Factors Affecting Prices of Apples

By Ben H. Pubols

When a farmer decides whether or not to plant apple trees he is concerned with the long-term outlook covering the next 10 or 20 years. When he sells his apples he is concerned with the immediate outlook covering the period from 3 to 9 months after his crop is harvested. Most of the research on demand for apples has attempted to explain variations in annual average prices. It gives no indication of the long-term outlook. Nor does it give much information about probable changes in prices during the marketing season. When the apple grower decides how much to store and when to take apples out of storage he needs a more detailed analysis of the factors that affect apple prices at different periods during the year. The study here reported is an attempt to provide the kind of analysis that can be used for this purpose.

STUDIES OF FACTORS affecting season-average prices of apples were made by Gordon Ockey in 1938 and by Karl Fox in 1951, both on the staff of the former Bureau of Agricultural Economics. Ockey found that changes in the season average price received by growers for the entire United States apple crop are determined largely by the following factors: (1) Supply of apples available for market, (2) supply of competing fruits (particularly oranges), and (3) the level of domestic demand (as indicated by income of industrial workers).[1] He also recognized foreign demand as important, but did not include it in his analysis. The study covered the years 1922–37.

In 1939, the analysis was recast and extended to include 1938.[2] In the revised study, for the measure of apple supply, figures for the commercial crop were substituted for figures for the total crop. To allow for shifts in demand, an index of nonagricultural income was substituted for an index of income of industrial workers. As in the preceding study, orange production on an apple-marketing-year basis (July–June) was taken as a measure of the supply of competing fruits. Actual figures were used in both studies. Results were similar. The 1939 study showed that for 1922–38 more than 96 percent of the annual changes in season average prices received by growers for apples were associated with annual changes in the size of the commercial apple and orange crops and in nonagricultural income.

As part of a larger study by Karl Fox in 1951, year-to-year changes in prices received by growers for apples were related to year-to-year changes in production of apples and in disposable income of domestic consumers for 1922–41.[3] Disposable income of domestic consumers was used to allow for shifts in demand for apples. The annual data for production and consumer income were first converted to a per-capita basis to eliminate the effect of changes in population. Data for all three variables were next transformed to first differences of logarithms. These first differences of annual data were then correlated, using least-squares, single-equation techniques.

This study indicated that 96 percent of the year-to-year changes in season average prices received by growers for apples during 1922–41 were associated with corresponding year-to-year changes in size of the apple crop and in amount of disposable income of domestic consumers. A 1-percent change in production was found to be related to a net change of 0.8 percent in price in the opposite direction, and a 1-percent change in disposable income in a net change of 1 percent in price in the same direction. With only two factors over a longer period and a variation in method, Fox accounted for about the same percentage (96) of the annual change in apple prices as did Ockey.

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[1] See FRUIT SITUATION, August 1938. Issued quarterly by the Agricultural Marketing Service, United States Department of Agriculture.

[2] See FRUIT SITUATION, August 1939.

[3] FACTORS AFFECTING FARM INCOME, FARM PRICES, AND FOOD CONSUMPTION. Agricultural Economics Research. 3: 65–82, July 1951.

Analyses Relating to Periods Within the Season

A more recent study, which was conducted by the author and is reported by him in this paper, extended research to include analysis of changes in price for sales during different parts of the marketing season. Economic relationships involved in this study are depicted in figure 1.

Basic data analyzed in this study are mainly those prepared and published by the United States Department of Agriculture. Prices for apples and oranges are those received by growers on the 15th of the month through all methods of sale. Figures for stocks of apples are those reported in cold storage at the end of the month. Series on both total production and commercial crop are used as measures of size of crop. For a continuous series on size, the two series on production, in terms of year-to-year change, are spliced at the year 1935, for which the percentage change in production from 1934 is nearly the same for both series. Figures on disposable personal income are in terms of annual rates, regardless of the number of months covered in a particular analysis. Except for analyses dealing with early season estimates of production, series on production, stocks, and disposable income, where used as independent factors affecting prices, are adjusted for population to allow for growth in number of people.

For the purpose of analysis, basic data in most cases were transformed to first differences of logarithms. Use of logarithms implies that relationships among the variables are proportional rather than absolute. Distortions due to trends and cycles are reduced or eliminated by use of first differences. To measure relationships among variables, the least-squares, single-equation correlation method was used. Independent variables in each of the analyses made can be assumed to be determined mainly by factors other than the dependent variable. In such cases, the single-equation approach generally can be used.

Early Season Estimates of Production

Although qualitative information on the progress of each new apple crop becomes available during the spring months and especially in June, the first official Government forecast of the size of the crop is released about July 10, giving the indicated production based on July 1 conditions. Similar estimates are made each month during the summer and fall. Each successive estimate is based on the condition of the crop on the first of the month, together with the assumption of average weather during the remainder of the growing and harvesting season. A concluding estimate is made in December as part of the annual summary on crop production. This December figure may be revised the following July on the basis of data on utilization of the crop and other relevant information. Even these figures are subject to further revision, especially on the basis of benchmark data every 5 years from the census of agriculture.

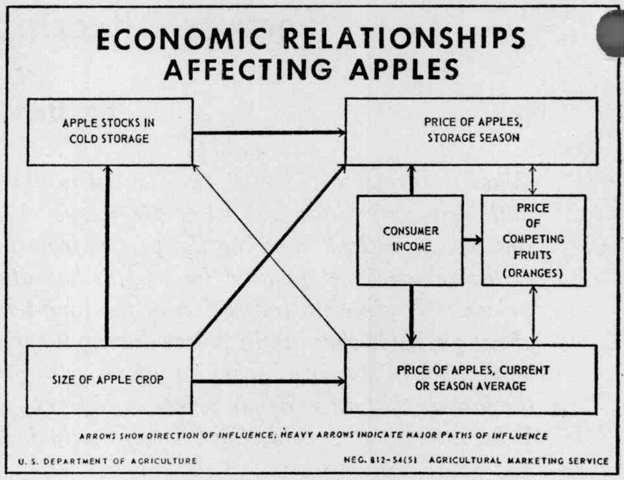

FIGURE 1.

Current early season estimates on the size of the crop tend to influence the utilization, marketing, and pricing of apples during summer and fall. Similarly, the December estimate of production and the monthly figures on stocks in cold storage become influential factors during the following winter and spring. Because each of the estimates on size of crop made early in the season assumes average weather until completion of harvest, departure from average weather will tend to make such estimates higher or lower than the December figure. Moreover, the estimate for July will tend to vary the most from December, while each successive monthly figure will tend to be closer to December.

Figure 2 depicts standard deviations of the differences between December estimates and those made in earlier months for the total apple crop, 1920–38, the commercial crop, 1940–53, and the commercial crop, 1944–53. Estimates of total production were discontinued with the 1938 crop. Beginning with the 1939 crop, estimates were made for only the commercial crop, that is, total production of apples in the commercial apple areas of each State. In 1939, however, no early season estimates were made for the commercial crop comparable with the December estimate of that year and with early season estimates of subsequent years. Moreover, July estimates for the commercial crop were not started until 1944. Because of these changes in estimating the apple crop, standard deviations covering three situations are presented in figure 2.

Patterns of variability of estimates each month from July to December are similar for both total production and the commercial crop. July estimates tend to differ most from December estimates, and successive monthly estimates tend to be progressively closer to December figures. But estimates for the total apple crop tend to differ more widely from the December figure than do those for the commercial crop. This is probably because of the greater difficulty of estimating the size of the noncommercial part of the total crop, for which growing conditions are not so well controlled as for the commercial crop and for which check data on production are less satisfactory. But even for the commercial crop, the July estimates for 1944–53 varied from the December figures by an average of 7.5 million bushels and these differences had a standard deviation of about 9 million bushels.

By October, when harvesting in the late-producing States was well under way, estimates of the

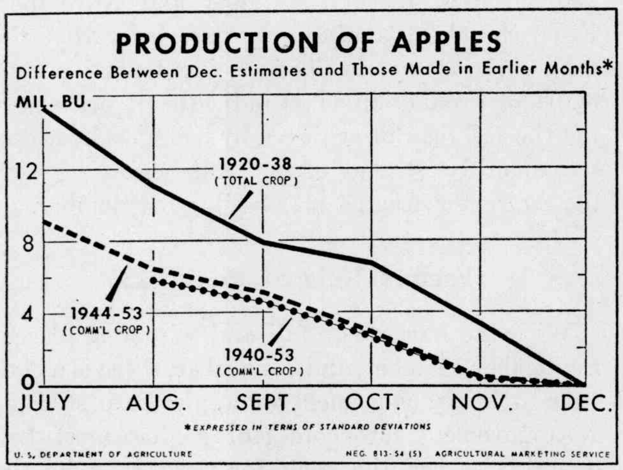

FIGURE 2.

crop varied from the December figure by mean and standard deviations of less than 3 million bushels. Average year-to-year variation in the total crop for these years was 59 million bushels; in the commercial crop it was 33–35 million bushels. Thus, in years of large changes from the preceding year, even the July estimate would be likely to indicate reliably the direction of change.

The summer months are a critical period for the growth, sizing, and maturing of apples. Hail, winds, lack of moisture, other weather conditions, insects and diseases, may reduce the size of the crop below that in prospect on July 1. On the other hand, unusually favorable conditions may increase production. Because of departures from average of such conditions affecting production and the tendency for estimates made in summer to differ rather widely from the December estimate, use of early season estimates in forecasting prices for the crop is hazardous.

Prices in Summer and Fall

Use of early season estimates of apple production as a factor in forecasting apple prices is risky, but persons who are concerned with the marketing of apples during summer and fall, as in other seasons, are faced with the necessity of making assumptions or estimates concerning probable future prices. June and July are transitional months during which prices of new-crop apples are influenced by the price level for old-crop apples, supplies of merchantable new-crop apples, and demand for such early apples. Moreover, during August and perhaps September, supplies of summer apples probably are more influential in determining price than is the size of the entire crop. But with the availability in October of heavy supplies of fall and winter varieties, which usually comprise about 95 percent of the crop, total production becomes a dominant factor in price.

To measure the effect of early season estimates upon price, grower prices for apples in September, October, and November, in turn, were correlated with August estimates of production and fourth-quarter disposable consumer income. Similarly, grower prices in November, December, and January were correlated with October estimates of production and fourth-quarter disposable income. For these analyses based on tentative estimates of production, no adjustments for population

TABLE 1.—*Apples: Effect on year-to-year changes in price received by growers during September–January of year-to-year changes in production and disposable consumer income, United States, 1921–53* [1]

Item	Coefficient of determination	Value for constant "a" [2]	Effect on price of a 1-percent change in— Production: Net effect[3]	Production: Standard error	Disposable income (4th quarter): Net effect[3]	Disposable income (4th quarter): Standard error
Production estimate:						
August—			*Percent*	*Percent*	*Percent*	*Percent*
Price: September	0.66	−0.010	−0.63	0.09	1.00	0.26
October	.81	−.014	−.88	.08	1.14	.25
November	.83	−.014	−.93	.08	1.15	.24
October—						
Price: November	.85	−.015	−.89	.07	1.18	.23
December	.84	−.016	−.86	.07	1.15	.23
January	.82	−.016	−.79	.07	1.28	.23

[1] Excluding 1939 and 1940 because there were no production forecasts for August and October 1939.
[2] Values for the constant "a" are here given for convenience in constructing the estimating equations. For example: The equation for estimating the annual change in price in November based on the August estimate of production and 4th quarter disposable income would be: $X'_1 = -0.014 - 0.93X_2 + 1.15X_3$.
[3] Regression coefficients from analyses based on first differences of logarithms.

were made in the figures for production and income, as were made for analyses relating to the storage season for apples. Furthermore, oranges were excluded. Results of these analyses are given in table 1.

Of the six situations summarized in table 1, the first, showing results for apple prices in September related to the August production estimate and fourth-quarter income, is the least satisfactory. Annual changes in the two factors of production and income were associated with only 66 percent of the annual changes in the price for September. Moreover, the regression coefficients for production and income with prices were the lowest, and the standard errors of these two coefficients were the highest, of the six sets shown. Supplies of summer apples apparently exert considerable influence on price as late as September.

Considerably better results were achieved in the situations in which prices in October and November were related to August production estimates. In these two situations, production apparently becomes a stronger factor in price.

Further improvement in results was obtained in the situations in which October production estimates were used. Within this group, the results for prices in January were less satisfactory than those for prices in November and December. Prices in January may be more influenced by the December estimate of total production and the December 1 estimate of cold storage stocks.

Although estimates of the size of the apple crop made during the summer and fall are tentative and tend to differ from the December figure, improvement in the estimate by October is good enough to use with considerable confidence as a factor in forecasting the price of apples in November and December. Even the August estimate of production may be used to give a fairly good indication of price in October and November. From the above analyses we may infer that the most satisfactory results in using tentative estimates of production as an indicator of price during the fall may be achieved by using each successive monthly estimate of the crop, beginning with the figure for August or, possibly, September.

Factors Related to Stocks

With the harvest of fall and winter apples in September, October, and November, there is a concurrent heavy movement of apples into storage. Net movement into cold storage has most frequently reached the peak for the season by the end of November. With the availability of figures on December 15 each year giving the quantities of apples in cold storage on November 30 (or December 1) of the same year, these figures may be used as an alternative factor for the December production figures for estimating prices for sales from storage after the first of the year. Partly for this reason, it is of interest to obtain some idea early in the season of the probable size of stocks of apples in cold storage on December 1.

To analyze factors that might affect the quantity of apples stored each year, cold storage holdings of apples December 1 were related to size of the apple crop, price of apples during harvest, and price of apples during the preceding storage season. The December estimate of production was used to measure the size of the apple crop. For a price at harvesttime, when decisions are made on quantities to store, the average price received by growers on October 15 was used. To measure any influence of price in the preceding storage season on quantity stored in the current season, the average price received by growers during January–May of the preceding season was used.

Figures for the above-mentioned four variables for the years 1922–51, without adjustments for population, were converted to first differences of logarithms for the purpose of analysis. Separate correlations were run for the years 1922–41, 1942–51, and the two periods combined, 1922–51.

Results for 1922–41 were statistically not significant, and those for 1922–51 were not conclusive. Even for 1942–51, results were only partly satisfactory. There was little correlation between price of apples during January–May and quantity of apples stored the following season. Hence, this variable was dropped, and the correlation was re-run for apples in cold storage on December 1 as the dependent variable and size of the apple crop and price of apples October 15 as the two independent variables, for the 10 years 1942–51. Cold storage capacity has increased and has become more widely distributed in the last decade, so storage is a more influential factor in apple marketing now than previously. Statistics on quantities in storage also have improved considerably in recent years. Conditions and relationships of 1942–51 are therefore likely to be more applicable to probable quantities of apples stored during the next few years.

On the basis of the analysis as recast for 1942–51, the two factors of annual changes in size of apple crop (X_2) and in price of apples October 15 (X_3) accounted for about 87 percent of the year-to-year changes in volume of apples in cold storage December 1 (X_1). The results showed further that, on the average, after allowing for the effect of price of apples on October 15, a 1-percent change in size of crop was associated with a change in the same direction of 1.24 percent in volume stored. Similarly, after allowance for size of apple crop, a 1-percent change in price was associated with a change in the same direction of nearly 0.4 percent in the quantity of apples stored. The regression equation for this analysis, when all variables are expressed as first differences of logarithms, is as follows:

$$X'_1 = -0.014 + \underset{(0.22)}{1.24}\, X_2 + \underset{(0.26)}{0.38}\, X_3.$$

The numbers in parentheses indicate the standard errors of the respective regression coefficients.

The results of this study based on relationships during 1942–51 when applied to data for the 1952 crop indicate that the quantity of apples in cold storage December 1, 1952, would be 24.0 million bushels. The actual volume reported in storage was 24.9 million bushels, 4 percent larger than calculated. For the 1953 crop, the expected stocks on December 1 were 24.6 million bushels. The reported stocks were 25.3 million, or 3 percent larger than calculated.

In considering how apple prices during the storage season affect the quantity stored, it might have been anticipated that low prices would be associated with the placing of large quantities in storage and high prices with placing smaller quantities in storage. But results of the analysis indicate that prices have the opposite effect; that is, stocks change in the same direction as do prices. One explanation is as follows:

The size of production is allowed for in this analysis by a separate factor. Hence the coefficient on price reflects the effects of a change in price for any given level of production. If consumers are willing to pay relatively high prices early in the season, producers may assume that they will pay high prices later as well. This apparently causes producers to place larger quantities in storage.

If this explanation is correct, the substitution

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of consumer income for price in this analysis should give results that are similar to those obtained from the analysis to which the above regression equation applies. Such an analysis was run. It was found that production and consumer income explained 84 percent of the variation in storage stocks as compared with the 87 percent explained by production and price. When income was used, however, the percentage change in stocks associated with a 1-percent change in production was reduced from 1.24 to 1.0 percent.

Prices in Winter and Spring

Prices for apples in winter and spring may be estimated as early as fall, or even summer, on the basis of preliminary estimates of production. By mid-December the final estimate of production and the December 1 estimate of stocks in cold storage become available, the latter providing an additional base for estimating prices for most of the storage season. The way that the October estimate of production, the December estimate of production, and the December 1 figure on stocks in cold storage are associated with prices during the following January–May period is summarized in table 2.

In the analysis including the October estimate of production, annual changes in this estimate and in estimated disposable consumer income for the following January–June period were correlated with annual changes in the average price received by growers for apples during January–May. This analysis did not include the price of oranges during January–May as did the companion analyses, because of the problem of forecasting in October the probable supplies and prices of oranges after January 1.

Except for this difference, the three analyses were carried out in the same fashion. Figures on production, stocks, and income were adjusted for population growth, after which all series were converted to first differences of logarithms for purposes of analysis. Separate analyses were made for the 20 years, 1921–40, the 10 years, 1941–50, and the two periods combined.

Although the second period includes the years of World War II when price controls and other wartime measures were in effect, most factors continued to operate rather freely in response to the usual natural and economic forces. In fact, price ceilings were set at the higher levels reached after much of the wartime rise in prices had occurred.

Based on relationships during 1921–50, the two factors of production of apples as estimated October 1 and disposable income for January-June gave a good indication of the price of apples during January-May. In fact, the results were almost as good as those obtained when the December estimate of production or the December 1 figure for stocks was used.

In all three situations, the independent factors explained about three-fourths of the year-to-year variations in apple prices. But the effect of some individual factors upon price was more variable. On the average, a 1-percent change in the December estimate of production was associated with a change in the opposite direction of about 0.6 percent in price. Similarly, for the October estimate of production, the change in price associated with a 1-percent change in production was 0.7 percent, and for stocks the change in price was 0.8 percent.

The effect of income upon price in the analysis using the October production estimate was somewhat larger than in the situations involving the December estimate of production and December 1 stocks. For the latter two situations, the effects of income upon price were about the same.

The effect of price of oranges upon price of apples was relatively small. In fact, another analysis that excluded the price of oranges but used adjusted data for stocks of apples and consumer income yielded results that were nearly as good as the one in which oranges were included. In a similar analysis, price was related to stocks and income unadjusted for population. The results were about the same as those obtained from the analysis based on adjusted data.

The results of the analysis involving December 1 stocks of apples, income, and price of oranges for 1921–50 when applied to data for the 1951–52 season indicate that the price of apples for January-May would average $2.50 per bushel. The actual price was $2.51. For January–May 1953, the indicated price was $3.10. Actual price was $3.29, about 6 percent higher than calculated price.

In December, supplies of apples as a factor in price may be considered in terms of the December estimate of production, the final for the season, or the December 1 figure for cold storage holdings,

TABLE 2.—*Apples: Effect on year-to-year changes in price received by growers during January–May of year-to-year changes in production or stocks, disposable consumer income, and price of oranges, United States, 1921–50* [1]

Period and supply factor	Coefficient of determination	Value for constant "a" [2]	Effect on price of a 1-percent change in—					
			Supply		Disposable income		Price of oranges	
			Net effect [3]	Standard error	Net effect [3]	Standard error	Net effect [3]	Standard error
1921–40:								
Production estimate:			*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
October	0.85	−0.022	−0.70	0.08	1.05	0.29		
December	.89	−.019	−.63	.09	.93	.24	0.16	0.07
Stocks, December 1	.76	−.004	−1.10	.30	.94	.36	.10	.13
1941–50:								
Production estimate:								
October	.87	−.011	−1.35	.15	1.04	.70		
December	.63	−.019	−.66	.26	1.17	1.32	.33	.32
Stocks, December 1	.75	−.026	−.75	.22	1.56	1.12	.18	.28
1921–50:								
Production estimate:								
October	.73	−.018	−.70	.09	1.15	.33		
December	.79	−.016	−.63	.10	.99	.29	.19	.09
Stocks, December 1	.74	−.006	−.81	.15	.98	.32	.19	.10

[1] Excluding 1939 and 1940 because there were no production forecasts for October 1939.
[2] Values for the constant "a" are here given for convenience in constructing estimating equations.
[3] Regression coefficients from analyses based on first differences of logarithms.

which usually is the largest for the season. From this month to the end of the storage season, attention turns to the successive monthly figures on stocks as the dominant supply factor influencing prices for the remainder of the season.

To measure the influence of stocks upon price after the first of the year, the price of apples for January through May, each month in turn, was related to stocks the first of the preceding month and to disposable consumer income for the current quarter, covering the 1941–50 crops (table 3). The analyses were limited to this period partly because of the more recent increased importance of storage in the marketing process. For purposes of analysis the series on stocks and income were adjusted for population, and all variables were

TABLE 3.—*Apples: Effect on year-to-year changes in price received by growers during January through May of year-to-year changes in stocks in cold storage and disposable consumer income, United States, 1941–50*

Price for specified month	Coefficient of determination	Value for constant "a" [1]	Effect on price of a 1-percent change in—			
			Stocks, first of preceding month		Disposable income, current quarter	
			Net effect [2]	Standard error	Net effect [2]	Standard error
			Percent	*Percent*	*Percent*	*Percent*
January	0.73	−0.022	−0.88	0.20	1.73	0.89
February	.73	−.038	−.82	.19	2.07	.92
March	.79	−.043	−.76	.15	2.10	.82
April	.61	−.006	−.53	.16	.91	1.28
May	.63	−.011	−.47	.14	1.13	1.23

[1] Values for the constant "a" are here given for convenience in constructing estimating equations.
[2] Regression coefficients from analyses based on first differences of logarithms.

transformed to first differences of logarithms.

According to the above analyses, year-to-year changes in stocks and income were associated with approximately three-fourths of the year-to-year changes in price for January, February, and March, and more than three-fifths for April and May. The net effect of stocks upon price was weakest during April and May. The smaller percentage effect of a 1-*percent* change in stocks on price as the season progresses reflects the smaller physical volume in storage. It is likely that a 1 million *bushel* change in stocks would have nearly the same effect on price in each month.

Stocks and income appear to be fairly good indicators of price during the winter months. But in the spring, as the marketing season for apples nears the end, these two factors, although still good, become less reliable.

Concluding Observations

This study presents and evaluates factors and methods whereby the average price received by growers for apples during various parts of the marketing season can be estimated with considerable accuracy relatively early in the season and progressively during the season as revised or new data become available.

Much of the usefulness of estimates of apple prices over the marketing season rests upon their determination early in the season. But to make such early determinations requires the use of preliminary basic figures when they are available, or of assumptions on their size early in the season. Although the first Government forecasts on the size of the apple crop tend to differ considerably from the final estimate in December, each month they become progressively closer to the December figure. By late summer or early fall, they are stable enough to give fairly reliable estimates of apple prices in the months ahead.

Information on probable price behavior early in the season is timely and should prove helpful in making decisions on quantities to market during harvest, quantities to store, and rates of sales from storage. As final figures on production and monthly figures on stocks in cold storage become available, new estimates of prices in the months ahead can be made so as to give revised or new bases for judging the market.

It should be recognized that part of the year-to-year change in the price of apples is not accounted for by the basic factors analyzed in this study. Each new season attention needs to be given to any likely additional factors that may be important in that particular season.

Livestock Marketing Practices in Iowa

By Emil H. Jebe and Norman V. Strand

This is the second of two articles on a survey of cattle and hog marketing practices of Iowa livestock farmers conducted in the spring of 1952 by the Statistical Laboratory of Iowa State College in cooperation with the Iowa Crop and Livestock Reporting Service and the Agricultural Estimates Division, Agricultural Marketing Service. Part of the study was intended to evaluate the use of a new mail survey, initiated in Iowa, on farmers' marketing intentions. The earlier paper [1] gave results on the use made by farm operators of the monthly releases. This paper examines the sources of marketing information available to the same livestock farmers, and looks into some aspects of farm operators' habits and practices in marketing selected lots of livestock.

IT WAS NOT THE PRIME OBJECTIVE of the study reported here to examine in detail how livestock farmers get their marketing information, but when pursuing inquiries about the

[1] Strand, N. V., and Jebe, E. H., a study of livestock marketing in iowa. Agricultural Economics Research. 6: 1–9. January 1954.