, 1930-54.

SEASONAL PRICE RELATIONSHIP OF ALFALFA IN DIFFERENT TYPES OF ROUGHAGE PRODUCTION PERIODS IN KANSAS AND FLINT HILLS AREA

The supply and price movements of hay in Kansas are quite uncertain from one year to the next. It was thought benefical to study the seasonal price movements for those years connected with the various types of roughage production periods, during the period 1930-54, of which the previous analysis was made.

The production periods were divided into small, average, and large years. As stated previously, these three periods were separated according to the number of standard deviations from the adjusted mean in Kansas. Arbitrary divisions were set up to divide these production periods. The middle two-thirds of the roughage production years were called average production years. This group theoretically should fall between the adjusted mean plus one standard deviation and the adjusted mean minus one standard deviation. This would leave, theoretically, one-sixth of the years having production greater than the adjusted mean plus one standard deviation, termed large production years, and one-sixth having production of less than the adjusted mean minus one standard deviation, termed small production years. This division was used in determining if there was a difference in the seasonal price movements in the different types of roughage production periods. It was felt that all three periods should be studied and that important information could be gained from them in making marketing decisions. A division of the periods by one-half a standard deviation was also used, which was again arbitrarily set.

The years included in the small production period--those yearly means that were less than the adjusted mean minus one standard deviation--were the

years 1936, 1937, 1939, 1949, and 1952. The years included in the large production period--those yearly means greater than the adjusted mean plus one standard deviation--were the years 1935, 1941, 1942, and 1951. The years included in the average production period--those years falling between the adjusted mean minus one standard deviation and plus one standard deviation--were those years between 1930 and 1954 which were not included in the above two production periods.[1]

By reading Fig. 7 and Table 3, the movements in monthly alfalfa prices in the different type roughage production periods can be visualized. The curves relating the average monthly alfalfa prices above or below the yearly mean for that particular type production period are shown in Fig. 7.

The price of alfalfa in Kansas for the small production years goes up rapidly until after August. The increase in price after August is much slower and is quite similar to the other types of production periods. The time period of November through January shows small variation in prices and is the highest price time of the year.

The saving which a person could make by buying alfalfa during any one month instead of buying it the next month is shown in Table 4. It shows that in the small production period the increase in price from June to July is $2.22 per ton compared with $0.52 per ton for the overall average of all the production periods. From July to August, in the small period, the increase in price is $3.42 per ton compared with $1.81 per ton for the overall average of all the periods.

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[1]Method of dividing the years into the different type production periods and then the constructing of Fig. 7 is shown in Appendix C.

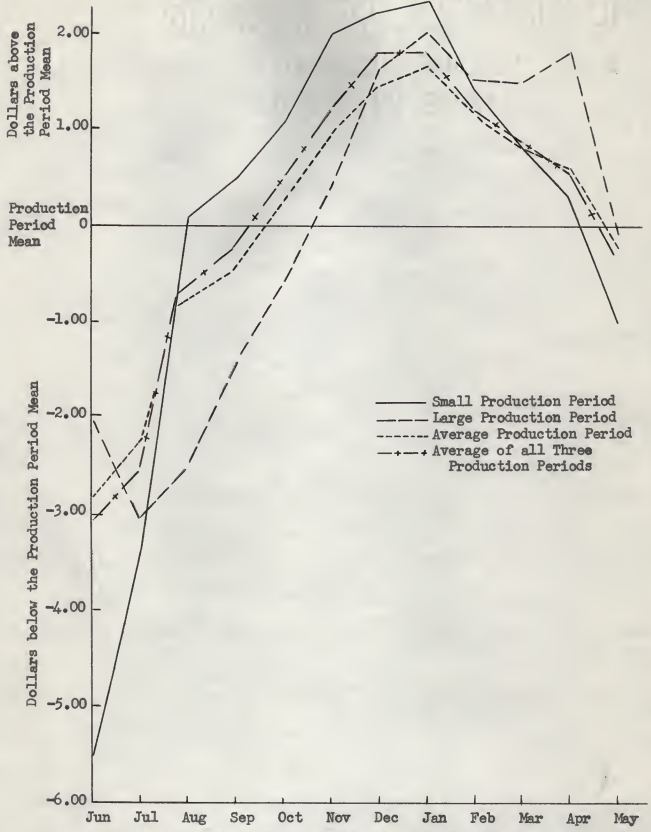

Fig. 7. Average seasonal monthly alfalfa prices above and below the mean in Kansas for years in various type production periods, 1930-54.

Table 3. Price range of alfalfa hay for various months in relation to price in highest month of that particular type of roughage production period in Kansas, 1930-54.

Month	Average of all periods	Small period (minus 1σ)	Large period (plus 1σ)	Average period between (-1σ and $+1\sigma$)	Small period (minus $\frac{1}{2}\sigma$)	Large period (plus $\frac{1}{2}\sigma$)	Average period between ($-\frac{1}{2}\sigma$ and $+\frac{1}{2}\sigma$)
June	$ 4.85	$ 7.84	$ 4.18	$ 4.46	$ 7.02	$ 3.74	$ 4.94
July	4.33	5.62	5.28	3.94	5.57	3.95	4.19
Aug.	2.52	2.20	4.60	2.45	2.99	3.14	2.16
Sept.	2.03	1.80	3.70	2.07	2.45	2.61	1.81
Oct.	1.32	1.26	2.88	1.35	1.60	2.00	1.12
Nov.	.58	.34	1.88	.70	.73	1.27	.48
Dec.	.06	.12	.70	.20	.16	.41	.19
Jan.	—	—	—	—	—	—	—
Feb.	.55	.92	.28	.52	1.16	.19	.47
March	.97	1.52	.80	.85	1.77	.45	.88
April	1.17	2.06	.50	1.07	2.30	.76	.72
May	2.17	3.34	2.10	1.83	3.45	1.43	1.88

Source: Compiled from data taken from Farm Facts, Kansas State Board of Agriculture.

By looking at Fig. 7, it can be seen that a person could buy alfalfa in the small period more cheaply any time after February than during the period of November through January.

During a large production period, the price was shown to go down from June to July. In this case July offers the lowest price for alfalfa. Whether a person should buy or sell in this or in another period still depends upon many things of course, particularly the storage facilities available and the risk the farmer is willing to take.

The average price movement of all the production periods compared with the average type production period seems to move in a very similar way. After August the increase in price is quite regular. Here again the high prices for alfalfa are during the months of December and January.

Although the time of buying and selling is important in all types of roughage production periods, the small production period presents the greatest range in prices. So the time of buying and selling may be much more important here, financially, than in the other periods.

The production periods in Kansas were also divided according to a less extreme classification. Here the small production period included those years which were less than the adjusted mean minus one-half, instead of one, a standard deviation. The large years were those greater than plus one-half a standard deviation. The average years were those not included in the other two periods. Two additional years were then included in the small period, the years 1938 and 1947. Five more years were included in the large period, those being 1932, 1933, 1940, 1943, and 1944. As can be seen from the second part of Tables 3 and 4, showing this type period, the small production period prices, in particular, are very similar to those when one standard deviation

Table 4. Marginal changes in monthly prices of alfalfa hay according to type of roughage production periods in Kansas, 1930-54.

Month	Average of all periods	Small period (minus 1σ)	Large period (plus 1σ)	Average period between (-1σ and $+1\sigma$)	Small period (minus $\frac{1}{2}\sigma$)	Large period (plus $\frac{1}{2}\sigma$)	Average period between ($-\frac{1}{2}\sigma$ and $+\frac{1}{2}\sigma$)
June	$ .52	$ 2.22	$-1.10	$ .52	$ 1.45	$- .21	$ .75
July	1.81	3.42	.68	1.49	2.58	.81	2.03
Aug.	.49	.40	.90	.38	.54	.53	.35
Sept.	.71	.54	.82	.72	.85	.61	.69
Oct.	.74	.92	1.00	.65	.87	.73	.64
Nov.	.52	.22	1.18	.50	.57	.86	.29
Dec.	.06	.12	.70	.20	.16	.41	.19
Jan.	- .55	- .92	- .28	- .52	-1.16	- .19	- .47
Feb.	- .42	- .60	- .52	- .33	- .61	- .26	- .41
March	- .20	- .54	+ .30	- .22	- .53	- .31	+ .16
April	-1.00	-1.28	-1.60	- .76	-1.15	- .67	-1.16
May	—	—	—	—	—	—	—

Source; Compiled from data taken from Farm Facts, Kansas State Board of Agriculture.

was used. Seasonal price movements of the other production periods are also quite similar.

The same situation occurred when production periods were divided according to production in the Flint Hills area. The Flint Hills area was used because of its importance as an alfalfa and prairie hay producing area and its large use of hay for feed. The division into the three periods was done in a manner similar to that for production in all of Kansas. As shown in Tables 5 and 6, there was again a rise in price of alfalfa after June and July. Also shown are the high prices that must be paid for alfalfa during November through January in particular.

The amount of money a person may be able to save or make by buying or selling alfalfa in any particular month, during any production period, might be seen by looking at Table 3 and Table 4. Table 3 shows how much cheaper in price alfalfa is in any month over what it would be in January, the highest month. Table 4 shows how much cheaper alfalfa is in any one month over what it would likely be the subsequent month. This may help in deciding when to buy or sell alfalfa to maximize profits. If the marginal change in price of alfalfa from any month to the next is greater than the amount needed to cover the risk of owning it, then it may be best to buy alfalfa, or sell it as the case may be.

SEASONAL PRICE RELATIONSHIP OF PRAIRIE HAY IN DIFFERENT TYPES OF ROUGHAGE PRODUCTION PERIODS IN KANSAS AND FLINT HILLS AREA

A similar analysis for prairie hay was conducted in this study. Fig. 8 and Tables 7 and 8 show the relationships between the seasonal price movements of prairie hay with respect to the various type roughage production periods in Kansas.

Table 5. Price range of alfalfa hay for various months in relation to price in highest month of that particular type roughage production period in Flint Hills Area, 1930-54.

Month	Average of all periods	Small period (minus 1σ)	Large period (plus 1σ)	Average period (between -1σ and +1σ)
June	$ 4.85	$ 10.94	$ 6.55	$ 4.07
July	4.33	7.50	6.30	3.86
Aug.	2.52	1.54	5.10	2.66
Sept.	2.03	2.00	4.25	2.12
Oct.	1.32	1.60	2.75	1.46
Nov.	.58	.30	1.85	.79
Dec.	.06	.14	.60	.25
Jan.	—	—	—	—
Feb.	.55	1.00	.10	.54
March	.97	2.30	.35	.84
April	1.17	2.94	1.70	.86
May	2.17	4.74	1.90	1.82

Source: Compiled from data taken from Farm Facts, Kansas State Board of Agriculture.

Table 6. Marginal changes in monthly prices of alfalfa hay according to type of roughage production period in Flint Hills area, 1930-54.

Month	Average of all periods	Small period (minus 1σ)	Large period (plus 1σ)	Average period (between -1σ and +1σ)
June	$ + .52	$ 3.44	$ .25	$ .21
July	+1.81	5.96	1.20	1.20
Aug.	+ .49	- .46	.85	.54
Sept.	+ .71	.40	1.50	.66
Oct.	+ .74	1.30	.90	.67
Nov.	+ .52	.16	1.25	.54
Dec.	+ .06	.14	.60	.25
Jan.	- .55	-1.00	- .10	- .54
Feb.	- .42	-1.30	- .25	- .30
March	- .20	- .64	-1.35	- .02
April	-1.00	-1.80	- .20	- .96
May	—	—	—	—

Source: Compiled from data taken from Farm Facts, Kansas State Board of Agriculture.

Table 7. Price range of prairie hay for various months in relation to price in highest month of that particular type roughage production period in Kansas, 1930-54.

Months	Average of all periods	Small period (minus 1σ)	Large period (plus 1σ)	Average period between (-1σ and $+1\sigma$)	Small period (minus $\frac{1}{2}\sigma$)	Large period (plus $\frac{1}{2}\sigma$)	Average period between ($-\frac{1}{2}\sigma$ and $+\frac{1}{2}\sigma$)
June	$ 2.33	$ 4.02	$ 1.76	$ 2.65	$ 3.06	$ 1.33	$ 3.51
July	2.03	2.60	2.62	2.32	2.30	1.73	2.67
Aug.	1.51	1.36	3.19	1.79	1.57	1.70	1.87
Sept.	1.16	1.36	2.59	1.55	1.35	1.52	1.54
Oct.	.85	1.10	2.37	1.18	1.02	1.38	1.04
Nov.	.47	.54	1.40	1.00	.49	.71	1.06
Dec.	—	—	.60	—	—	.23	.61
Jan.	.05	.02	.12	.33	.13	—	—
Feb.	.44	.40	—	.85	.87	.04	.47
March	.77	.94	.40	1.10	1.45	.22	.76
April	1.01	1.74	.65	1.17	2.09	.50	.66
May	1.18	1.84	.95	1.32	2.15	.69	.89

Source: Compiled from data taken from Farm Facts, Kansas State Board of Agriculture.

Table 8. Marginal changes in monthly prices of prairie hay according to type of roughage production periods in Kansas, 1930-54.

Months	Average of all periods	Small period (minus 1σ)	Large period (plus 1σ)	Average period between (-1σ and $+1\sigma$)	Small period (minus $\frac{1}{2}\sigma$)	Large period (plus $\frac{1}{2}\sigma$)	Average period between ($-\frac{1}{2}\sigma$ and $+\frac{1}{2}\sigma$)
June	$ .30	$ 1.42	$ -.86	$ .33	$ .76	$ -.40	$ .84
July	.52	1.24	-.57	.53	.73	.03	.80
Aug.	.35	.00	.60	.24	.22	.18	.33
Sept.	.31	.26	.22	.37	.33	.14	.50
Oct.	.38	.56	.97	.18	.53	.67	-.02
Nov.	.47	.54	.80	1.00	.49	.48	.45
Dec.	-.05	-.02	.48	-.33	-.13	.23	.61
Jan.	-.39	-.38	.12	-.52	-.74	-.04	-.47
Feb.	-.33	-.54	-.40	-.25	-.58	-.18	-.29
March	-.24	-.80	-.25	-.07	-.64	-.28	.10
April	-.17	-.10	-.30	-.15	-.06	-.19	-.23
May	—	—	—	—	—	—	—

Source: Compiled from data taken from Farm Facts, Kansas State Board of Agriculture.

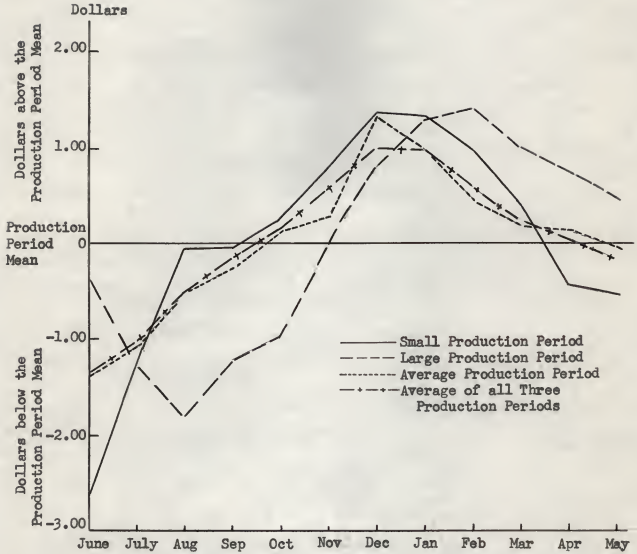

Fig. 8. Average seasonal monthly prairie hay prices above and below the mean in Kansas for years in various type production periods, 1930-54.

During June through August in the small production period, the price of prairie hay goes up at a rather rapid rate. After August the price moves upward at a much slower rate. The downward movement of the price after January, as it was with alfalfa, is greater during this type of production period than it was for any of the other type production periods.

In the large production period, the price is shown to go down from June through August, making August the lowest priced month in relation to the price for prairie hay. The profitableness of buying and selling prairie hay at any time, as was the case with alfalfa, is determined to a high degree by the risk and holding cost, and the expected change in price. The highest price month here is February.

The price movement during the average type production period is rather steady. Here it may be easier to make the marketing decision. The decision is again whether these rather steady monthly changes in price are more or less than the risk and holding cost.

Many individuals do not buy any or much of their hay until November through January. The reasons for this may be many, some possibly being: (1) they may be ignorant of the market situation, (2) they would rather pay a higher price later than to take the risk of holding it, (3) they simply put it off, hoping that the relative feed problem will not be too great, and (4) they may be accustomed to buying their hay supply at a certain time of the year and so do not pay a great deal of attention to the market condition. Many more reasons could probably be cited.

By looking at the production periods, as determined by the production of roughages in the Flint Hills area, a similar set of price movements can be seen. Tables 9 and 10 show the seasonal price movements according to the

Table 9. Price range of prairie hay for various months in relation to price in highest month of that particular type of roughage production period in Flint Hills area, 1930-54.

Month	Average of all periods	Small period (minus 1σ)	Large period (plus 1σ)	Average period (between -1σ and +1σ)
June	$ 2.33	$ 7.30	$ 2.50	$ 1.83
July	2.03	4.07	2.80	1.85
Aug.	1.51	1.87	1.75	1.65
Sept.	1.16	1.60	2.00	1.36
Oct.	.85	1.27	1.65	1.04
Nov.	.47	.97	1.00	.67
Dec.	—	.20	.20	.28
Jan.	.05	—	—	—
Feb.	.44	.80	.15	.35
March	.77	1.87	.25	.59
April	1.01	3.30	.85	.62
May	1.18	3.74	1.45	.71

Source: Compiled from data taken from Farm Facts, Kansas State Board of Agriculture.

Table 10. Marginal changes in monthly prices of prairie hay according to type of roughage production periods in Flint Hills area, 1930-54.

Month	Average of all periods	Small period (minus 1σ)	Large period (plus 1σ)	Average period (between -1σ and +1σ)
June	$ .30	$ 3.23	$- .30	$ -.02
July	.52	2.20	1.05	.20
Aug.	.35	.27	- .25	.29
Sept.	.31	.33	.35	.32
Oct.	.38	.30	.65	.37
Nov.	.47	.77	.80	.39
Dec.	-.05	.20	.20	.28
Jan.	-.39	- .80	- .15	-.35
Feb.	-.33	-1.07	- .10	-.24
March	-.24	-1.43	- .60	-.03
April	-.17	- .44	- .60	-.09
May	—	—	—	—

Source: Compiled from data taken from Farm Facts, Kansas State Board of Agriculture.

different types of roughage production periods for prairie hay in the Flint Hills area.

The small production period again shows the rather rapid increase in price from June through August. After August the price rise is reduced with December and January again being the highest priced months. This relationship indicates--as all others analyzed for this type period--the vast increase in price of prairie hay from harvest time to January. Table 9 indicates that prairie hay could be bought at a lower price probably any time after January than it could during the period of November through January.

The other roughage production periods display a much smaller degree of extremes of seasonal price movements than does the poor production period. As with alfalfa, the time prairie hay is bought or sold will have to be determined after consideration of all costs including risk and holding costs.

SEASONAL BEEF CATTLE PRICES FOR DIFFERENT PRODUCTION PERIODS

A livestock producer is often faced with the problem--when he has a shortage of hay and other roughages--whether he should buy more hay or possibly sell at least a portion of his livestock. The seasonal beef cattle prices for the various type roughage production periods may help in determining the time either to sell some livestock or to buy some hay, whichever he decides to do, so as to maximize profits. This is shown in Fig. 9.

June has shown to be the highest price month for beef cattle in the small period, whereas, April was the high priced month in all other cases. December was the lowest priced month for the small production period, while it was either October or November for the other periods. In the event a producer runs out of hay in the small production period and the price of hay is high, it may be better to buy additional supplies of hay as it is needed

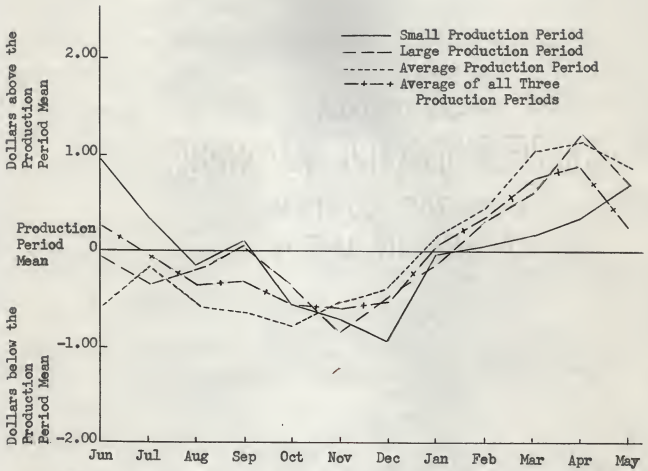

Fig. 9. Average seasonal monthly beef cattle prices above and below the mean in Kansas, according to the years in the various type roughage production periods, 1930-54.

to feed the livestock in the spring months rather than sell livestock during December or January. This is true because of the increased price of cattle from December to June and also the decrease in price of hay after January.

There may have been and may still be a great deal of inefficiency in these marketing operations, not only in the buying and selling of hay but also in the marketing of livestock in order to adjust the farmers' livestock numbers to his feed supply.

SEASONAL MARKETING OF HAY IN KANSAS

The percentage of the total hay sold in each month in Kansas was analyzed according to roughage production periods. The percentage of hay marketed in Kansas for the various months would then indicate if there was any relationship between marketing of hay and the price movements of hay in the different roughage production periods. The same period, 1930-54, was used here as was used in the previous analyses.

A comparison of Fig. 10, the seasonal marketing of hay, with that of Figs. 7 and 8, the seasonal price movements of alfalfa and prairie hay, respectively, shows the relationship of the price and time of marketing of hay. The seasonal movement of the marketing of hay appears to be quite similar in all three type production periods. This may indicate that hay is bought or sold at nearly the same time each year, regardless of the roughage supply available or the price movements of hay in these different production periods. Factors other than price of hay may have been more important in determining when hay was to be bought or sold in Kansas. Marketings of hay are greater for the last six months of the season, November through April, in all three type production periods.

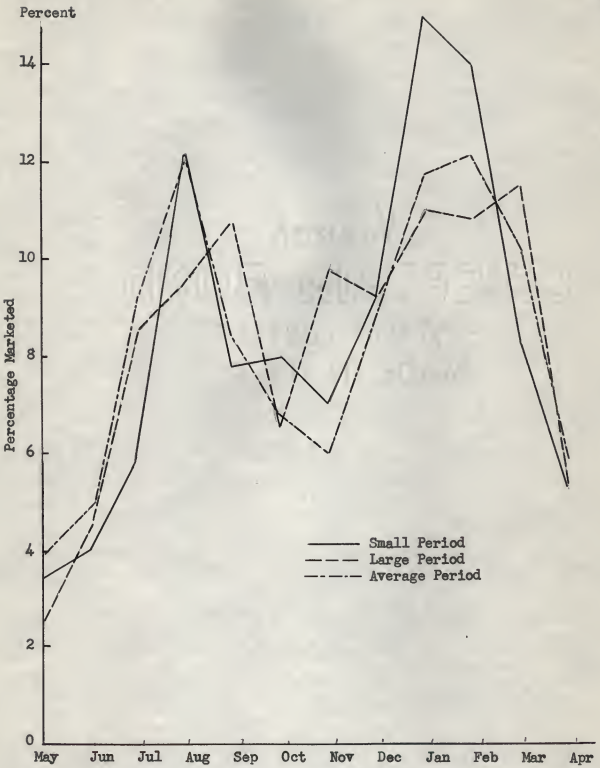

Fig. 10. Average monthly percentage of hay marketed in Kansas for different type roughage production periods for years 1930-54.

In the small roughage production period, a rather large amount of hay is marketed near harvest time, which is the lowest priced time. However, a still larger amount of hay is marketed during the highest priced period of December through February. The quantity marketed after January tapers off quite rapidly and the price also drops off quite rapidly after January. Hay can be bought at a lower price if it is bought from February on to summer as it is needed rather than bought in large quantities in December and January.

The percentage marketed each month for the large and average type roughage production periods are quite similar to that of the small production period. The price movements for the different production periods may not be the same however, so the best time to buy or sell hay may differ for each type period.

There appears to be two periods of time when the larger amount of hay is marketed in Kansas. The first time period is centered around the period of July through September. The second, and largest sized marketing period, is centered around the time period of December through February.

For various reasons, very often not economic, many people are accustomed to buying their hay in December through February. Before this time generally not much hay is needed, so many producers simply may not yet think it necessary to buy hay or do not bother themselves about buying hay. During the period of December through February, many farmers estimate their future needs for the winter and in this period buy nearly all of the hay needed for the season. The farmer, by waiting until this time period, is forced to pay the highest price possible for hay.

The demand for hay has generally been light during harvest time and has often increased steadily late in the fall and reached its high point about

January. This has been a factor in the high price of hay in the winter months. Demand generally has fallen off after January, or possibly February, and the price has followed in like manner.

It is not known whether the above seasonal marketing movement of all hay is representative of the marketing movements of both alfalfa and prairie hay for all of Kansas. Reports from the Kansas City terminal market indicated that alfalfa has been marketed mainly during the time period centered around November through February. This same market indicated that prairie hay was marketed mainly during the time period centered around July through October. This activity on the Kansas City market may not be representative of marketing activity in Kansas. If alfalfa and prairie hay have been marketed mainly at different times of the year, with the seasonal price movements being very similar, one of these hay crops may quite likely have been marketed more profitably than the other. It is likely that the most profitable time for marketing both hay crops is near the same time.

The percent of the total hay supply marketed during the years associated with the different type roughage production periods in Kansas was shown to be very similar. There appeared to be very little effect of the size of the roughage supply upon the proportion of the hay supply that was sold. There was normally from 14 to 15.5 percent of the hay production sold each year during the time period of 1930-54.

The three type production periods each showed that 14.7 percent of total production of hay was sold. This is presented in Table 11.

It is possible that economic considerations have not been dominant in selecting the time in which hay has been marketed. If these factors had been considered to a greater extent, it may have changed the marketing activities considerably.

Table 11. Percentage of all hay sold out of total production in the different type roughage production periods in Kansas for years 1930-54.

Years	Total hay production	Hay sold	Percentage of hay production sold
	(in thousand of tons)		
Small Period:			
1937	1388	208	15.0
1939	1423	221	15.5
1952	2369	332	14.0
1936	1320	198	15.0
1949	3269	474	14.5
Total	9769	1433	14.7
Large Period:			
1942	2944	442	15.0
1951	3548	514	14.5
1935	2590	388	15.0
1941	2325	337	14.5
Total	11407	1681	14.7
Average Period:			
1938	1782	223	12.5
1947	3155	473	15.0
1946	2354	353	15.0
1934	1135	148	13.0
1945	2876	417	14.5
1948	3479	504	14.5
1931	2309	323	14.0
1930	2288	332	14.5
1953	2719	394	14.5
1950	3366	471	14.0
1954	3397	561	16.5
1932	2760	414	15.0
1933	2062	278	13.5
1940	1829	265	14.5
1943	2667	413	15.5
1944	2982	462	15.5
Total	41160	6031	14.7

Source: Compiled from data supplied by the Kansas Crop Reporting Service, and arranged according to size of the deviation from the adjusted mean for the yearly roughage production in Kansas.

Final marketing decisions in any one of these different type roughage production periods may require a great deal of study before the most satisfactory long-run marketing operation can be determined.

SUMMARY AND CONCLUSIONS

Hay and other roughages are very important as feed for livestock in Kansas. The acreage and production of roughage crops have been increasing in Kansas during the past 25 years while a decrease in acreage and production of feed grains has been taking place. The reliance upon roughages--a large part of which consists of alfalfa and prairie hay--is very important in Kansas.

Fluctuations in the production of hay and other roughages in Kansas causes a large variation in the supply of hay and other roughages from year to year. This causes many livestock producers using large amounts of hay and other roughages to be short in certain years and have to acquire additional supplies. The coefficient of variation of the total roughage supply from year to year was 18.3.

The number of roughage-consuming livestock in Kansas has been increasing over the past 25 years, and the number of grain-consuming livestock has had a very significant decrease. A study of the roughage supply and its price movements is thus very important.

Some relationship between the total roughage supply and the total roughage-consuming livestock was found, but this was not very great. Beef cattle and milk cows two years old and older make up a large part of the cow herds in Kansas. When the number of these animals was correlated with the total roughage supply, it was found that there was no significant correlation for beef cattle and a low correlation for milk cows. This seems to indicate that producers have bought the needed roughage supply in the small production

years rather than sell their cow herds. Uncertain hay and other roughage supply and the desire not to sell livestock when short of feed often causes the livestock producer to buy more hay sometime during the year. This time of buying hay must be analyzed carefully if profits are to be maximized.

There appears to be no relationship between the roughage supply in Kansas and the price of beef cattle. If high costs of feed, alfalfa and prairie hay, do not affect the price of cattle, the need for the livestock producer to buy hay at the most profitable time is very important.

There appears to be an inverse relationship between both the alfalfa and prairie hay supplies in Kansas and the alfalfa and prairie hay prices, respectively. These correlations are not, however, extremely high, indicating that other factors have an influence. The coefficient of variation of the alfalfa supply for the period of 1930-54 was 46.8. For the prairie hay supply, it was 23.3.

The period of 1930-54 was divided into three types of roughage production periods. The seasonal price movements and the monthly changes in prices were calculated and analyzed for each type of period. There were significant differences for several of these seasonal price movements but wide variations were often present for the same seasonal price movements. The advantage of buying or selling at various times during any one of these periods can likely be visualized and it is hoped that this can be used in making marketing decisions. These decisions may make a great difference in the final profit or loss for a livestock producer. The marketing decisions may differ depending upon the type of roughage production period. The small production period appears to present the greatest problem because of its wide range in seasonal prices for hay.

The seasonal movement of beef cattle prices was calculated for the different production periods. This was done to provide a better basis for deciding what marketing activity was most advantageous in the different type production periods. For example, in a small production year it may be best for a farmer to sell some livestock or buy some roughage, but whichever one the farmer decides to do, there is probably only one time in the year in which he can do either and still maximize his profits. The seasonal price movements of hay and livestock can be used very beneficially in making such decisions.

The percentage of the total hay sold in each month was analyzed according to roughage production periods so as to observe the seasonal marketing movement of hay. This seasonal movement of the marketing of hay appears to be quite similar in all three type production periods. There were two periods when the largest amount of hay was marketed in Kansas. The first was July through September and the second was centered around December through February. There appeared to be very little effect of the size of the roughage supply upon the proportion of the total hay production that was sold.

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APPENDICES

Appendix A: DEPENDABILITY OF CROP REPORTS

To give an indication of the dependability of the crop reports as published by the Federal-State Crop Reporting Service, correlation coefficients between the July 1 and December 1 estimates of alfalfa production and between the August 1 and the December 1 alfalfa production estimate were computed.[1] The correlation coefficient between the July 1 estimate of alfalfa production and that of the December 1 figure was calculated to be 0.9220. The correlation coefficient between the August 1 estimate and that of the December 1 figure was 0.9725. This would indicate that normally a rather high degree of reliability could be placed upon the crop report estimate figures for alfalfa given by the Crop Reporting Service at this early date. This may then make it quite possible to closely predict the type of roughage production period that any year represents as early as possibly July 10 or August 10. This prediction may be helpful in making marketing decisions.

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[1] Calculations were done by the grain marketing staff of the Kansas Agricultural Experiment Station from data derived from the Federal-State Crop Reporting Service. Years used in these calculations were 1927-41, and 1943-52.

Appendix B: VARIABILITY OF SEASONAL PRICES OF HAY

An indication of the variability of the seasonal prices of alfalfa for the time period of 1930-54 is shown in Fig. 11 by use of a scatter diagram showing the index of individual monthly prices for the three type production periods. This may indicate the reliability of predicting the seasonal price movement of alfalfa in any type production period.

The price for alfalfa may be expected to be lower in June and July relative to prices later in the season in the small production period than in the other type periods. This is thought to be true since three of the five greatest deviations below the yearly mean for the months of June and July are those of the small type production period. Alfalfa also appears to be higher in price later in the season, in respect to the yearly mean, than is the price for alfalfa in the other periods. Three of the five largest deviations above the yearly mean are found for the months of August and October, and the two largest out of four for the months of September, November, and December.

Outside of these above relationships, the variability of the seasonal prices of the three periods are so great and the prices fall so close together that no definite price movement appears to be characteristic of the different type production periods. Fig. 7, as well as the other similar figures, is of value in showing the average price movement for the different type production periods, but its use in forecasting or predicting future prices is limited due to the variability of the seasonal prices in each type period.

In order to determine if the curves for alfalfa, as shown, do truly represent that particular type of roughage production period, the variation

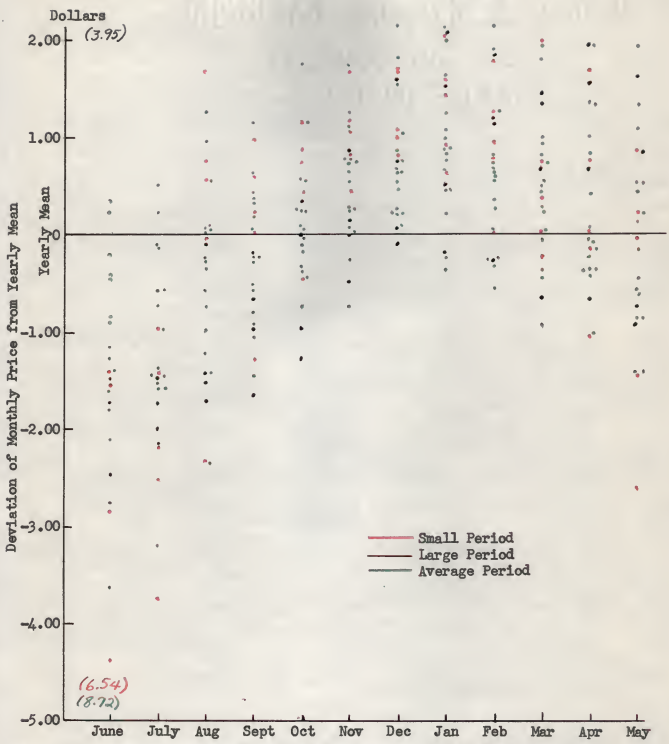

Fig. 11. Scatter diagram of index of monthly prices of alfalfa according to type of roughage production periods in Kansas, 1930-54.

within the same type of production period was compared with the variation among the three periods. The variations for two months were analyzed, these being June and April. These months were picked because of the significant difference from the other type production periods of the small production period in June and the large production period in April. Coefficient of variations calculated for alfalfa during June showed the following figures: for the small production period — 57.3, for the large production period — 606.0, for the average production period — 124.6, for among the three production periods — 128.3. The variation for each type production period and among all three types was shown to be quite high. However, the variation for the small production period was comparatively less than among the three type periods, indicating this marketing activity may be somewhat characteristic of this period. The variation of the large period in April showed a coefficient of variation of 110.6, the small period was 368.4, the average period was 329.6, the variation among the three types was 253.1. The variation for the large period was smaller than the variation among the three types, but the variations in all cases were, however, rather high.

Appendix C: METHOD USED IN DETERMINING TYPES OF ROUGHAGE PRODUCTION PERIODS IN KANSAS

The following method was used in dividing the years for the period of 1930-54 into the different type roughage production periods in Kansas.

First, the trend for roughage production during the time period studied was removed and the deviations from the adjusted mean of the roughage supply was calculated along with its standard deviation (Table 12).

Second, an array of the deviation from the adjusted mean for the yearly roughage production in Kansas was set up (Table 13). From this array, those years having a deviation from the adjusted mean of less than minus one standard deviation were termed small roughage years. Those years greater than plus one standard deviation were termed large roughage years. The years between minus one and plus one standard deviation were termed the average roughage production years.

Third, the method used in deriving Fig. 7 was as follows: The average price for each month for all those years in each type roughage production period was calculated. Then the overall average price for all months of the period was obtained. This overall average price was used as the base line which was designated as the production period mean for the different type production periods in Fig. 7. The deviation of each month from this overall mean is what is shown in the figure for the periods. This method was felt to be adapted to this analysis and would give information comparable to that of an index of these prices. This was felt to be true because each type production period contained a year or years in each of the 1930's, 1940's and 1950's.

Table 12. Removal of trend from the roughage supply in Kansas and the finding of the deviations from the adjusted mean of the roughage supply, 1930-54.

Year	(x)	Roughage supply (Y)	(xY)	$(x)^2$	Adjusted roughage supply (Y)	Adjusted mean of the roughage supply (Y)	Deviation from adjusted mean (y)	$(y)^2$
1930	-12	5,787	- 69,444	144	7,521.0	7,580.4	- 59.4	3,528.36
1931	-11	5,774	- 63,514	121	7,363.5		- 216.9	47,045.61
1932	-10	6,527	- 65,270	100	7,972.0		391.6	153,350.56
1933	- 9	6,880	- 61,920	81	8,180.5		600.1	360,120.01
1934	- 8	6,050	- 48,400	64	7,206.0		- 374.4	140,175.36
1935	- 7	8,439	- 59,073	49	9,450.5		1,870.1	3,497,274.01
1936	- 6	5,463	- 32,778	36	6,330.0		-1,250.4	1,563,500.16
1937	- 5	4,571	- 22,855	25	5,293.5		-2,286.9	5,229,911.61
1938	- 4	6,215	- 24,860	16	6,793.0		- 787.4	619,998.76
1939	- 3	5,806	- 17,418	9	6,239.5		-1,340.9	1,798,012.81
1940	- 2	8,035	- 16,070	4	8,324.0		743.6	552,940.96
1941	- 1	9,317	- 9,317	1	9,461.5		1,881.1	3,538,537.21
1942	0	8,850	—	0	8,850.0		1,269.6	1,611,884.16
1943	1	8,504	8,504	1	8,359.5		779.1	606,996.81
1944	2	8,694	34,776	4	8,405.0		824.6	679,965.16
1945	3	7,746	23,238	9	7,312.5		- 267.9	71,770.41
1946	4	7,770	31,080	16	7,192.0		- 388.4	150,854.56
1947	5	7,517	37,585	25	6,794.5		- 785.9	617,638.81
1948	6	8,195	49,170	36	7,328.0		- 252.4	63,705.76
1949	7	7,394	51,758	49	6,382.5		-1,197.9	1,434,964.41
1950	8	9,012	72,096	64	7,856.0		275.6	75,955.36
1951	9	10,305	92,745	81	9,004.5		1,424.1	2,028,060.81
1952	10	7,711	77,110	100	6,266.0		-1,314.4	1,727,647.36

Table 12. (Concl.)

Year	(x)	Roughage supply (Y)	(xY)	$(x)^2$	Adjusted roughage supply (Y)	Adjusted mean of the roughage supply (Y)	Deviation from adjusted mean (y)	$(y)^2$
1953	11	9,290	120,190	121	7,700.5		120.1	14,424.01
1954	12	9,657	115,885	144	7,923.0		342.6	117,374.76
		189,509	+187,829	1,300	189,509.0		- 1.0	26,705,637.80

$a = \frac{Y}{N} = \frac{189,509}{25} = 7580.4$

$b = \frac{\Sigma xY}{\Sigma y^2} = \frac{187,829}{1300} = 144.5$

$\sigma y = \sqrt{\frac{\Sigma y^2}{N}} = \sqrt{\frac{26,705,637.80}{25}}$

$\sigma y = \sqrt{1,068,225.51} = 1,033.5$

Source: Calculated by method described in Blair, Morris, Myers, Elementary Statistics, Henry Holt and Co., p. 430, 1952.

Following is a worksheet used in deriving the curves shown in Fig. 7 (Table 14). The order in which the years are placed in each type production period was according to the size of the deviation from the adjusted mean for the yearly roughage production in Kansas.

Table 13. Array of the deviations from the adjusted mean for the yearly roughage production figures in Kansas, 1930-54.

Year	Deviation of adjusted mean in Kansas	Year	Deviation of adjusted mean in Kansas
	(1000 Tons)		
Small period		Average period	
1937	-2,286.9	1938	- 787.4
1939	-1,340.9	1947	- 785.9
1952	-1,314.4	1946	- 388.4
1936	-1,250.4	1934	- 374.4
1949	-1,197.9	1945	- 267.9
		1948	- 252.4
		1931	- 216.9
		1930	- 59.4
Large period		1953	120.1
1942	1,269.6	1950	275.6
1951	1,424.1	1954	342.6
1935	1,870.1	1932	391.6
1941	1,881.1	1933	600.1
		1940	743.6
		1943	779.1
		1944	824.6

σ_y = 1,033.5

Table 14. Average monthly prices of alfalfa for all years in each type roughage production period in Kansas, 1930-54.

Year	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	Total	Average
Small period														
1937	$10.50	$10.50	$12.00	$13.10	$13.00	$13.20	$13.90	$13.60	$12.90	$11.80	$10.90	$ 9.20	$ 144.60	$12.05
1939	8.50	8.50	9.00	10.00	10.80	11.70	12.30	12.80	13.00	13.20	12.90	12.10	135.10	11.26
1952	22.50	28.50	36.50	34.50	36.50	39.00	39.00	40.00	37.00	35.50	34.00	30.50	413.50	34.46
1936	6.50	9.80	16.20	16.10	15.60	15.60	15.40	15.30	15.70	15.10	15.10	14.20	170.60	14.22
1949	13.50	15.00	16.00	18.00	18.50	19.50	19.50	19.00	17.50	17.50	17.50	18.00	209.50	17.46
Total	61.50	72.60	89.70	91.70	94.40	99.00	100.10	100.70	96.10	93.10	90.40	84.00	1,073.30	
Average	12.30	14.52	17.94	18.34	18.88	19.80	20.02	20.14	19.22	18.62	18.08	16.80	214.26	17.85
Large period														
1942	10.00	10.00	10.10	10.80	10.80	11.70	12.70	13.50	14.60	15.10	16.00	15.40	150.70	12.56
1951	18.80	20.10	21.50	24.00	27.00	28.50	31.00	32.00	29.50	28.00	28.00	23.30	311.70	25.98
1935	13.20	7.50	8.70	8.60	8.80	8.80	8.70	8.60	8.50	8.10	8.10	8.00	105.60	8.80
1941	8.50	8.50	8.50	9.00	9.10	10.70	12.00	13.10	13.50	12.80	13.10	12.10	130.70	10.91
Total	50.50	46.10	48.80	52.40	55.70	59.70	64.40	67.20	66.10	64.00	65.20	58.80	698.70	
Average	12.62	11.52	12.20	13.10	13.92	14.92	16.10	16.80	16.52	16.00	16.30	14.70	174.68	14.55

Table 14. (Concl.)

Year	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	Total	Average
Average period														
1938	$ 8.70	$ 8.20	$ 8.20	$ 8.00	$ 8.20	$ 8.20	$ 9.10	$10.10	$ 9.60	$ 9.30	$ 9.30	$ 9.40	$ 106.80	$ 8.90
1947	20.50	20.00	21.00	23.00	26.00	27.50	29.50	29.00	26.00	24.50	24.00	22.00	273.00	24.42
1946	20.50	22.00	25.00	26.00	26.50	27.50	27.50	28.00	26.00	26.50	28.00	27.00	310.50	25.88
1934	8.90	10.10	17.60	18.00	19.30	19.30	19.70	19.70	19.70	19.50	19.50	19.50	210.80	17.57
1945	17.00	16.60	16.70	17.50	19.40	21.00	21.30	22.00	22.60	22.00	22.00	19.50	237.60	19.80
1948	18.50	19.50	19.00	19.00	20.00	20.50	21.00	21.00	20.50	20.50	20.00	17.50	237.00	19.75
1931	8.10	7.40	7.40	7.40	7.60	8.40	8.00	8.00	7.60	8.40	7.80	8.00	94.10	7.84
1930	10.60	9.80	12.50	12.70	12.70	12.80	12.40	12.40	10.90	10.50	10.40	10.00	137.70	11.48
1953	23.00	26.50	28.50	28.00	28.50	29.00	29.00	29.00	28.00	26.00	26.00	23.50	325.00	27.08
1950	17.00	17.50	17.50	18.00	19.00	19.50	20.50	21.50	22.50	22.50	24.00	23.30	242.80	20.23
1954	19.50	20.50	24.00	24.70	24.50	25.80	26.50	26.00	25.60	23.80	23.40	22.40	286.70	23.89
1932	6.00	6.00	5.90	5.70	5.90	5.90	6.00	5.70	5.70	5.60	5.60	6.20	70.20	5.85
1933	5.60	8.20	8.80	8.30	8.00	8.00	8.00	7.50	7.60	8.20	7.50	7.90	93.60	7.80
1940	9.10	8.50	10.20	10.30	9.60	10.40	10.80	11.30	10.80	10.60	10.00	9.60	121.20	10.10
1943	14.40	15.20	16.90	18.60	21.20	22.90	24.40	25.30	25.10	24.90	24.00	24.00	256.90	21.41
1944	18.60	18.30	19.00	19.00	19.40	19.50	20.50	20.80	20.80	20.50	18.70	13.30	233.40	19.45
Total	226.00	234.30	258.20	264.20	275.80	286.20	294.20	297.30	289.00	283.80	280.20	268.10	3,257.30	
Average	14.12	14.64	16.13	16.51	17.23	17.88	18.38	18.58	18.06	17.73	17.51	16.75	203.52	16.96

THE EFFECTS OF THE PRODUCTION OF HAY ON ITS SEASONAL PRICE AND SEASONAL MARKETING MOVEMENT IN KANSAS

by

John Richard Unger

B. S., Kansas State College
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AN ABSTRACT OF A THESIS

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The use of hay and other roughages as feed for livestock has become very important to farmers in Kansas. The acreage and production of roughage crops have been increasing in Kansas during the past 25 years while at the same time a decrease in acreage and production of feed grains has been taking place. Farmers rely upon alfalfa and prairie hay, which make up a significant part of the roughage supply, as they are two of the main roughages used in their feeding operations.

The primary purpose and objective of this study was to analyze trends, relationships, and production fluctuations of hay and the influence such factors have had on seasonal price and seasonal marketing movements of hay in Kansas.

Knowing when to enter the market is very important, and marketing decisions must be made with care. There may be only one time during the year when profit can be maximized.

Trends and correlations were calculated to illustrate problems which apparently are present in regard to the roughage supply, the numbers of livestock and the eventual price movements of hay.

Seasonal price movements of alfalfa and prairie hay for the years in different types of roughage production periods were calculated. Investigation of past production and price movements should provide a basis for making decisions concerning buying and selling roughages so that marketing activities can be carried out to the best advantage in view of the existing roughage supply.

There have been large fluctuations in the hay and roughage supplies in Kansas due to production uncertainties. For example, feeders using large amounts of roughages often have a shortage of supply, and they are thus faced

with the necessity of acquiring additional supplies to feed their livestock. The coefficient of variation of the total roughage supply from year to year was 18.3.

The number of roughage-consuming livestock in Kansas has been increasing over the past 25 years, and the number of grain-consuming livestock has had a very significant decrease. A study of the roughage supply and its price movements is thus very important.

Some relationship, though not very great, was found between the total roughage supply and the total roughage-consuming livestock. But beef cattle two-years old and older, which make up a large share of the cow herds in Kansas, were found to have no significant correlation with the total roughage supply. Milk cows showed a small relationship with the roughage supply. This seems to indicate that farmers have bought the needed roughage supply, or fed something else, in the small production years rather than sell their cow herds.

There appears to be no relationship between the total roughage supply in Kansas and the price of beef cattle. So both need to be analyzed carefully before decisions can be made to buy or sell either roughages or livestock in any one year.

An inverse relationship has been shown to exist between the supplies of alfalfa and prairie hay and prices in Kansas. For example, the price that is paid for hay, especially in the small hay crop years, can be a very important cost item, so the farmer must try to buy at his best possible time.

The coefficient of variation of the alfalfa supply for the period of 1930-54 was 46.8. For the prairie-hay supply, it was 23.5.

The period of 1930-54 was divided into three types of roughage production periods. The seasonal price movements for these different type roughage production periods show the advantages and disadvantages of buying and selling hay during various times of the year. Profit may be increased greatly by marketing at the proper time in these different type production periods. However, the variation in respect to the seasonal price movement is often quite wide, making prediction difficult.

The seasonal beef-cattle prices in these types of roughage production periods can be used by the livestock producer to decide upon the kind and perhaps the size of livestock program. Study of the movements of the price and supply of hay and other roughages may make it easier for a livestock producer to decide whether to buy or sell either livestock or hay so as to obtain the largest gain.

The percentage of the total hay sold in each month was analyzed according to roughage production periods so as to observe the seasonal marketing movement of hay. This seasonal movement appeared to be quite similar in all three type production periods. There was shown to be two periods of time when the largest amount of hay was marketed in Kansas. The first time period was July through September and the second, and largest sized marketing period, was centered around December through February. The size of the roughage supply appeared to have little effect upon the proportion of the total hay production that was sold.