To the Graduate Council:

I am submitting herewith a thesis written by Bobby Dennis Banks entitled "The Effects of Selected Criteria on the Sale Price of Performance Tested Bulls." I recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Science, with a major in Animal Science.

Haley M. Jamison, Major Professor

We have read this thesis
and recommend its acceptance:

Accepted for the Council:

Vice Chancellor
Graduate Studies and Research

THE EFFECTS OF SELECTED CRITERIA ON THE SALE PRICE OF PERFORMANCE TESTED BULLS

A Thesis

Presented for the

Master of Science

Degree

The University of Tennessee, Knoxville

Bobby Dennis Banks

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ABSTRACT

The objective of this study was to partition the total variability of sale price received for performance tested bulls into that which is attributed to various selected criteria. The records of seven Tennessee performance tested bull sales were included. These records were collected from year 1973 through 1979 and consisted of 52 Hereford, 193 Angus and 321 Polled Hereford bulls. The mean sale price varied greatly among years with a low of $707 in 1974 to a high in 1978 of $1521. Realizing the tremendous amount of inflation that has occurred during this time interval, an analysis was performed in which the consumer price index (CPI) was entered into the model as a co-variate to adjust for inflation. The prices of slaughter bulls (SB) and slaughter cows (SC) as well as market prices of feeder calves (FC) were also entered to adjust for yearly market fluctuations. Performance data were entered into the model last in a logical order relating to the ease of obtainability by the buyer. Results of the subsequent analysis indicated that 54 percent of the total variability was explained by the model. The CPI accounted for 8.61 percent of the total explained variation. Market prices, when considered sequentially after CPI, were responsible for 27.2 percent. The addition of performance data explained the remaining 18 percent of the variability explained by the model. A second analysis was conducted in which the variability of price was partitioned into the constituents of a mathematical model which included the effects of year, breed and year by breed interaction as independent

variables. This analysis indicated that the effect of year was very highly significant ($P < .0001$) as well as the year by breed interaction ($P < .0001$). Breed was also significant ($P < .05$).

A third analysis to evaluate the effects of performance information alone on sale price was conducted. Buyers found sale-day age and 365-day weight to significantly ($P < .05$) explain variation in sale price of bulls irregardless of breed. Major breed differences occurred with 205-day weight. This variable was only significant for Angus buyers. Final off-test weight and preweaning average daily gain were non-significant for Polled Hereford.

All performance traits increased significantly during the years of this study with the exception of preweaning average daily gain which decreased significantly during the latter years. The effect of inflation, market trends and performance traits all affect bull prices. Important performance traits included sale-day age and 365-day weight.

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CHAPTER I

INTRODUCTION

The Tennessee Beef Cattle Improvement Program (TBCIP) began in 1956 as a joint project between the Tennessee Agricultural Experiment Station and the Tennessee Extension Service. This service was created to provide beef cattle producers in Tennessee performance records that were accurate, uniform and easily accessible. The performance information allows breeders to identify superior animals by a comparison of the quantitative measurements that are assembled in the record of each individual. Breeders can use these records to increase the genetic worth of their herd by selecting only those animals that exceed specific goals to be parents of the next generation. The TBCIP offers both preweaning and postweaning phases of performance testing. The postweaning phase consists of a 140-day feed test which is performed on the farm. The postweaning phase later led to the creation of the public auction sale of the tested bulls. Since the initiation of this, many questions have arisen pertaining to factors attributing to the sale price of any bull, and to which are the most important.

The sale price is composed of an infinite number of individual characteristics of the bull as well as various economical and non-measurable factors including levels of optimism, price trends, supply and demand.

The quality of the animal being sold contributes the major portion of the financial worth. Animals which possess performance

records allow potential buyers to identify the superiority or inferiority of the gaining ability of that animal and they also have an estimate of quantitatively desirable genes that will be transmitted to the progeny. Records such as adjusted average daily gain, adjusted 205-day weight, and weight-per-day of age are all excellent indicators of growth. Boggs and Merkel (1979) state the identification of superior sires is of the utmost importance in the selection of today's beef breeding stock. The length of the generation interval and initial cost of breeding stock make the selection of appropriate sires a crucial portion of management if one is to be successful in the production of beef animals. Although the performance information is available each buyer emphasizes the factors differently, and this may change with the trends of various breed associations and the changes in the type of animal which the industry considers acceptable to its ever changing standards.

Another factor which influences the price of bulls is the economical stage of the cattle market. Cattle prices have been reported to cycle approximately every 15 years beginning in 1890 (Cox, et al., 1953). Prices received for market animals greatly influence the demand for breeding stock thus the price received for the breeding stock is directly influenced.

The objectives of this study are to consider various selected criteria including inflation, slaughter market prices and performance information in order to determine the fraction of total variation in sale price that is attributed to each factor.

CHAPTER II

REVIEW OF LITERATURE

The factors which influence the price received for bulls sold at public auction have been estimated several times, but because of the numerous sources of variation, accurate estimates are somewhat difficult to ascertain. These sources range from subjective estimates of type grades, conformation or pedigree to the more objective and quantitative traits like gains or weights.

Decisions made in the selection of breeding stock are perhaps more important in beef cattle than any other species. The producer of beef cattle can neither make rapid changes in type nor rapid recovery from selection mistakes (Boggs and Merkel, 1979).

Rutherford et al. (1966) surveyed 227 southern Indiana beef cattle producers and asked them to indicate the three most important factors they considered when selecting a bull. Conformation was reported as the most important criterion in the selection of herd sires. The second most important factor was that of the animal's size. Health and breed type was recognized as being the third variable by managers of small herds consisting of three to twenty cows, while reputation of the breeder influenced managers of herds consisting of 51 to 400 cows.

Selection based on type has been shown to produce insignificant or even negative progress in rate of gain (Patterson et al., 1955; Patterson et al., 1949; and Gregory et al., 1964).

Gregory et al. (1964) states that show ring placings are highly subjective and selection based entirely upon visual appraisal of conformation has been shown to be ineffective or even undesirable.

Chapman et al. (1969) states that selection for type alone resulted in a lowered post weaning average daily gain ($P < .05$).

Selection based upon performance of the individual should prove to be the most effective method of improving rate of gain in beef cattle (Patterson et al., 1949).

Danker et al. (1975) report traits of vital economic importance are best measured by performance testing and not by the visual appraisal of the animal or show ring performance.

Progeny produced by sires and dams selected for weaning weight or type score tend to produce progeny with greater mean performance in those traits than progeny from parents selected on other criteria (Chapman et al., 1972).

According to Patterson et al. (1949), the greatest rate of progress, at least in the initial stage, would be expected from mating superior performing animals irrespective of any predetermined breeding lines. However, we must remember that performance indicates the ability of the animal to gain. Performance testing does not make good bulls from bad ones; it merely ranks them in order of weight gain (Henry, 1971). It identifies the poorer bulls with startling accuracy but does not justify the popular misconception that a performance tested bull is automatically a good bull.

The future of economically successful beef production must place

less emphasis on selection of individuality *per se* and more on herd output/input (Cartwright *et al.*, 1970).

Patterson *et al.* (1955) identified rate of gain, efficiency of gain and reproductive efficiency as the most important factors in economical beef production. One conclusion drawn was that selection based on performance could increase the volume of meat produced and lower the cost of production.

The original idea of performance testing began between 1930 and 1935 by the United States Department of Agriculture at the Range Livestock Research Station in Miles City, Montana. The concept of performance testing has grown rapidly in past years (Baker, 1967) and the use of this information in the selection of animals has grown even faster (Jamison *et al.*, 1971). Danker *et al.* (1976) states that a large part of the increase in bull prices has been due to a significant improvement in performance traits.

In a twelve year study of 489 yearling performance tested Angus bulls at Ames Plantation, Jamison *et al.* (1971) reported that 48.8 and 30.5 percent of the total variation was explained by performance information in spring and fall bulls, respectively. The traits examined included lifetime average daily gain, final grade, adjusted average daily gain from birth to weaning, weaning grade, average daily gain on full feed, weight off test and age at end of test. A greater amount of emphasis was placed on lifetime average daily gains and final grade. The lifetime average daily gain explained 30.5 and 16 percent of the total variation in sale price of bulls purchased in the spring and fall, respectively. Lifetime average daily gain and final grade were found to significantly

affect sale price. An increase of one-tenth pound of lifetime average daily gain resulted in an increase of $37.48 in sale price. Other factors added to the model accounted for very little of the predictability of sale price. This agrees with work of Marlow and Morrow (1967), Marlow (1969), Danker et al. (1976) and Osborne and Marlow (1976) when they found final grade to be significant in explaining variation in bull prices.

Jamison et al. (1971) also reported that breeders who purchased bulls at performance tested sales seem to study the performance data made available to them which agrees with Bryan (1971) and Danker et al. (1976).

Marlow and Morrow (1967) conducted a study on 390 Angus bulls and 233 Hereford bulls. They fitted a regression model containing 16 performance and non-performance related variables. A separate analysis was performed within each breed. Among Angus buyers six variables were found to be significant. The rank and approximate dollar values were: (1) final grade (pt.) $137.13; (2) age (mo.) $39.00; (3) 365-day weight (100 lb.) $88.54; (4) lifetime average daily gain (.1 lb.) $28.35; (5) clean pedigree $36.54; (6) test average daily gain (.1 lb.) $11.20.

Among Hereford buyers Marlow and Morrow (1967) found seven variables to be significant. They included: (1) final grade (pt.) $200.70; (2) 365-day weight (100 lb.) $229.50; (3) clean pedigree $104.27; (4) polled condition $106.37; (5) preweaning average daily gain (.1 lb.) $20.94; (6) test average daily gain (.1 lb.) $13.84; and (7) age (mo.) $20.58. These results somewhat disagree with the work

of Danker et al. (1976) and Osborne and Marlow (1976) when they reported that test average daily gain had no significant effect on price. Danker et al. (1976) also suggest that the effect of age was nonsignificant ($P > .01$) in explaining price variation.

When the effects of year (the most significant factor) was removed from the model, Marlow and Morrow (1976) reported that buyers place more emphasis on conformation and type (grade) than any other factors. Hereford buyers placed major emphasis on preweaning gains while Angus buyers paid little attention to this factor. The reverse was true for lifetime gains. This corroborates work by Jamison et al. (1971) when they reported that preweaning average daily gain was not significant ($P > .05$) and lifetime average daily gains were significant ($P < .05$) in explaining variation in the sale price of Angus bulls.

Marlow and Morrow (1967) suggest the effects of lifetime average daily gain are negatively associated with price. According to Marlow and Morrow (1967) the effects of yearly fluctuations were highly significant and agree with the work of Jamison et al. (1971), Danker et al. (1976) and Osborne and Marlow (1976).

Osborne and Marlow (1976) found 365-day weight, grade, sale age, condition and sale order to be highly significant in explaining variation in sale price. Head score and 205-day weights were non-significant. The R^2 value for the analysis on all bulls in this study was .58. R^2 values of .52, .80 and .55 were found for the final models of Angus, Charolais and Hereford breeds, respectively. The single most important variable affecting sale price was the adjusted 365-day weights for Angus

and Hereford. Variables which were not significant included 205-day weights and average daily gain on test. Other significant variables only for Hereford were the polled condition of the animals and color.

Marlow (1969) conducted a study on sale prices of 791 Angus and Hereford bulls. He found type and conformation were the most important criterion used in selection of beef sires with an average price increase of $110.00 per-grade for Angus and $170.00 per-grade for Hereford. Angus buyers placed little importance on preweaning gains and 365-day weights. Hereford buyers placed major emphasis on 365-day weights in selection, while placing lesser attention to preweaning or lifetime gains. This could be explained by the simple correlation coefficient between lifetime average daily gain and 365-day weight (r = .96). The correlation and regression coefficients and relative importance of the variables on sale price are presented in Table 1.

A similar study was conducted by Osborne and Marlow (1976) on 597 Angus, 48 Charolais, 75 Hereford, and 293 Polled Herefords. The 365-day weights were found to be of major importance for all breeds. Other significant variables included age, grade, frame score, and horned or polled condition. Variables found to be nonsignificant were location of sale, sale order, 205-day weight and muscling score. Sale prices varied greatly among years.

In a study conducted by Bryan (1972) seven performance traits explained 60.4 percent of the total variation in the selling price of performance tested bulls. Weight off-test alone accounted for 28.6 percent of the total variation and average daily gain only added 11.0 percent to the explanation of the variation.

TABLE 1

CORRELATION AND REGRESSION COEFFICIENTS AND RELATIVE IMPORTANCE OF SEVERAL VARIABLES ON SALE PRICE OF BULLS

Variables	Part. reg. coef. and std. dev.,$	Correlation Coefficients		Std. part. reg. coef.	Rank[a]
		Simple	Partial		
		Angus			
Final grade	109.61±14.53**	0.49	0.33	2.045	1
Year of sale	-14.73±6.72*	0.19	-.10	-1.343	2
Life ADG, .1 kg.	18.44± 8.54*	0.46	0.10	1.316	3
Age in days	0.70± 0.23**	0.18	0.14	0.436	4
Sale order	- 7.58± 0.91**	-.60	-.36	- .312	5
Prewean ADG, .1 kg.	4.43± 3.23	0.37	0.06	0.293	6
Dwarfism status	35.53±10.71**	0.13	0.15	0.174	7
Herd	0.09± 0.14	-.02	0.03	0.145	8
Feed test ADG, .1 kg.	1.26± 2.10	0.31	0.03	0.099	9
365-day wt., kg.	0.03± 0.21	0.45	0.01	0.095	10
		Hereford			
Final grade	170.16±22.34**	0.48	0.41	2.866	1
365-day wt., kg.	0.94± 0.25**	0.47	0.21	2.354	2
Year of sale	-28.28± 9.72**	0.01	-.17	2.318	3
Herd	- ,80± 0.21**	-.20	-.22	-2.153	4
Life ADG, .1 kg.	-17.74± 9.12	0.34	-.11	1.163	5
Feed test ADG, .1 kg.	8.07± 2.59**	0.34	0.18	0.590	6
Prewean ADG, .1 kg.	8.54± 4.05*	0.35	0.12	0.531	7
Age in days	0.75± 0.32*	0.27	0.14	0.420	8
Polledness	149.10±28.28**	0.24	0.30	0.420	9
Dwarf status	77.62±24.25**	0.19	0.25	0.378	10
Sale order	- 6.28± 2.28**	-.61	-.16	0.144	11

[a]Based on the size of the standard partial regression coefficient.

*P < .05.

**P < .01.

Warren (1957) found that lifetime average daily gain, conformation and weight-per-day of age were not significantly correlated with sale price. However, when these traits were combined in an index, the correlation coefficient was .74 and was highly significant. The fraction of total variation in sale price that was explained by average daily gain, weight-per-day of age and conformation was 70 percent.

Simms (1971) concluded that Illinois performance tested bull buyers placed great emphasis on weaning weight, yearling weight and test average daily gain. This partially disagrees with research by Danker et al. (1976) and Osborne and Marlow (1976) who state that the test average daily gain was not significant in explaining the sale price of bulls.

Research by Danker et al. (1976) indicate that non-performance factors of breed, year, season and sale order were all significant. This corroborates all reports except Bryan (1972) when he reports no apparent breed differences were found.

Danker et al. (1976) indicate that performance traits significantly ($P < .01$) explaining the variation in sale price included sale-day grade, sale-day weight, 365-day weight and yearling conformation. Buyers generally preferred heavier bulls with a more desirable grade or type. Sale-day grade was by far the most important factor explaining sale price variation ($R^2 = 0.33$). On the average, buyers paid an additional $293.38 for each increment increase in sale day grade. Sale-day weight accounted for 9 percent of the sale price variation. Three hundred and sixty-five day weight was responsible for 2 percent and yearling conformation accounted for the remaining 1 percent.

In conclusion of this study, Danker et al. (1976) indicated that the performance price relationship is significant, but buyers still seem to be selecting herd sires on the basis of weight on sale day and conformation rather than performance data.

Osborne et al. (1976) reports that the sale price of beef bulls is influenced by the sale price of feeder calves since their sale price is largely determined by weight, grade, sex and the way they are packaged for sale.

In order to determine if feeder calf prices were related to bull prices, the average price per hundredweight for feeder calves in Missouri was graphed on the same chart as bull prices (Danker et al., 1976). The coefficient of correlation between feeder calf prices and bull prices was .74. Feeder calf prices were highly significant ($P < .01$) in explaining 55 percent of the total variation in bull prices.

Beef cattle price fluctuations in the United States are influenced by five major factors (Robertson et al., 1940):

1. General price level
2. General business conditions
3. Beef cattle production cycles
4. Past margins of profit
5. Consumer demands

Cox et al. (1953) state that the price level represents to a certain extent the relationship between commodities and services on one hand and credit on the other.

The general price level is considered by many authors (Robertson et al., 1940; Mitchell et al., 1941; Cox et al., 1953) to be the single most influential factor in price demand analysis.

Beef cattle prices tend to rise and fall in line with the general price level (Robertson et al., 1940).

Cox et al. (1953) states that the general price level affects beef prices the most while beef production numbers are the second most influential variable. These two variables explained 70 percent of the variation in price. A 10 percent increase in the general price level caused a 6 percent increase in beef prices. If beef production number increased 10 percent, a decrease of 5 percent in beef prices was reflected.

In order to adjust for the effect of the general price level Cox et al. (1953) adjusted price data using the "Wholesale Price Index of 28 Basic Commodities."

Foote (1958) reports that in order to isolate price-quantity relationships on demand curves by statistical means, variables that cause such curves to shift back and forth must be included in the model. If we have reason to believe that a doubling of all prices and income variables has no effect on consumption, effects of the general price level should be allowed for by deflation; that is, by dividing each price, income or marketing margin by a variable such as the Bureau of Labor Statistics Consumers Price Index (CPI). Changes in the value of money may affect the nature of the demand for certain items that involve initial expenditures. In such cases we might allow for changes in the price level by including the CPI as a separate

variable or deflate and include variables that relate to fixed assets in the equation. If a variable relating to marketing cost is included in the analysis, then we can show that the CPI is an appropriate series to use to represent the general price level.

Tomek et al. (1972) states that with the passage of time the average level of all prices tends to change.

A common practice is to deflate the observed price and income series by a general price index, i.e. the Consumers Price Index (Tomek et al., 1972).

CHAPTER III

EXPERIMENTAL PROCEDURE

I. SOURCE OF DATA

The data used in this study were taken from 566 bulls which were sold at public auction through the Tennessee Performance Tested Bull Sale between the years of 1973 through 1979. These bulls were enrolled in both the preweaning and postweaning phases of the Tennessee Beef Cattle Improvement Program (TBCIP). All records were processed at the state office. The records of these seven years consisted of 193 Angus, 321 Polled Hereford and 52 Hereford bulls.

II. DATA AVAILABLE TO BUYERS

Sale catalogs were made available to buyers preceding sale time. Each bull sold was listed in the catalog with a photocopy of the certificate of registration. The information available to the buyers included breeder and the identity of the owner. The pedigree data included the identity of the paternal and maternal grandsire and granddam. The performance information included three phases of growth. Preweaning management practices, adjusted average daily gain and adjusted 205-day weight constituted the preweaning phase. Information involving the 140-day feed test included average daily gain, day off test and weight off test. Lifetime information was included as the final set of performance information. The bull's adjusted 365-day weight and lifetime weight-per-day of age were made available to buyers.

III. PREWEANING DATA

Data recorded at birth on each bull included birth date, breed of sire and dam. Birth weights were not required but could be submitted as part of the birth record. Birth weight constants were used for those bulls which had no recorded birth weights. These were 65 and 60 lbs. for Angus and Shorthorn and 70 and 65 lbs. for all other breeds, male and female, respectively. All calves must have been weighed between 160 and 250 days to be eligible for processing through the TBCIP.

Weaning data included weaning weight, weaning date and feed management practices. From these data performance information was calculated which included age in days, actual weaning weight, average daily gain, 205-day adjusted weight and adjusted average daily gain. Both 205-day weight and average daily gain were adjusted for sex of calf and age of dam according to recommendation of the Beef Improvement Federation (BIF).

IV. POSTWEANING DATA

The post weaning phase of the TBCIP includes a 140-day feed test on the farm of the owner. This feed test must have begun between 210 and 300 days of age. Post weaning data includes the date and weight of the bull when going on test and the date and weight of the animal at the conclusion of the test. These data were used along with pre-weaning data to obtain performance information including weight-per-day of age, feed test average daily gain and adjusted 365-day weight. Three

hundred sixty-five day weights were adjusted for sex of calf and age of dam.

V. PREREQUISITES OF ELIGIBILITY

In order to qualify for the sale each bull must exceed standards imposed by the TBCIP. These prerequisites of eligibility included that the bull must have been a participant in the TBCIP, and must be registered in the appropriate purebred herd book. These bulls must have exceeded either 222.26 or 240.48 kg. for adjusted 205-day weight, creep and non-creep fed calves, respectively. The length of test must have been 140 days and the adjusted 365-day weight must have exceeded 408.24 kg. and lifetime average daily gain must have been greater than or equal to 0.91 kg. for both creep and non-creep fed calves. All bulls must have begun the 140-day full feed test between 210 and 300 days of age and must have been at least 18 but not more than 30 months of age at time of sale. All bulls consigned will be subjected to a screening committee for final approval of sale and determining sale order. The bulls sold must be free of obvious defects of conformation and unsoundness.

VI. FEED RATIONS

The ration suggested by the Extension Service of The University of Tennessee is presented in Table 2.

VII. VARIABLES STUDIED

Performance data utilized in this study were final off-test weight, sale-day age, adjusted 365-day weight, adjusted 205-day weight,

TABLE 2

SUGGESTED FEED RATIONS

Constituent	Starter Ration kg. (first 4 weeks)	Main Ration kg. (last 100 days)
Coarsely cracked, flaked and/or rolled No. 2 yellow corn	282.59	375.58
44 percent soybean meal	136.08	124.74
Alfalfa meal pellets	45.36	45.36
Cotton seed hulls*	381.02	299.38
Molasses	45.36	45.36
Animal fat	9.07	9.07
Trace mineralized salt	4.54	4.54
Limestone	3.17	3.17
Vitamin A	2 Million (I.U.)	2 Million (I.U.)
Aueromycin	8,000 (I.U.)	

*Good hay may be substituted.

adjusted preweaning average daily gain and weight-per-day of age. The actual price received was the monetary value, in dollars, that was received for the bulls.

The rate of inflation in this research was measured by the United States Department of Labor's Consumers Price Index (CPI) (U.S. Dept. Commerce, Bureau of Economic Analysis, Survey of Business Statistics). This index was used in order to obtain an unbiased estimate of inflation rate. The CPI was used to simulate the relative worth of the dollar when all items purchased by consumers were measured.

Current market prices were determined by calculating the average November sale price of slaughter bulls, cutter grade cows and 181 to 227 kg. choice grade feeder calves sold throughtout Tennessee (U.S.D.A. Consumer and Marketing Service, Livestock Division).

VIII. SCOPE OF RESEARCH

Inferences drawn pertain only to the particular years and breeds included in this study. The variables year and breed were stratified in such a way that they included the entirety of the finite population of performance tested bulls; therefore, they were assumed to be fixed effects.

Prices of performance tested bulls, the dependent variable, was not intended to represent the entire population of bulls sold at public auction nor all performance tested bulls sold. This population was restricted to a subpopulation of Tennessee performance tested bulls to be inclusive of years 1973 through 1979.

IX. METHOD OF ANALYSIS

Four analyses were conducted to investigate the effects of inflation, current market conditions and performance data.

Analysis I

The objective of the first analysis is to examine the effects that three factors had on the sale price received for bulls. The factors include inflation, market prices and performance data. The effects of inflation were measured by including the consumers price index, all items from year 1973 through 1979 previously adjusted to a 1979 base. This variable measures the relative decrease in the value of the dollar. The effects of current market prices were measured by three variables which include the market prices of slaughter bulls, cutter grade cows and feeder calves. The importance of performance information was measured by six performance variables entered into the model in a manner which might simulate the order in which a buyer would evaluate the animal. The factors were linearly combined into the following models.

Model I.

$$Y_i = \mu + b_1 CPI + b_2 FS + b_3 SB + b_4 CC + b_5 FW + b_6 A + b_7 365 + b_8 205 + b_9 AADG + b_{10} WDA + e_i$$

where:

Y_i = the known random observation of the i^{th} individual and $y \sim (\mu, \sigma^2)$

μ = an unknown constant common to all Y_i observations

b_1 = the unknown partial regression coefficient of Y on the consumers price index

b_2 = the unknown partial regression coefficient of Y on the price of 181 to 227 kg. choice grade feeder steers

b_3 = the unknown partial regression coefficient of Y on the price of slaughter bulls

b_4 = the unknown partial regression coefficient of Y on the price of cutter grade cows

b_5 = the unknown partial regression coefficient of Y on final weight off-test

b_6 = the unknown partial regression coefficient of Y on sale-day age

b_7 = the unknown partial regression coefficient of Y on adjusted 365-day weight

b_8 = the unknown partial regression coefficient of Y on adjusted 205-day weight

b_9 = the unknown partial regression coefficient of Y on adjusted average daily gain

b_{10} = the unknown partial regression coefficient of Y on life-time weight-per-day of age

CPI = the Consumers Price Index, 1973 through 1979, adjusted to 1979 base

FS = the market price of 181 to 227 kg. choice grade feeder steers

SB = the market price of slaughter bulls

CC = the market price of cutter grade cows

FW = final off-test weight

A = sale day age

365 = adjusted 365-day weight

205 = adjusted 205-day weight

AADG = preweaning adjusted average daily gain

WDA = lifetime weight-per-day of age

e_i = the random residual error associated with the i^{th} observation of $e \sim (o, \sigma^2)$

Least squares regression analysis was used to determine if in fact performance information is considered by bull buyers when inflation and current market prices are held constant. Sequential sums of squares were calculated and these sums of squares were totaled for each of the three factors. Thus, the percentage of variation explained by the performance data was that variation remaining after the data had been adjusted for inflation and market prices according to procedures used by Foote (1958).

In order to examine the partial effect of inflation, the same model was used but the variables rearranged such that the data was preadjusted for market prices and performance data.

Model II.

$$Y_i = \mu + b_1FS + b_2SB + b_3CC + b_4FW + b_6365 + b_7205 + b_8AADG + b_9WDA + b_{10}CPI + e_i$$

where:

The symbols represent the other model identically but arranged in a different order.

In order to measure the partial effect of market prices, the same variables were used as in Model I but arranged as to preadjust the data for the effects of inflation and performance data. The model used was:

Model III.

$$Y_i = \mu + b_1 CPI + b_2 FW + b_3 A + b_4 365 + b_5 205 + b_6 AADG + b_7 WDA + b_8 FS + b_9 SB + b_{10} CC + e_i$$

Again, the symbols represent the same variables as Model I but are arranged in order to examine the partial effects of market prices.

Analysis II

A preliminary analysis of variance indicated, when all performance variables were included in a model along with year and breed, that two performance variables significantly ($P < .05$) explained the sale price of bulls. The effect of inflation was preadjusted from sale price by procedures used by Tomek and Robinson (1972) using the following formula:

$$\text{adjusted sale price} = \frac{\text{actual sale price}}{\text{CPI adjusted to 1979 base}}$$

Therefore, the prices were inflated to 1979 real dollar basis and the following model was used to perform an analysis of variance:

$$Y_{ijk} = \mu + Yr_i + B_j + (YrB)_{ij} + b_1 365 + b_2 A + e_{ijk}$$

where:

Y_{ijk} = the known random observation of the ijk^{th} individual adjusted to a 1979 dollar basis. $Y \sim N(\mu + Yr_i + B_j + (YrB)_{ij}, \sigma^2)$.

μ = an unknown constant common to all Y_{ijk} observations

Yr_i = the unknown fixed effect of the i^{th} year, i = 1, 2, 3, ... 7

B_j = the unknown fixed effect of the j^{th} breed, j = 1, 2, 3

$(YrB)_{ij}$ = the unknown fixed effect of the interaction between the i^{th} and the j^{th} breed

b_1 = the unknown partial regression coefficient of Y on adjusted 365-day weight

b_2 = the unknown partial regression coefficient of Y on sale-day age

365 = adjusted 365-day weight

A = sale-day age

e_{ijk} = the random residual error associated with the ijk^{th} observation of $e \sim N(o, \sigma^2)$

This analysis was performed to analyze the effect of year, breed and performance information. The interaction was examined by the quartet test of subcells (Mao, 1981).

Analysis III

Analysis III was conducted to examine the effects of performance information on price. In order to accomplish this, the data was pre-adjusted to remove the effects of year, inflation and market fluctation by procedures used by Danker et al. (1976) where:

$$\text{adjusted sale price} = \frac{\text{actual sale price}}{\text{mean sale price by year}}$$

The following model was used to perform an analysis of variance.

$$Y_i = \mu + b_1FW + b_2A + b_3365 + b_4205 + b_5AADG + b_6WDA + e_i$$

where:

Y_i = the known random observation of the i^{th} individual adjusted, $Y \sim N(\mu, \sigma^2)$

μ = an unknown constant common to all Y_i observations

b_1 = the unknown partial regression coefficient of Y on final off-test weight

b_2 = the unknown partial regression coefficient of Y on sale-day age

b_3 = the unknown partial regression coefficient of Y on adjusted 365-day weight

b_4 = the unknown partial regression coefficient on adjusted 205-day weight

b_5 = the unknown partial regression coefficient of Y on preweaning adjusted average daily gain

b_6 = the unknown partial regression coefficient of Y on lifetime adjusted weight-per-day of age

FW = final weight off-test

A = sale day age

365 = adjusted 365-day weight

205 = adjusted 205-day weight

AADG = preweaning adjusted average daily gain

WDA = lifetime weight-per-day of age

e = the random residual error associated with the i^{th} observation of $e \sim N(o, \sigma^2)$

Analysis IV

Analysis IV investigates the effects of year, breed and the interaction of year and breed on performance variables. The following model was used to determine the effects:

$Y_{ijk} = \mu + Yr_i + B_j + (YrB)_{ij} + e_{ijk}$

Y_{ijk} = the known random observation of the ijk^{th} individuals where y_{ijk} is one of six different performance variables, $Y \sim N (\mu + Yr_i + B_j + (YrB)_{ij}, \sigma^2)$

μ = an unknown constant to all Y_{ijk} observations

Yr_i = the unknown fixed effect of the i^{th} year, i = 1,2,3,...7

B_j = the unknown fixed effect of the j^{th} breed, j = 1,2,3

$(YrB)_{ij}$ = the unknown fixed effect of i^{th} year and the j^{th} breed

e_{ijk} = the random residual associated with the ijk^{th} observation of Y, $e \sim N (o, \sigma^2)$

Significant main effects were then analyzed by Scheffe's Multiple Range test to separate mean differences.

For ease of discussion, future references will be made as Analyses I, II, III and IV, respectively. All analyses were performed through the use of the Statistical Analysis System 1979 (SAS79) (Barr et al., 1979). Least squares means were obtained as described by Harvey (1960).

CHAPTER IV

RESULTS AND DISCUSSION

The average sale price of all bulls sold was $1,002.72. The mean sale price among years along with the number of bulls sold are shown in Table 3. The highest unadjusted sale average was in 1978 ($1,521), while 1974 had the lowest mean price ($707). The number and average sale price of bulls sold by breed are presented in Table 4. These data indicate that Polled Herefords had the highest average breed price, followed by Angus and Hereford, respectively. The means and standard deviations of selected variables (Table 5) indicate that Polled Herefords sold for a higher mean price in the early years of this study while Angus and Herefords sold for higher mean prices during the terminal years.

Linear relationships of variables included in this study are listed in Table 6.

I. ANALYSIS I

In order to determine if the price of market animals were related to bull prices, the average November sale price of 181-227 kg. choice grade feeder calves, 409-499 kg. slaughter bulls and cutter cows were graphed on the same chart as bull prices (Figure 1). A trend was evident between the market prices and bull prices. The correlation coefficient (r) between feeder calves, slaughter bulls and cutter cows with the sale price of performance tested bulls were .54, .52 and .54,

TABLE 3

UNADJUSTED MEANS AND STANDARD DEVIATIONS
OF SALE PRICE ACROSS YEARS

Year	Number of Animals	Mean ($)	SD
1973	125	1066	420
1974	96	707	222
1975	63	952	249
1976	69	898	248
1977	86	753	299
1978	55	1521	444
1979	72	1331	429

TABLE 4

UNADJUSTED MEANS AND STANDARD DEVIATIONS
OF SALE PRICE ACROSS BREED

Breed	Number of Animals	Mean ($)	SD
Hereford	52	920	396
Angus	193	937	447
Polled Hereford	321	1055	420

TABLE 5

UNADJUSTED MEANS AND STANDARD DEVIATIONS OF SELECTED VARIABLES

Year of Sale	Breed	No. of Bulls	Final Off-test Weight	Sale-day Age	365-Day Weight	205-Day Weight	Average Daily Gain	Weight Per-day of Age	Price ($)
1973	Hereford	12	445.66±43.61	652.25±50.26	421.36±22.44	241.16±16.65	1.24±.16	1.11±.08	833.33±171.67
	Angus	51	431.90±28.30	611.80±83.05	424.64±24.04	231.05±20.08	1.38±.16	1.14±.07	845.69±369.62
	Polled Hereford	62	447.85±34.24	600.17±70.78	432.33±31.70	241.51±22.37	1.27±.15	1.14±.09	1283.47±382.14
1974	Hereford	10	463.13±33.69	663.70±38.92	444.75±35.36	243.49±20.10	1.43±.10	1.19±.08	659.00±221.59
	Angus	43	449.82±36.75	636.21±36.39	441.05±30.85	251.26±23.72	1.35±.19	1.17±.08	678.37±210.84
	Polled Hereford	43	444.06±41.45	627.19±51.33	328.14±30.33	247.25±24.55	1.28±.22	1.27±.09	747.67±231.99
1975	Hereford	5	449.61±44.70	654.40±15.27	446.80±40.08	262.73±24.52	1.27±.14	1.21±.10	815.00±187.58
	Angus	23	433.54±44.75	669.65±78.21	432.40±27.33	251.85±25.86	1.28±.15	1.14±.08	981.52±284.87
	Polled Hereford	35	462.37±42.39	645.14±73.23	451.47±35.63	256.09±26.23	1.32±.25	1.19±.09	952.86±230.15
1976	Hereford	5	482.27±15.55	680.40±180.21	464.12±35.52	258.91±43.18	1.30±.13	1.24±.09	820.00±451.18
	Angus	25	466.88±26.64	662.20±43.51	435.76±28.95	250.06±23.75	1.32±.15	1.17±.11	813.00±293.92
	Polled Hereford	39	460.23±33.24	619.60±55.52	449.79±41.09	250.39±25.99	1.37±.23	1.20±.11	962.82±242.51
1977	Hereford	6	465.39±35.86	698.00±30.74	454.36±36.61	244.72±20.93	1.35±.16	1.20±.09	818.33±405.17
	Angus	21	467.25±39.93	686.24±70.77	453.88±32.89	257.32±23.46	1.38±.19	1.21±.10	788.81±275.22
	Polled Hereford	59	469.35±36.17	661.24±96.73	474.53±35.70	268.44±28.90	1.40±.25	1.26±.09	733.73±298.79
1978	Hereford	6	473.41±39.47	636.00±116.11	465.92±23.07	245.77±11.34	1.08±.06	1.23±.08	1708.33±369.68
	Angus	13	477.26±35.86	693.38±70.00	469.86±47.73	255.59±23.88	1.10±.11	1.25±.14	1707.69±413.37
	Polled Hereford	36	463.52±34.07	628.86±42.71	455.39±24.04	259.70±20.83	1.11±.10	1.21±.07	1423.61±444.49
1979	Hereford	8	433.07±42.03	650.75±65.64	442.60±32.18	254.13±15.72	1.08±.08	1.17±.12	916.88±166.56
	Angus	17	475.00±40.63	667.41±68.24	451.60±28.57	244.92±18.39	1.04±.09	1.18±.11	1585.29±444.68
	Polled Hereford	47	463.78±42.47	637.30±82.82	468.44±33.55	261.49±23.33	1.18±.11	1.24±.10	1310.64±395.21
Total		566	455.85±38.70	638.10±73.83	439.35±35.38	251.41±25.52	1.28±.21	1.19±.10	1002.72±433.99

TABLE 6

CORRELATION COEFFICIENTS AMONG VARIABLES STUDIED

Variable	2	3	4	5	6	7	8	9	10	11
1. Cutter Cow Prices	.99	.99	.64	NS	-.44	.07*	.13	.11*	NS	.53
2. 402.24-498.96 kg. Slaughter Bull Prices		.99	.58	NS	-.43	NS	.11	.08**	NS	.52
3. 181.44-226.80 kg. Feeder Calf Prices			.61	NS	-.42	NS	.13	.10*	NS	.53
4. Consumers' Price Index				.28	-.31	.23	.35	.33	.17	.29
5. 205-Day Weight					NS	.34	.63	.51	NS	.28
6. Average Daily Gain						.34	.31	.34	NS	-.12
7. Final Off-test Weight							.60	.59	.17	.33
8. 365-Day Weight								.88	.08**	.41
9. Weight-Per-Day of Age									.11	.38
10. Sale-Day Age										.19
11. Sale Price										

$^{NS}P > .05.$

**P < .05.

*P < .01.

All other variables were significant (P < .001).

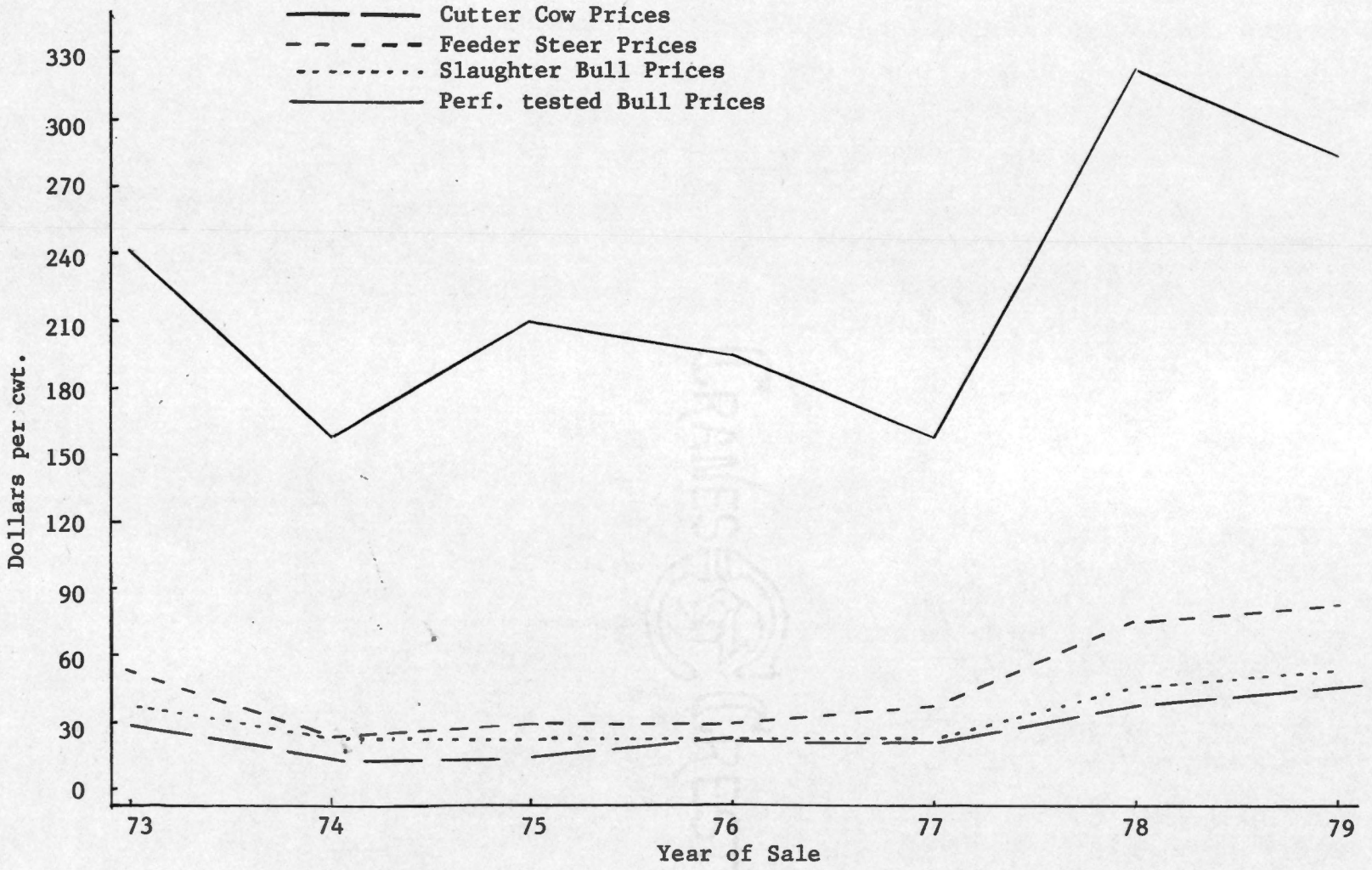


Figure 1. Mean price per cwt. of performances tested bulls, slaughter bulls, 181 to 227 kg. feeder calves and cutter cows across years.

respectively. The correlation was very highly significant ($P < .0001$) in all cases indicating that approximately 25 percent of the total variation in bull prices could be explained by any one market variable.

Results of Model I are presented in Table 7. This analysis was performed to examine the effects of preadjusting performance data for inflation and market data. The tabled values are sequential sums of squares (SAS Type I). The percentage of the total explained variation ($R^2 = .57$) which was accounted for by the partial effect of all performance variables was 21.6 percent. Table 8 presents the partial effects of inflation as measured by the consumers price index (Model II). Thirteen and eight hundreths percent of the explained variation was attributed to inflation. The partial effect of market prices (Model III) is shown in Table 9. The amount of explained variation explained by effect of market prices over and above inflation and performance data was 28.57 percent. From these data one may conclude that all three factors have an effect on the price received for performance tested bulls. Examination of the partial effect of the three factors indicated that buyers at the sale seemed to study the performance information made available to them. This agrees with Jamison et al. (1971) and Danker et al. (1976).

Buyers tend to place a great amount of emphasis on the current market prices of beef cattle when considering the price range within which they will operate.

When the sums of squares due to inflation and the three market price variables were summed, they accounted for approximately 95 percent of the total variation associated with the effect of year. This

TABLE 7

ANALYSIS OF THE PERCENTAGE OF TOTAL VARIATION EXPLAINED BY SELECTED VARIABLES, MODEL I[a]

Source of Variation	DF	Sequential Sums of Squares	Percent of Total Sums of Squares
Total	565	104,951,859.89	
Consumers' Price Index[b]	1	9,037,951.76	8.60
Feeder Steer Prices[c,d]	1	21,548,488.71	
Slaughter Bull Prices[c,e]	1	570,695.41	21.20
Cutter Cow Prices[c]	1	6,423,948.16	
Final Off-test Weight	1	9,714,189.40	
Sale-day Age	1	3,406,473.19	
365-day Weight[f]	1	9,079,393.33	21.60
205-day Weight[f]	1	452,739.56	
Preweaning Average Daily Gain[f]	1	4,040.62	
Weight-per-day of Age	1	99,817.07	

[a]Total R^2 = .57.

[b]Consumers' Price Index all items.

[c]Market prices are the mean November sale price per year from Tennessee auction sales.

[d]Feeder steer prices are averages of 181-227 kg. choice.

[e]Slaughter bull prices are averages of 408-499 kg.

[f]Adjusted for sex of calf and to mature dam equivalent weight according to BIF recommendations.

TABLE 8

ANALYSIS OF THE PERCENTAGE OF TOTAL VARIATION EXPLAINED BY SELECTED VARIABLES, MODEL II[a]

Source of Variation	DF	Sequential Sums of Squares	Percent of Total Sums of Squares
Total	565	104,951,859.89	
Feeder Steer Prices[b,c]	1	30,343,110.607	
Slaughter Bull Prices[b,d]	1	406,843.999	30.32
Cutter Cow Prices[b]	1	1,075,304.400	
Final Off-test Weight	1	7,643,321.248	
Sale-day Age	1	1,940,660.556	
265-day Weight[e]	1	4,923,187.401	14.08
205-day Weight[e]	1	171,742.598	
Preweaning Average Daily Gain[e]	1	68,438.603	
Weight-per-day of Age	1	30,579.773	
Consumers' Price Index[f]	1	13,734,548.024	13.08

[a]Total R^2 = .57.

[b]Market prices are the mean November sale price per year from Tennessee auction sales.

[c]Feeder steer prices are averages of 181-227 kg. choice.

[d]Slaughter bull prices are averages of 408-499 kg.

[e]Adjusted for sex of calf and to mature dam equivalent according to BIF recommendations.

[f]Consumers' Price Index all items.

TABLE 9

ANALYSIS OF THE PERCENTAGE OF TOTAL VARIATION EXPLAINED BY SELECTED VARIABLES, MODEL III[a]

Source of Variation	DF	Sequential Sums of Squares	Percent of Total Sums of Squares
Total	565	104,951,859.89	
Final Off-test Weight	1	11,281,322.77	
Sale-day Age	1	1,888,366.67	
365-day Weight[b]	1	7,926,355.19	28.90
205-day Weight[b]	1	12,618.49	
Preweaning Average Daily Gain[b]	1	9,165,333.05	
Weight-per-day of Age	1	59,368.26	
Consumers' Price Index[c]	1	15,724.96	.01
Feeder Steer Prices[d,e]	1	22,212,354.48	
Slaughter Bull Prices[d,f]	1	205,867.44	28.57
Cutter Cow Prices[d]	1	7,570,425.91	

[a]Total R^2 = .57.

[b]Adjusted for sex of calf and to a mature dam equivalent weight according to BEF recommendations.

[c]Consumers' Price Index all items.

[d]Market prices are the mean November sale price per year from Tennessee auction sales.

[e]Feeder steer prices are averages of 181-227 kg. choice.

[f]Slaughter bull prices are averages of 408-499 kg.

suggests that the majority of the inherent year differences were due to inflation and fluctuations in market prices.

The partial and standard partial regression coefficients are presented in Table 10. Examination of the standard partial regression coefficients indicate that the 365-day weight was the most important performance related variable. This agrees with work by Marlow and Morrow (1967), Marlow (1969) and Osborne et al. (1976). Buyers were willing to pay $3.44 for each additional increase of 365-day weight. Sale-day age was the second most influential variable. For each day increase, buyers paid an additional $1.22. This corroborates research by Marlow and Morrow (1967), Marlow (1969) and Danker et al. (1976). Marlow (1969) found comparable results for 365-day weight in Hereford bulls as an increase of $.94 per kg. increase of 365-day weight. Partial regression coefficients for 365-day weight and sale-day age were very highly significant ($P < .0001$). Other significant ($P < .05$) regression coefficients were 205-day weight and final weight off-test. From these data one could conclude that buyers of Tennessee performance tested bulls select more on the overall size of the bull at sale time rather than performance information based on daily gains. Weight-per-day of age and 365-day weight were highly correlated ($r = .88$), but when both were placed in a model, 365-day weight was the dominant influence.

II. ANALYSIS II

Analysis II was conducted to measure the effects of year, breed and performance data. A preliminary analysis indicated that two

TABLE 10

REGRESSION COEFFICIENTS AND RELATIVE IMPORTANCE OF PERFORMANCE VARIABLES

Variable	Part. Reg. Coef. and Std. Err. $	Std. Part. Reg. Coef.	Rank[a]
365-day Weight, kg.	3.4413±.86***	.2824	1
Sale-day Age, Days	1.2246±.17***	.2097	2
205-day Weight, kg.	1.4371±.69*	.0851	3
Final Off-test Weight, kg.	.9114±.41*	.0818	4
Weight-per-day of Age, .1 kg.	29.0617±260.79	.0672	5
Preweaning Average Daily Gain, .1 kg.	-2.9617± 86.75	-.0141	6

[a]Based on size of the standard partial regression coefficient.

*P < .05.

***P < .001.

performance variables which were significant ($P < .05$) in explaining sale price. The results of this analysis are presented in Table 11. The dependent variable in this analysis was the actual sale price adjusted to a 1979 dollar base as recommended by Tomek and Robinson (1972). The effect of all variables were highly significant ($P < .01$) indicating an effect on price by the variables year, breed, 365-day weight, sale-day age and the interaction of year and breed. Since the interaction was significant expounding on the main effect would prove erroneous. The effect of the interaction was examined by the quartet test of significance (Mao, 1981). The results are presented in Table 12. A significant interaction ($P < .01$) was exhibited between Hereford x Angus, Hereford x Polled Hereford and Angus x Polled Hereford when sequential years were analyzed. Angus bulls sold significantly higher than Hereford bulls ($P < .01$) in 1978 than in 1979 (Figure 2). The sale price of Polled Hereford bulls decreased significantly ($P < .01$) when compared to Hereford and when compared to Angus ($P < .05$) during 1973 and 1974. A significant interaction ($P < .01$) was evident between Hereford and Polled Hereford for 1978 through 1979.

Least squares means are shown in Table 13. Means in the first column are those calculated with the dependent variable being the actual price received. The year 1978 had the highest mean price. No differences ($P > .05$) were reflected between the years 1973 and 1979, although 1979 had a higher absolute value. The second column contains means of sale price adjusted to a 1979 dollar base. The least squares mean for 1973 was the largest value and was different ($P < .05$) from any other mean in the array. This suggests that even though the actual

TABLE 11

ANALYSIS OF VARIANCE OF ADJUSTED SALE PRICE OF ANGUS, HEREFORD AND POLLED HEREFORD BULLS[a,b,c,d]

Source of Variation	DF	Mean Square
Year	6	6617968.84***
Breed	2	659373.88***
Year x breed	12	1357078.39***
Regression of inflated sale price on:		
365-day weight	1	29826651.72***
Sale day age	1	7457727.65***
Residual	543	64170710.85

[a] $\hat{Y}$ = Year + breed + b_1 365-day weight + b_2 sale day age + year x breed + error.

[b] Adjusted sale price is the actual sale price received adjusted to a 1979 dollar basis by the Consumers' Price Index.

[c] R^2 = .637.

[d] Tabled values are partial mean squares.

***P < .001.

TABLE 12

ANALYSIS OF VARIANCE OF INTERACTION
OF YEAR BY BREED

Source of Variation	Degrees of Freedom	Mean Square
Hereford X Angus	6	363,335.6**
1973-1974	1	14,373.2
1974-1975	1	59,042.8
1975-1976	1	62,277.5
1976-1977	1	1,116.7
1977-1978	1	1,821.9
1978-1979	1	1,047,327.0**
Angus X Polled Hereford	6	389,693.8**
1973-1974	1	1,650,813.0**
1974-1975	1	80,949.8
1975-1976	1	231,366.0
1976-1977	1	322,439.0
1977-1978	1	309,810.0
1978-1979	1	480.7
Hereford X Polled Hereford	6	1,156,289.3**
1973-1974	1	435,561.0*
1974-1975	1	6,875.4
1975-1976	1	54.2
1976-1977	1	126,381.0
1977-1978	1	105,928.0
1978-1979	1	1,351,084.0**

**P < .01.

*P < .05.



Figure 2. Sale price trends by breed.

TABLE 13

LEAST SQUARE MEANS OF SALE PRICE BY YEAR[a]

Year	Number of Animals	Least Squares Mean[b] ($)	Least Squares Mean[c] ($)
1973	125	1145[d]	1826[d]
1974	96	723[e]	1062[e]
1975	63	913[f]	1236[f]
1976	69	849[f]	1083[e,f]
1977	86	646[e]	766[g]
1978	55	1504[g]	1655[h]
1979	72	1215[d]	1199[e,f]

[a] $\hat{Y}$ = Year + breed + b_1 365-day weight + b_2 sale day age + year x breed + error.

[b] Least-squares means of the actual price received.

[c] Least-squares means of the actual price received adjusted by the Consumers' Price Index to a 1979 dollar basis.

[d,e,f,g,h] Those means followed by the same letter within a column do not differ significantly ($P > .05$).

dollar values were lower for 1973, the buyers were willing to pay a higher percent of their income for bulls than in any other year of the study.

From the results of Analysis II, a large amount of the variation in the sale price of bulls can be attributed to the effect of yearly differences. This agrees with work by Marlow and Morrow (1967), Marlow (1969) and Danker et al. (1976). Breed differences were found to affect sale price ($P < .05$) and will be examined extensively in Analysis III.

III. ANALYSIS III

The objective of this analysis was to study the effects of performance data on sale price. A price ratio was computed within each sale to remove the effect of inflation, market fluctuations and other outside effects. The effects of breed were found to significantly affect price in Analysis II; therefore, an analysis was performed within each breed.

Hereford. All performance variables were positively correlated ($P < .001$) with price with the exception of preweaning average daily gain. The correlation coefficient between preweaning average daily gain and sale price was -.22 and was not significant. Marlow (1969) found a negative association between price and preweaning average daily gain of Hereford bulls. The results of various models, when each variable was fitted singularly, are presented in Table 14. The most important variable explaining the sale price of performance tested bulls was the adjusted 365-day weight ($R^2 = .349$). This agrees with work of Marlow and Morrow (1967) in which they found 365-day weight to be significant in explaining price variation of Hereford bulls. Osborne and Marlow

TABLE 14

CHANGES IN R^2 OF HEREFORD BULLS PRODUCED BY PERFORMANCE VARIABLES[a,b]

Variable	R^2	ΔR^2
Preweaning Average Daily Gain[c]	.126**	
205-day Weight[c]	.148**	.022
Sale-day Age	.166**	.018
Weight-per-day of Age	.311**	.245
Final Off-test Weight	.313**	.002
365-day Weight[c]	.349**	.036

[a]Adjustment for year and inflation was performed by creating an index that consisted of the sale price for each year being divided by the mean sale price by year.

[b]Each variable was fitted singularly in separate analysis.

[c]Adjusted for sex of calf and age of dam.

**P < .01.

(1976) indicated that 365-day weight was the most important variable affecting the sale price of Hereford bulls. Final off-test weight was the second most important variable explaining 31.3 percent of the total price variation. Danker et al. (1976) found sale-day weight to be associated with sale price. Preweaning average daily gain was found to be the least important variable in price relationships (R^2 = .126). Marlow (1969) reports lifetime average daily gain not associated ($P > .05$) with the sale price of Hereford bulls. This disagrees with research by Jamison et al. (1971) when they reported that lifetime average daily gain was the most important variable. This disagreement could be explained by the changes in the emphasis placed on this trait by producers today and the changes in the type of animal the cattle industry considers desirable. A stepwise regression analysis was then conducted and results are presented in Table 15. Hereford buyers placed major emphasis on the adjusted 365-day weight. This variable alone explained 34.9 percent of the total variation and was significantly associated with price ($P < .001$). Sale-day age also had a significant ($P < .01$) effect on price and explained an additional 12.6 percent of the total variation. These two variables alone explained the major portion of price variation. Variables not significant ($P > .05$) included preweaning average daily gain, final off-test weight, 205-day weight and weight-per-day of age. Major discrepencies between the analysis of each variable fitted singularly and the stepwise regression occurred with the variables final off-test weight and weight-per-day of age. The coefficient of correlation between these variables and 365-day weight was moderately high (.74 and .94 for final off-test weight and weight-

TABLE 15

REGRESSION ANALYSIS OF PERFORMANCE VARIABLES ON ADJUSTED SALE PRICE OF HEREFORD BULLS[a]

Number in Model	365-day weight[b]	Sale Day Age	Preweaning Avg. Daily Gain[b]	Final Off-test Weight	205-day Weight[b]	Weight-per-day of Age	R^2	ΔR^2
1	X						.349	
2	X	X					.465	.126
3	X	X	X				.493	.028
4	X	X	X	X			.494	.001
5	X	X	X	X	X		.495	.001
6	X	X	X	X	X	X	.495	.000

[a]Adjustment for year and inflation was performed by creating an index that consisted of the sale price for each year being divided by the mean sale price by year.

[b]Adjusted for sex of calf and age of dam.

per-day of age, respectively). When all three were included in a model, 365-day weight was the dominant variable.

Angus. The sale price of Angus bulls was significantly correlated with all performance variables ($P < .001$). This correlation was positive with the exception of preweaning average daily gain. Results of an analysis with each variable fitted singularly are presented in Table 16. The performance variable explaining the major portion of variation was 365-day weight explaining 35.5 percent of the total price variation. This agrees with previous research by Osborne and Marlow (1976). The second most influential variable was weight-per-day of age, and 205-day weight was third. Preweaning average daily gain explained the least amount of price variation and was not significant ($P > .1$).

Results of a stepwise regression analysis are presented in Table 17. Buyers of Angus bulls considered 365-day weight to be the most important variable. Previous research by Danker et al. (1976) and Osborne and Marlow (1976) report 365-day weight to significantly affect price variation. Sale-day age was the second most influential variable explaining an additional 5 percent of variation in sale price. Both 365-day weight and sale day age were significant ($P < .001$) in affecting bull prices. When added to the model, 205-day weight was significant but the additional variation explained was negligible. Again a moderate correlation existed between 365-day weight, final off-test weight and weight-per-day of age. When all three were included simultaneously, 365-day weight was more influential. Variables not significant ($P > .05$) include final off-test weight, preweaning average daily gain and weight-per-day of age.

TABLE 16

CHANGES IN R^2 OF ANGUS BULLS PRODUCED BY PERFORMANCE VARIABLES[a,b]

Variable	R^2	ΔR^2
Preweaning Average Daily Gain	.001	
Sale-day Age	.093**	.092
Final Off-test Weight	.097**	.004
205-day Weight	.224**	.127
Weight-per-day of Age	.246**	.022
365-day Weight	.355**	.089

[a]Adjustment for year and inflation was performed by creating an index that consisted of the sale price for each year being divided by the mean sale price by year.

[b]Each variable fitted singularly in separate analysis.

[c]Adjusted for sex of calf and age of dam.

**P < .01.

TABLE 17

REGRESSION ANALYSIS OF PERFORMANCE VARIABLES ON ADJUSTED SALE PRICE OF ANGUS BULLS[a]

Number in Model	365-day Weight[b]	Sale Day Age	205-day Weight[b]	Final Off-test Weight	Preweaning Avg. Daily Gain[b]	Weight per-day of Age	R^2	ΔR^2
1	X						.355	
2	X	X					.405	.050
3	X	X	X				.417	.012
4	X	X	X	X			.421	.004
5	X	X	X	X	X	X	.423	.002
6	X	X	X	X	X	X	.424	.001

[a]Adjustment for year and inflation was performed by creating an index that consisted of the sale price for each year being divided by the mean sale price by year.

[b]Adjusted for sex of calf and age of dam.

Polled Hereford. All performance variables were significantly correlated ($P < .01$) with sale price with the exception of adjusted preweaning average daily gain. Final off-test weight, 365-day weight and weight-per-day of age were correlated ($r = .32$) with sale price. Weight-per-day of age explained more variation in sale price than any other variable (Table 18). This variable alone explained 17.4 percent of total variation. Three hundred and sixty-five day weight was considered to be the second most important trait to Polled Hereford buyers. Sale-day age was the least important variable explaining only 5.1 percent of the total variation. Results of a stepwise regression analysis are shown in Table 19. Buyers of Polled Hereford bulls place major emphasis on weight-per-day of age. The coefficient of correlation between 365-day weight and weight-per-day of age was moderately high ($r = .88$); therefore, the best two variable models consisted of sale-day age and 365-day weight. Polled Hereford buyers emphasized final off-test weight and preweaning average daily gain as the third and fourth most influential variables. This coincides with previous research by Jamison et al. (1971) when they found lifetime average daily gain to be significant. The moderately high correlation existed again between weight-per-day of age and 365-day weight ($r = .86$). Under single consideration weight-per-day of age took precedence, however when both variables were considered simultaneously, 365-day weight dominated.

Discussion. Across all breeds the variables sale-day age and 365-day weight were significant ($P < .05$). This suggests that buyers of Tennessee performance tested bulls are concentrating on the size

TABLE 18

CHANGES IN R^2 OF POLLED HEREFORD BULLS PRODUCED BY PERFORMANCE VARIABLES[a,b]

Variable	R^2	ΔR^2
Sale-day Age	.051**	
205-day Weight	.065**	.014
Preweaning Average Daily Gain	.088**	.023
Final Off-test Weight	.150**	.062
365-day Weight	.173**	.023
Weight-per-day of Age	.174**	.001

[a]Adjustment for year and inflation was performed by creating an index that consisted of the sale price for each year being divided by the mean sale price by year.

[b]Each variable fitted singularly in separate analysis.

[c]Adjusted for sex of calf and age of dam.

**P < .01.

TABLE 19

REGRESSION ANALYSIS OF PERFORMANCE VARIABLES ON ADJUSTED SALE PRICE OF POLLED HEREFORD BULLS[a]

Number in Model	Weight-per-day of Age	Sale Day Age	365-day Weight[b]	Final Off-test Weight	Preweaning Avg. Daily Gain[b]	205-day Weight[b]	R^2	ΔR^2
1	X						.174	
2		X	X				.206	.032
3		X	X	X			.232	.026
4		X	X	X	X		.244	.012
5		X	X	X	X	X	.248	.008
6	X	X	X	X	X	X	.251	.003

[a]Adjustment for year and inflation was performed by creating an index that consisted of the sale price for each year being divided by the mean price by year.

[b]Adjusted for sex of calf and age of dam.

and age of bulls. Rutherford et al. (1966) found southern Indiana cattle producers ranked size as the second most important criterion in bull selection. Gregory et al. (1961) suggests weights at 12 to 18 months are better measures in differences in growth rates than any of its components parts such as birthweight, preweaning gains or postweaning gains.

Major breed differences occurred with 205-day weight. Two hundred and five day weight was significant only within the Angus breed. Final off-test weight and preweaning average daily gain were only significant for Polled Herefords.

The coefficient of determination was .424 and .495 for Angus and Hereford, respectively. The percentage of variation explained by the six performance variables was .251 for Polled Hereford bulls. This indicates that buyers of Angus and Hereford are emphasizing performance data more intensively than Polled Hereford buyers when selecting herd sires. Polled Hereford buyers may place a greater amount of emphasis on other factors such as type, conformation or pedigree than do buyers of Angus and Hereford bulls.

From these data one could conclude that buyers at the Tennessee Performance Tested Bull Sale do consider the performance of the animal when selecting herd sires. However, buyers seem more interested in overall size and age of the animal at time of sale rather than daily gains.

IV. ANALYSIS IV

In order to understand the relationship between performance and price of the animals, an examination of the performance traits among years and breeds was conducted.

Final off-test weight has increased substantially over the years involved in this study (Figure 3). The effect of year was significant ($P < .001$) in explaining variation in final off-test weight (Table 20). The interaction of year by breed was also significant ($P < .05$). Examination of yearly differences (Table 21) indicated 1977 had the highest final off-test weight (468.56 kg.) and 1973 the lowest (441.13 kg.). This difference was significant ($P < .05$). All breeds of bulls responded similarly in performance of this trait ($P < .05$).

Sale-day age fluctuated greatly among years ($P < .01$) and breeds ($P < .001$) (Table 22). The highest mean sale-day age was in 1977 (670 days). The smallest mean age occurred in 1973 (Table 23). Sale-day age has increased significantly ($P < .05$) from 1973 to 1979. Differences among breeds are presented in Table 24. Polled Herefords had the youngest mean age while Hereford was the oldest. This difference was significant ($P < .05$) and may be explained by the availability of the respective breeds. There were 321 Polled Hereford bulls sold during this study while Hereford breeders consigned only 52 bulls. This may reflect a demand for Polled Hereford bulls. If this is true, breeders would have no reason to keep bulls to an older age.

It should also be noted that the highest mean sale age occurred in 1977 when the price of bulls was at the second lowest price during this study and had been steadily declining for three years. This would indicate that producers tend to grow bulls to an older age when prices are low. When the price of bulls increased considerably in 1978, this conversely affected the mean sale-day age (Figure 4).

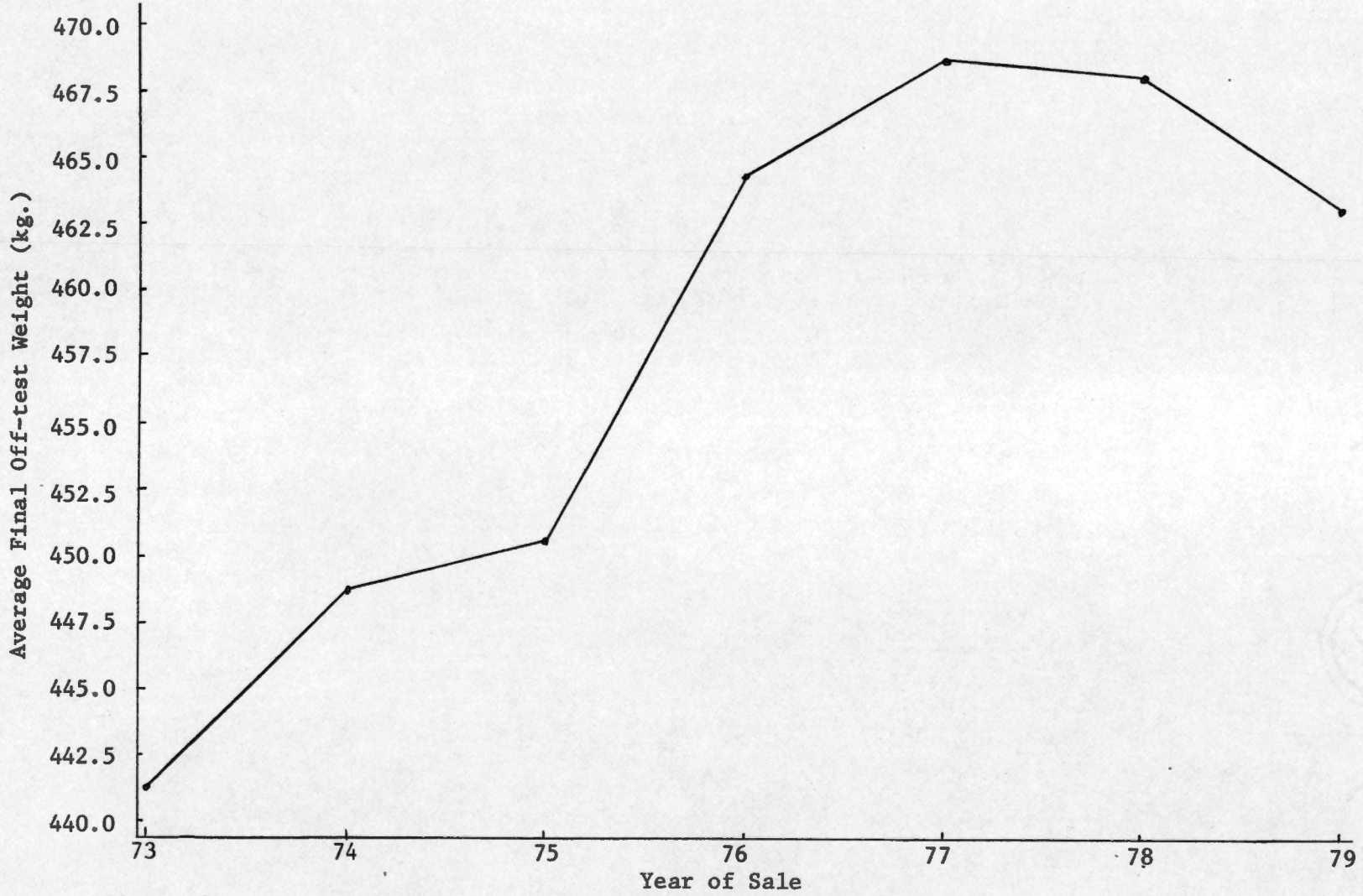


Figure 3. Average final off-test weight across years.

TABLE 20

ANALYSIS OF VARIANCE OF THE EFFECTS OF YEAR AND BREED ON FINAL OFF-TEST WEIGHT

Source of Variation	DF	Mean Square
Year	6	30,188.0528***
Breed	2	515.7292
Year X Breed	12	13,984.5845*
Residual	545	6,650.7470
Total	565	

*P < .05.

***P < .001.

TABLE 21

MEAN DIFFERENCES IN FINAL OFF-TEST WEIGHT AMONG YEARS[d]

Year	Final Off-test Weight (kg.)
1973	441.1314[a]
1974	448.6434[a,b]
1975	450.8350[a,b,c]
1979	463.0184[b,c]
1976	464.2365[b,c]
1978	467.8429[b,c]
1977	468.5581[c]

[a,b,c]Those means followed by the same letter do not differ significantly ($P < .05$).

[d]Scheffe's multiple range test. Critical value equals $\sqrt{s_e^2 /2} \times 5.04 \times \sqrt{(1/n_i + 1/n_j)}$.

TABLE 22

ANALYSIS OF VARIANCE OF THE EFFECTS OF YEAR AND BREED ON SALE-DAY AGE

Source of Variation	DF	Mean Square
Year	6	17,329.4279**
Breed	2	40,889.2166***
Year X Breed	12	4,666.7424
Residual	545	5,002.3591
Total	565	

**P < .01.

***P < .001.

TABLE 23

MEAN DIFFERENCES IN SALE-DAY AGE AMONG YEARS[d]

Year	Sale-day Age (days)
1973	609.9199[a]
1976	624.9419[a,b]
1974	635.0313[a,b,c]
1978	644.8909[a,b,c]
1979	645.9026[a,b,c]
1975	654.8252[b,c]
1977	669.9067[b,c]

[a,b,c]Those means followed by the same letter do not differ significantly ($P < .05$).

[d]Scheffe's multiple range test. Critical value equals $\sqrt{s_e^2 /2 \times 5.04 \times \sqrt{1/n_i + 1/n_j}}$.

TABLE 24

MEAN DIFFERENCES IN SALE-DAY AGE
AMONG BREEDS[c]

Breed	Sale-day Age (days)
Polled Hereford	630.9314[a]
Angus	643.9739[a,b]
Hereford	660.5383[b]

[a,b]Those means followed by the same letter do not differ significantly ($P < .05$).

[c]Scheffe's multiple range test. Critical value equals $\sqrt{s_e^2 /2} \times 3.47 \times \sqrt{1/n_i + 1/n_j}$.

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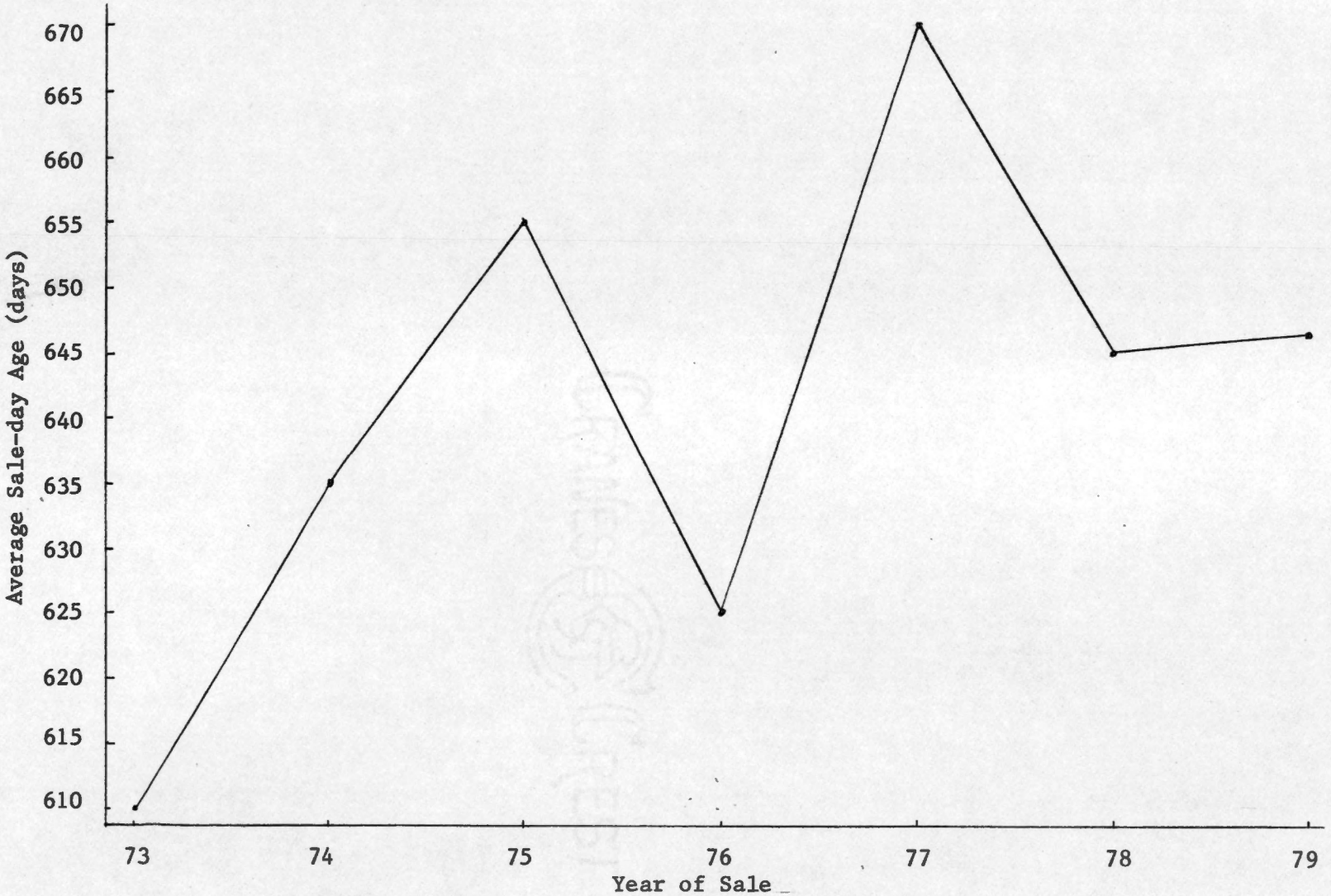


Figure 4. Average sale-day age across years.

Three hundred and sixty-five day weight was significantly affected by year and breed (Table 25). Figure 23 (see Appendix) reflects the consistent increase of 365-day weight across years. The low mean 365-day weight was 428.14 kg. in 1973 while the highest average weight was 486.08 kg. in 1977 (Table 26). Polled Hereford possessed the highest 365-day weight and was significantly higher ($P < .05$) than Angus as shown in Table 27.

The 205-day weights of bulls in this study differed significantly among years and breeds (Table 28). Two hundred and five day weights have increased significantly during this study. A significant difference was found between 1973 and 1979 (Table 29). This difference along with the trend of these traits across years is shown in Figure 5. Polled Herefords had the highest 205-day weights (Table 30). Absolute values were greater than Hereford and significantly ($P < .05$) higher than Angus.

The trend of mean average daily gain value by year are presented in Figure 6. Average daily gain increased slightly until 1977 when a sharp decrease was evident between 1978 and 1979. The effect of year was highly significant ($P < .001$) on average daily gain. Differences among years are shown in Table 31. A significant decrease ($P < .05$) occurred after 1977 (Table 32).

Weight-per-day of age was significantly ($P < .001$) (Table 33) affected by yearly differences. This trait has increased significantly ($P < .05$) across the years involved in this study (Table 34). The effects of breed were associated with weight-per-day of age ($P < .05$). Polled Herefords had the highest weight-per-day of age and was significantly higher than Angus ($P < .05$) (Table 35).

TABLE 25

ANALYSIS OF VARIANCE OF THE EFFECTS OF YEAR AND BREED ON 365-DAY WEIGHT

Source of Variation	DF	Mean Square
Year	6	43,634.1650***
Breed	2	19,366.2909*
Year X Breed	12	7,976.1384
Residual	545	5,043.1647
Total	565	

*P < .05.

***P < .001.

TABLE 26

MEAN DIFFERENCES IN 365-DAY WEIGHT AMONG YEARS[e]

Year	365-day Weight (kg.)
1973	428.1402[a]
1974	440.1289[a,b]
1975	444.1391[a,b,c]
1976	445.7178[b,c]
1978	459.9586[c,d]
1979	461.5947[c,d]
1977	486.0835[d]

[a,b,c,d]Those means followed by the same letter do not differ significantly ($P < .05$).

[e]Scheffe's multiple range test. Critical value equals $\sqrt{s_e^2 /2} \times 5.04 \times \sqrt{1/n_i + 1/n_j}$.

TABLE 27

MEAN DIFFERENCES IN 365-DAY WEIGHT AMONG BREEDS[c]

Breed	365-day Weight (kg.)
Angus	439.2633[a]
Hereford	444.6326[a,b]
Polled Hereford	452.9414[b]

[a,b]Those means followed by the same letter do not differ significantly ($P < .05$).

[c]Scheffe's multiple range test. Critical value equals $\sqrt{s_e^2 /2} \times 3.47 \times \sqrt{1/n_i + 1/n_j}$.

TABLE 28

ANALYSIS OF VARIANCE OF THE EFFECTS OF YEAR AND BREED ON 205-DAY WEIGHT

Source of Variation	DF	Mean Square
Year	6	13,926.4488***
Breed	2	9,720.1431*
Year X Breed	12	3,432.0878
Residual	545	2,764.3006
Total	565	

*P < .05.

***P < .001.

TABLE 29

MEAN DIFFERENCES IN 205-DAY WEIGHT AMONG YEARS[d]

Year	205-day Weight (kg.)
1973	237.2073[a]
1974	248.6578[a,b]
1976	250.8867[b,c]
1975	255.0671[b,c]
1979	256.7564[b,c]
1978	258.1891[b,c]
1977	264.0678[c]

[a,b,c]Those means followed by the same letter do not differ significantly ($P < .05$).

[d]Scheffe's multiple range test. Critical value equals $\sqrt{s_e^2/2} \times 5.04 \times \sqrt{1/n_i + 1/n_j}$.

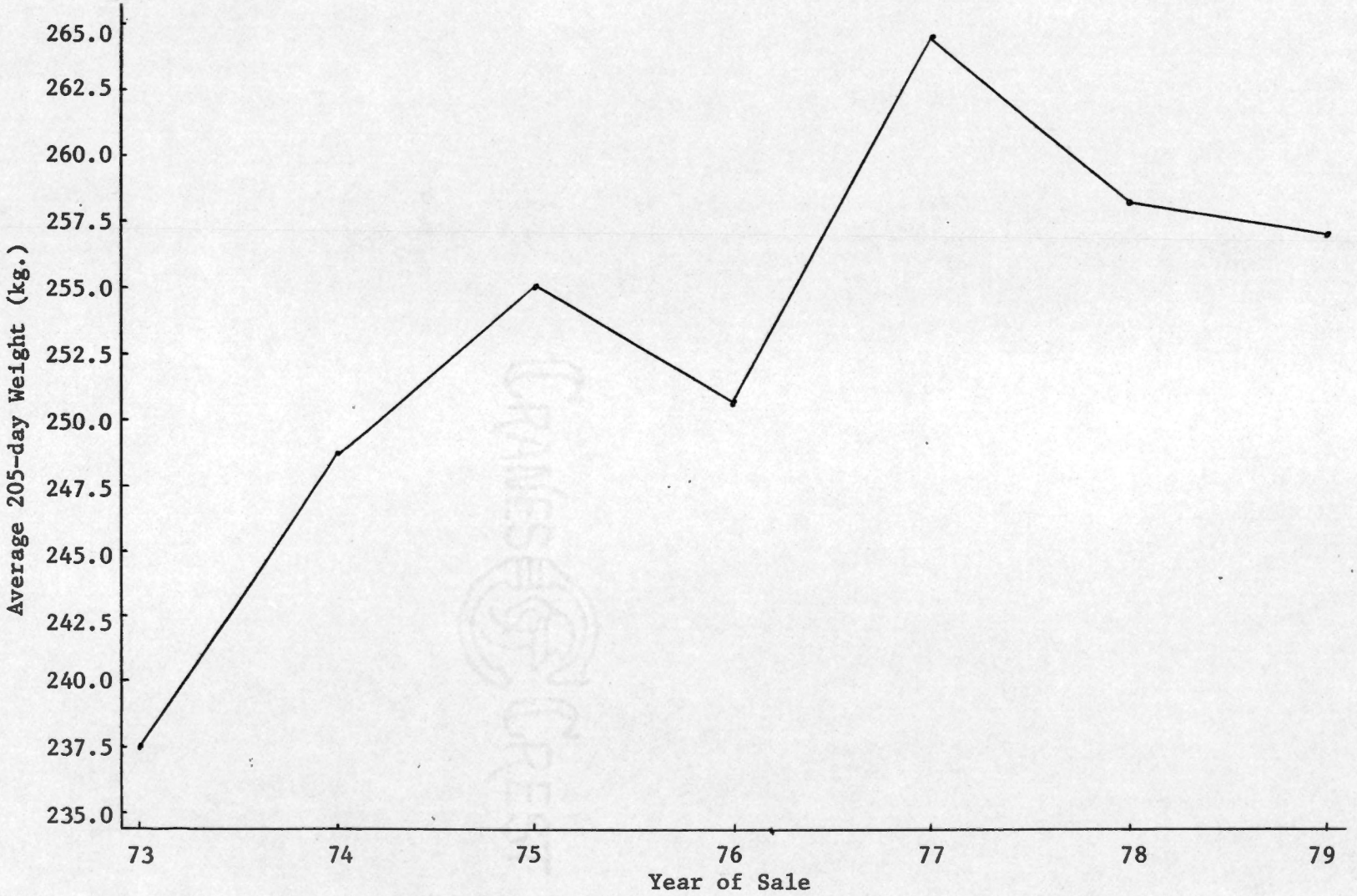


Figure 5. Average 205-day weight across years.

TABLE 30

MEAN DIFFERENCES IN 205-DAY WEIGHT AMONG BREEDS[c]

Breed	205-day Weight (kg.)
Angus	246.2271[a]
Hereford	249.3666[a,b]
Polled Hereford	254.8609[b]

[a,b]Those means followed by the same letter do not differ significantly ($P < .05$).

[c]Scheffe's multiple range test. Critical value equals $\sqrt{s_e^2 /2} \times 3.47 \times \sqrt{1/n_i + 1/n_j}$.

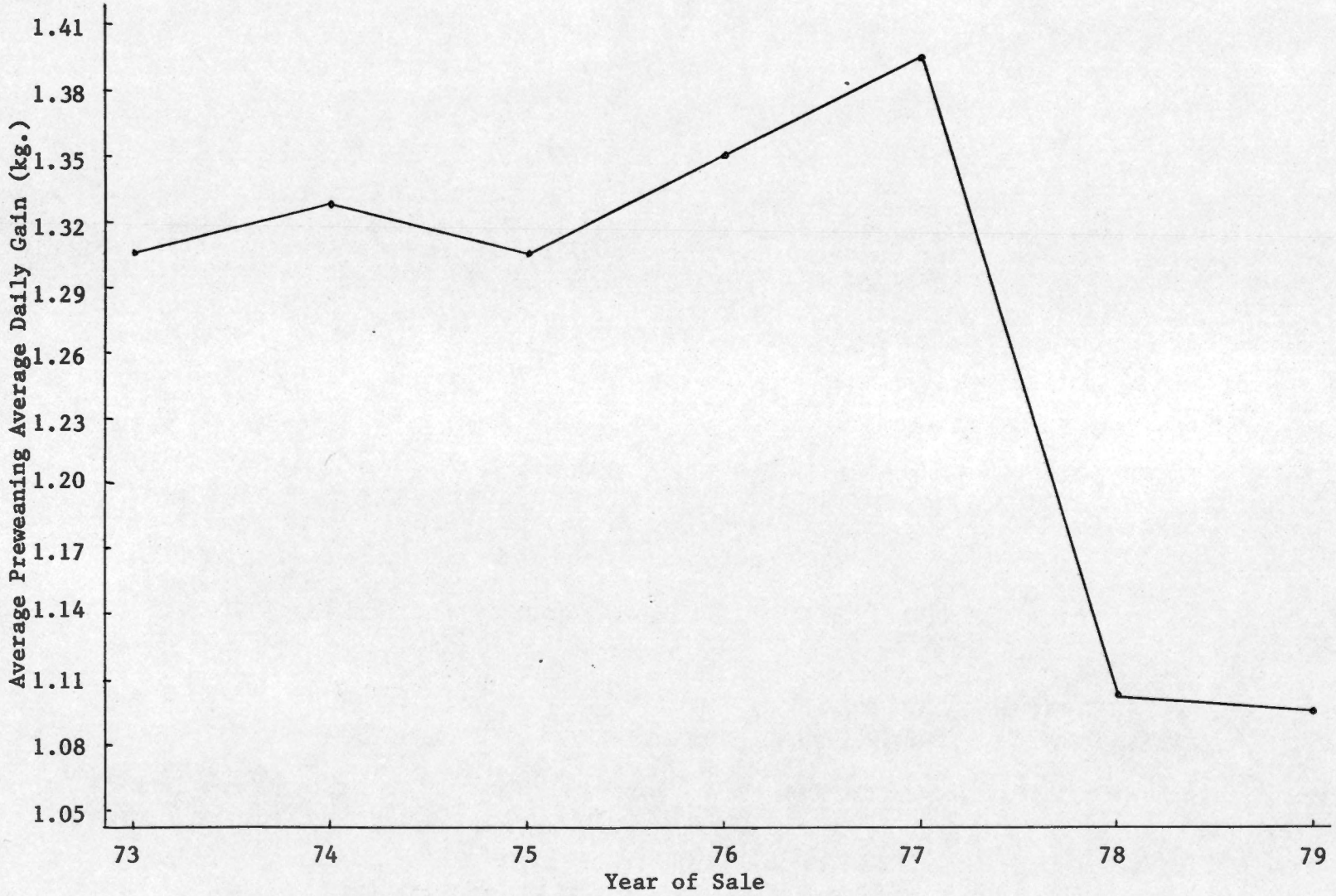


Figure 6. Average preweaning average daily gain across years.

TABLE 31

ANALYSIS OF VARIANCE OF THE EFFECTS OF YEAR AND BREED ON PREWEANING AVERAGE DAILY GAIN

Source of Variation	DF	Mean Square
Year	6	2.9614***
Breed	2	.0504
Year X Breed	12	.2522
Residual	545	.1563
Total	565	

***P < .001.

TABLE 32

MEAN DIFFERENCES IN PREWEANING AVERAGE DAILY GAIN AMONG YEARS[d]

Year	Preweaning Average Daily Gain (kg.)
1979	1.0942[a]
1978	1.1061[a]
1973	1.3035[b]
1975	1.3061[b,c]
1974	1.3247[b,c]
1976	1.3520[b,c]
1977	1.3936[c]

[a,b,c]Those means followed by the same letter do not differ significantly ($P < .05$).

[d]Scheffe's multiple range test. Critical value equals $\sqrt{s_e^2 /2} \times 5.04 \times \sqrt{1/n_i + 1/n_j}$.

TABLE 33

ANALYSIS OF VARIANCE OF THE EFFECTS OF YEAR AND BREED ON WEIGHT-PER-DAY OF AGE

Source of Variation	DF	Mean Square
Year	6	.3273***
Breed	2	.1198*
Year X Breed	12	.0689
Residual	545	.0407
Total	565	

*P < .05.

***P < .001.

TABLE 34

MEAN DIFFERENCES IN WEIGHT-PER-DAY OF AGE AMONG YEARS[c]

Year	Weight-per-day of Age (kg.)
1973	1.1344[a]
1974	1.1701[a,b]
1975	1.1743[a,b]
1976	1.1954[b,c]
1979	1.2211[b,c]
1978	1.2227[b,c]
1977	1.2451[c]

[a,b,c]Those means followed by the same letter do not differ significantly ($P < .05$).

[d]Scheffe's multiple range test. Critical value equals $\sqrt{s_e^2 /2} \times 5.04 \times \sqrt{1/n_i + 1/n_j}$.

TABLE 35

MEAN DIFFERENCES IN WEIGHT-PER-DAY OF AGE AMONG BREEDS[c]

Breed	Weight-per-day of Age (kg.)
Angus	1.1691[a]
Hereford	1.1823[a,b]
Polled Hereford	1.2015[b]

[a,b]Those means followed by the same letter do not differ significantly ($P < .05$).

[c]Scheffe's multiple range test. Critical value equals $\sqrt{s_e^2 /2} \times 3.47 \times \sqrt{1/n_i + 1/n_j}$.

In summary, final off-test weight, sale-day age, 365-day weight, 205-day weight and weight-per-day of age have all increased significantly over the years. Preweaning average daily gain has decreased ($P < .05$) during the years involved. Breed differences ($P < .05$) occurred involving 365-day weight, sale-day age, 205-day weight and weight-per-day of age. Polled Herefords had the highest average in all performance traits with the exception of preweaning average daily gain in which they had the lowest average. Hereford bulls were significantly ($P < .05$) older than Polled Herefords, Angus bulls had the lowest performance in all traits with the exception of sale-day age in which they had higher absolute values than Polled Hereford.

V. CONCLUSIONS

During the period of 1973 to 1979 bull prices have fluctuated greatly among years. The price of bulls seems to be dominated by inflation and the general market trends of beef animals. Buyers tend to let these factors determine the price differential they will fluctuate between. Performance traits seem to be the secondary criterion to bull buyers. After careful consideration of market trends, the buyers study performance traits in order to select the bulls they deem desirable to them both economically and productively.

The traits buyers emphasized during this study were to a great extent measures of the general size and age of the animal rather than daily gains.

CHAPTER V

SUMMARY

The objective of this study was to partition the total variability of sale price received for performance tested bulls into that which is attributed to various selected criteria. The records of seven Tennessee performance tested bull sales were included. These records were collected from year 1973 through 1979 and consisted of 52 Hereford, 193 Angus and 321 Polled Hereford bulls. The mean sale price varied greatly among years with a low of $707 in 1974 to a high in 1978 of $1521. Realizing the tremendous amount of inflation that has occurred during this time interval, an analysis was performed in which the consumer price index (CPI) was entered into the model as a co-variate to adjust for inflation. The prices of slaughter bulls (SB) and slaughter cows (SC) as well as market prices of feeder calves (FC) were also entered to adjust for yearly market fluctuations. Performance data were entered into the model last in a logical order relating to the ease of obtainability by the buyer. Results of the subsequent analysis indicated that 54 percent of the total variability was explained by the model. The CPI accounted for 8.61 percent of the total explained variation. Market prices, when considered sequentially after CPI, were responsible for 27.2 percent. The addition of performance data explained the remaining 18 percent of the variability explained by the model. A second analysis was conducted in which the variability of price was partitioned into the constituents of a mathematical model

which included the effects of year, breed and year by breed interaction as independent variables. This analysis indicated that the effect of year was very highly significant ($P < .0001$) as well as the year by breed interaction ($P < .0001$). Breed was significant ($P < .05$).

A third analysis involving the effects of performance information alone on sale price was conducted. Buyers found sale-day age and 365-day weight to significantly ($P < .05$) explain the variation in sale price of bulls irregardless of breed. Major breed differences occurred with 205-day weight. This variable was only significant for Angus buyers. Final off-test weight and preweaning average daily gain were non-significant for Polled Hereford.

All performance traits had increased significantly during the years of this study with the exception of preweaning average daily gain which decreases significantly during the latter years. The effect of inflation, market trends and performance traits all affect bull prices. Important performance traits included sale-day age and 365-day weight.

LITERATURE CITED

CRANES CREST

LITERATURE CITED

Baker, F. H. 1967. History and development of beef and dairy performance programs in the United States. J. Anim. Sci. 26:1261.

Barr, A. J., J. H. Goodnight, J. P. Small, W. H. Blair and D. M. Chilko. 1979. SAS Users Guide. SAS Institute Inc., Raleigh, N.C.

Boggs, D. L. and R. A. Merkel. 1979. Live Animal Carcass Evaluation and Selection Manual. Kendall and Hunt, Dubuque, Iowa.

Bryan, H. D. 1972. Factors influencing selling price of performance tested bulls. Masters thesis, University of Tennessee, Knoxville.

Cartwright, T. C. 1970. Selection criteria for beef cattle of the future. J. Anim. Sci. 30:706.

Chapman, H. D., T. M. Clyburn and W. C. McCormick. 1969. Selection of beef cattle for a specific trait. J. Anim. Sci. 29:225.

Chapman, H. D., T. M. Clyburn and W. C. McCormick. 1972. Comparison of criteria for selecting introduced beef sires. J. Anim. Sci. 35:321.

Cox, C. B., E. J. Eisenach and M. P. Mitchell. 1953. Beef cattle prices. Indiana Exp. Sta. Bul. 582.

Danker, D. M., M. R. Ellersieck, J. W. Massey and J. F. Lasley. 1976. Breed performance trends and price performance relationships in 13 years of Missouri Tested Bull Sales. Univ. of Mo. Agr. Expt. Sta. Bul. 1017.

Foote, R. J. 1958. Analytical tools for studying demand and price structures. U.S.D.A. Agr. Handbook 146.

Gregory, K. E. 1961. Improvement of beef cattle through breeding methods. North Carolina Reg. Publ. 120.

Gregory, K. E., L. A. Swiger, B. C. Breidenstein, V. H. Arthand, R. B. Warren and R. M. Koch. 1964. Subjective live appraisal of beef carcass traits. J. Anim. Sci. 23:1176.

Harvey, Walter R. 1960. Least squares analysis of data with unequal sub-class numbers. U.S.D.A. ARS-20-8.

Henry, E. S. 1971. Performance testing - an aid in bull selection. New South Wales Dept. of Agr., Agr. Gazette. 82:225.

Jamison, H. M., J. B. McLaren and J. M. Bryan. 1971. Factors influencing the selling price of performance-tested bulls. Tenn. Farm and Home Sci. 79.

Mao, I. L. 1981. Personal communication.

Marlow, T. J. and G. A. Morrow. 1967. Factors influencing the sale price of R.O.P. bulls. J. Anim. Sci. 26:205 (Abstract).

Marlow, T. J. and G. A. Morrow. 1967. What bull buyers spend their money for. 1966-67 Livestock Res. Rpt., V.P.I. and S.U. Res. Div. Rpt. 121:82.

Marlow, T. J. 1969. Bull selection criteria as indicated by sale price. J. Anim. Sci. 28:437.

Mitchell, M. P. 1941. Factors affecting beef cattle prices. Purdue Univ. Cooperative Ext. Ser. 224.

Osborne, J. W. and T. J. Marlow. 1976. Re-evaluation of factors affecting the sale price of R.O.P. bulls. Livestock Res. Rpt., V.P.I. and S.U. Res. Div. Rpt. 170:45.

Osborne, J. W. and T. J. Marlow. 1976. Important variables related to sale price of performance tested bulls. Va. Journal Sci. 27(2):35.

Patterson, R. E., J. H. Jones, J. J. Boyles and R. V. Turnbough. 1949. Performance testing and progeny testing of beef breeding stock as an aid to selection. J. Anim. Sci. 8:608.

Patterson, R. E., T. C. Cartwright, J. H. Jones and J. J. Boyles. 1955. Performance testing of beef stock. J. Anim. Sci. 14:1034.

Robertson, L. and M. P. Mitchell. 1940. Prices of beef cattle. Ind. Agr. Exp. Sta. Bul. 444.

Rutherford, J., L. L. Wilson, R. R. Garrigus and K. J. Drewry. 1966. Beef bull selection criteria used by Southern Indiana commercial producers. J. Anim. Sci. 25:1279 (Abstract).

Simms, R. H. 1971. What kind of bull do cattlemen prefer? Ill. Res. 13:15.

Tomek, W. G. and K. L. Robinson. 1972. Agricultural Product Prices. Cornell University Press. Cornell.

U.S.D.A. Consumer and Marketing Service, Livestock Division. 1973-79.

U.S. Dept. Commerce, Bureau of Economic Analysis. Survey of current business statistics. 1973-79.

Warren, W. M. 1957. Relationship of performance test score to price for beef bulls at public auction. Proceedings of the 54th Annual Meeting of the Assoc. of South. Agr. Workers. 91.

APPENDIX

CRANESBILL CREST

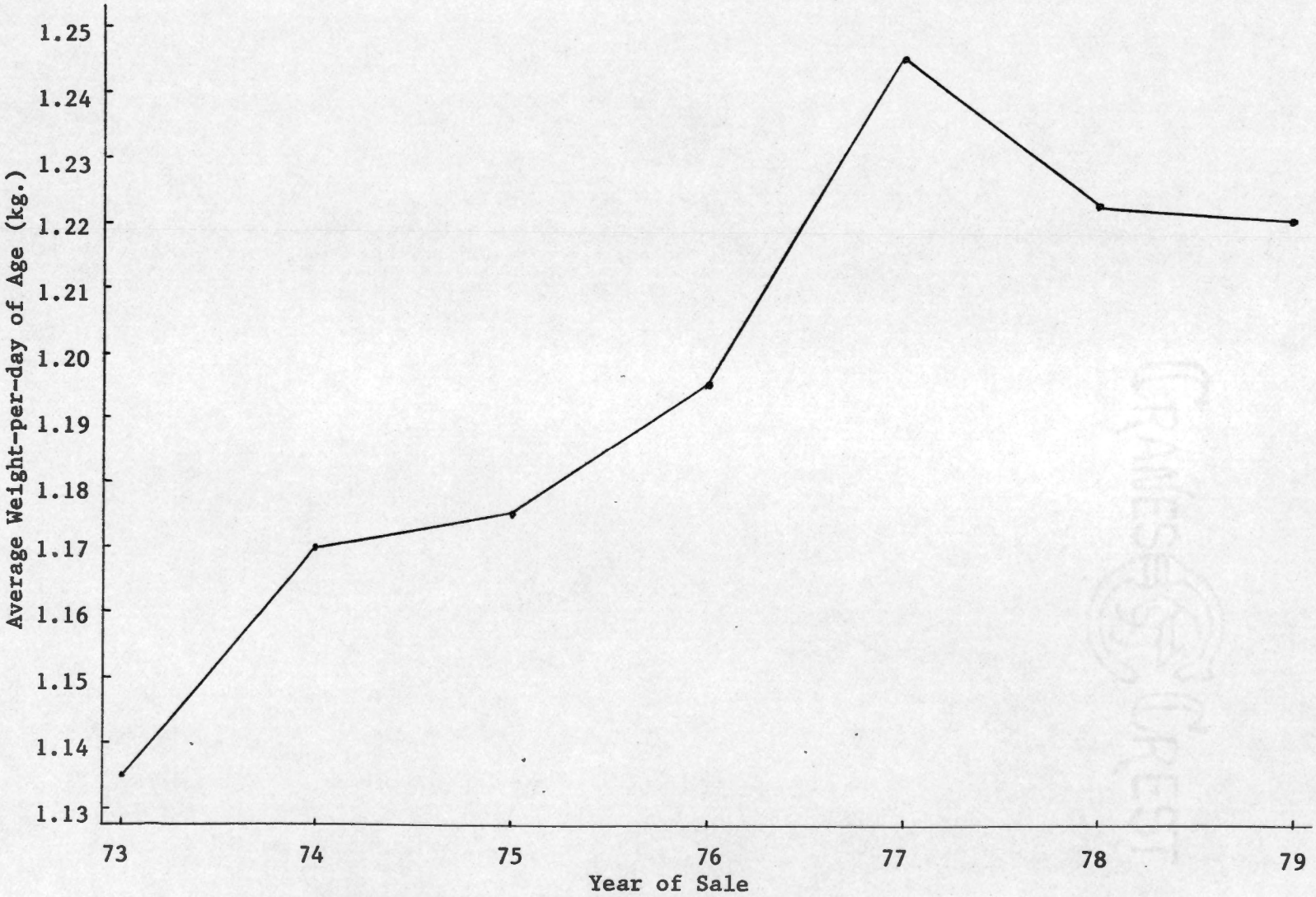


Figure 7. Average weight-per-day of age across years.

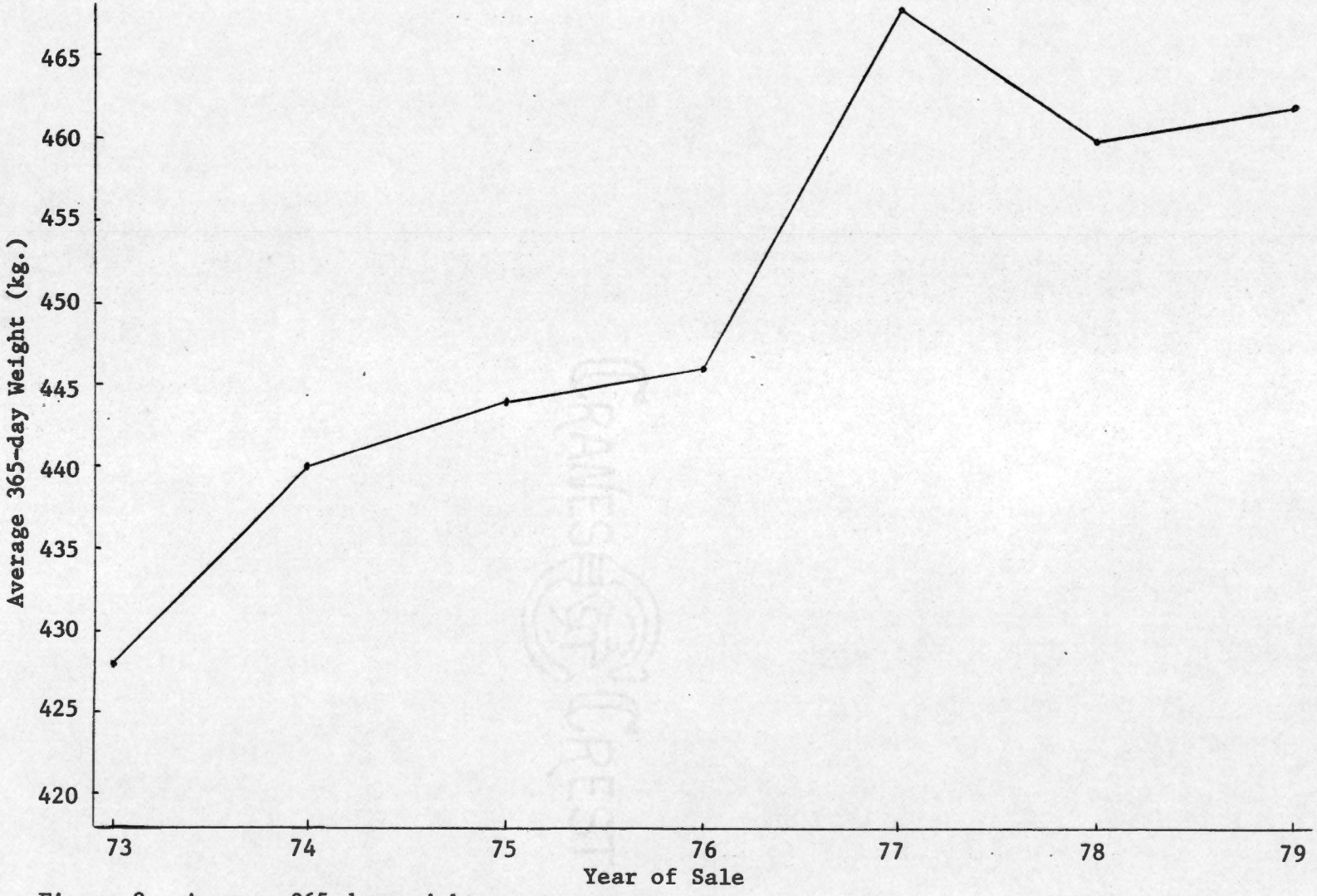


Figure 8. Average 365-day weight across years.

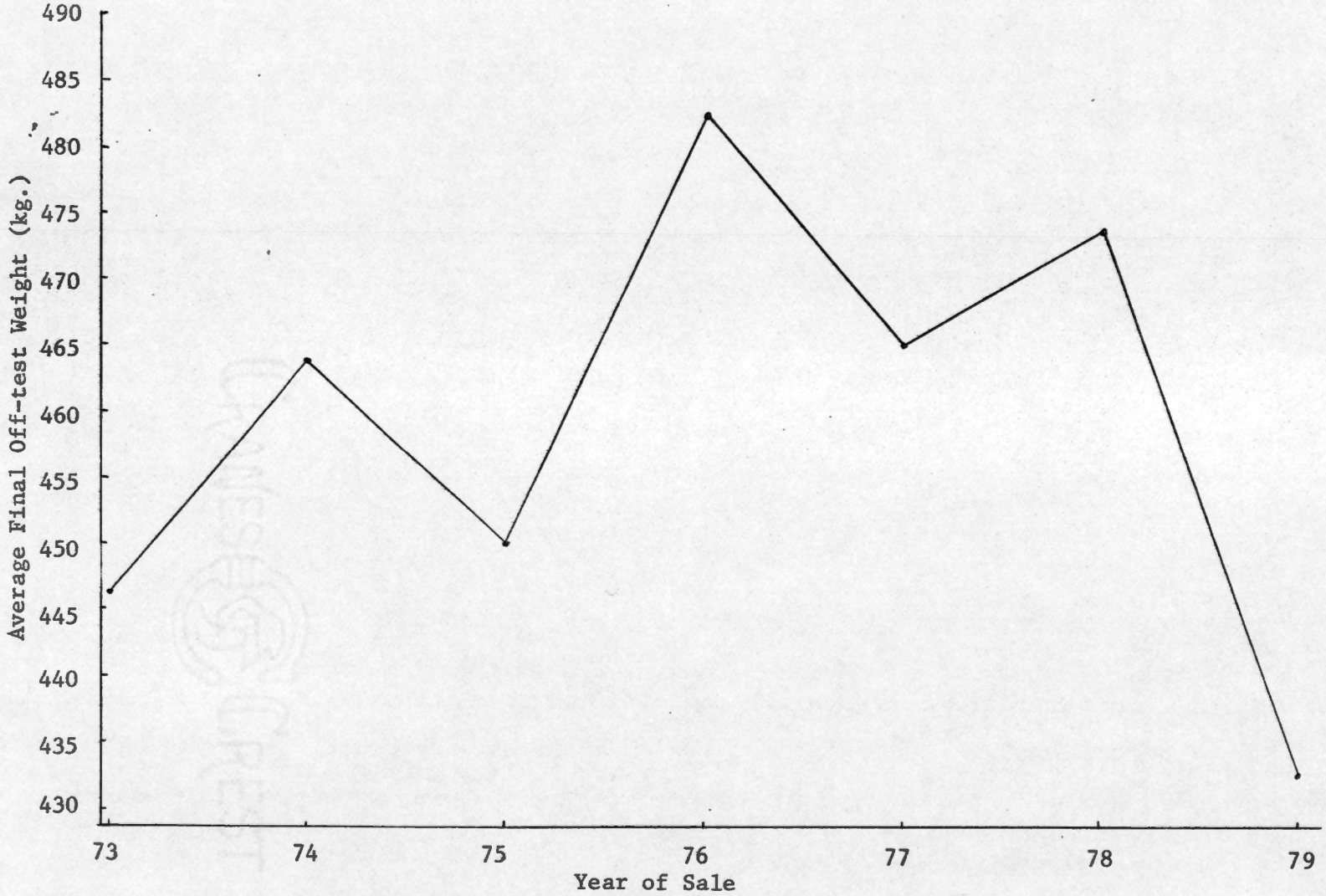


Figure 9. Average final off-test weight of Hereford bulls across years.

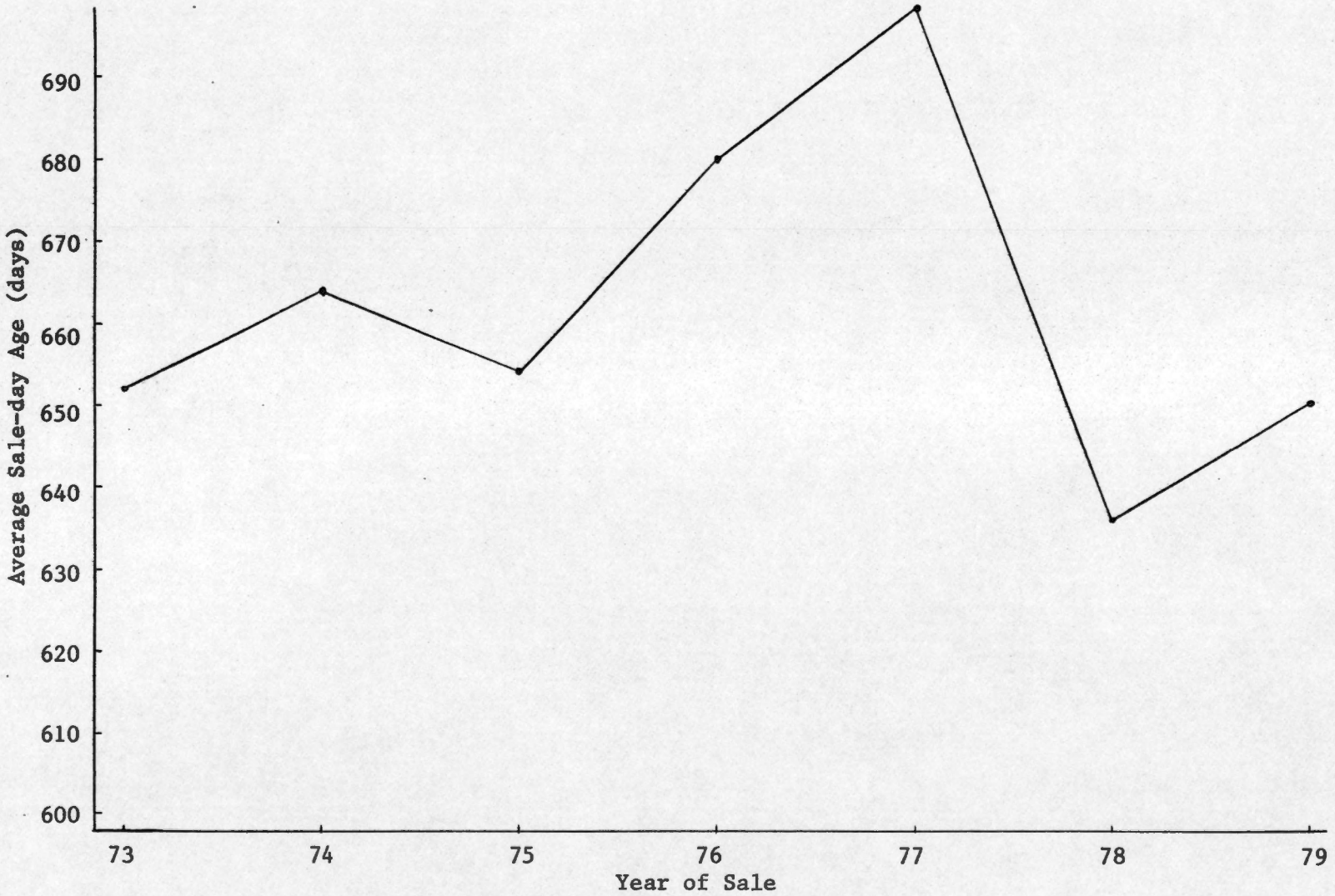


Figure 10. Average sale-day age of Hereford bulls across years.

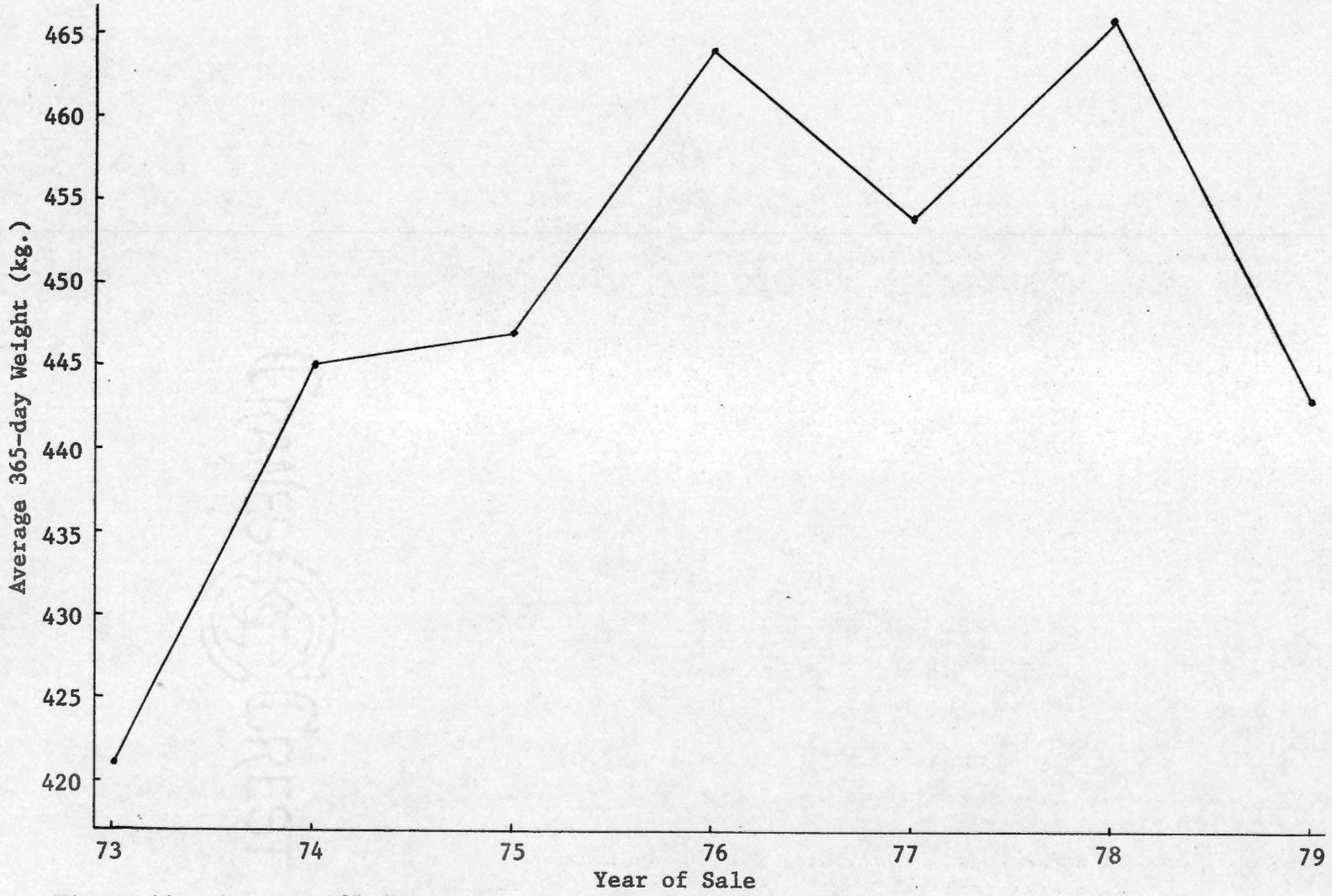


Figure 11. Average 365-day weight of Hereford bulls across years.

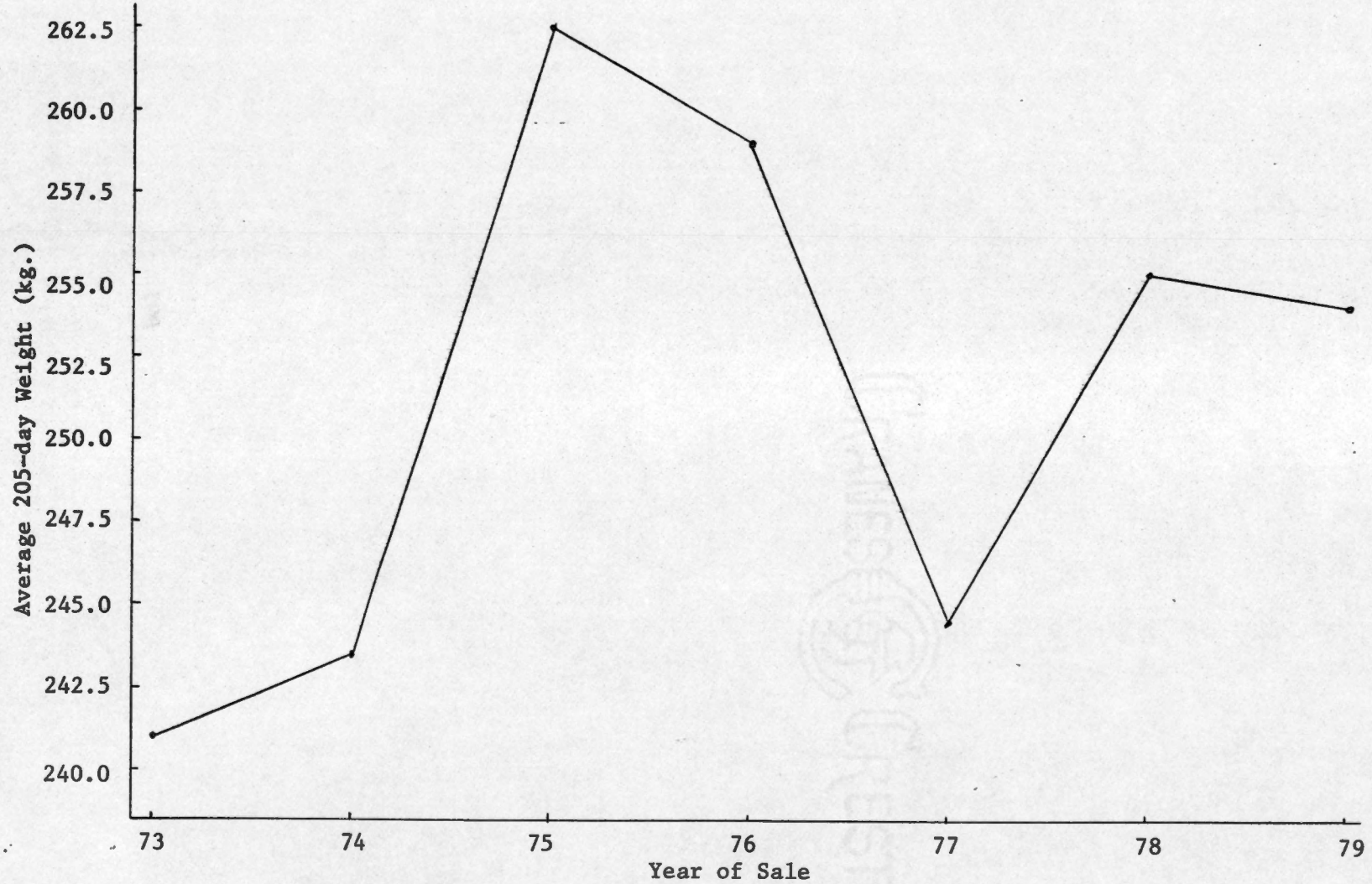


Figure 12. Average 205-day weight of Hereford bulls across years.

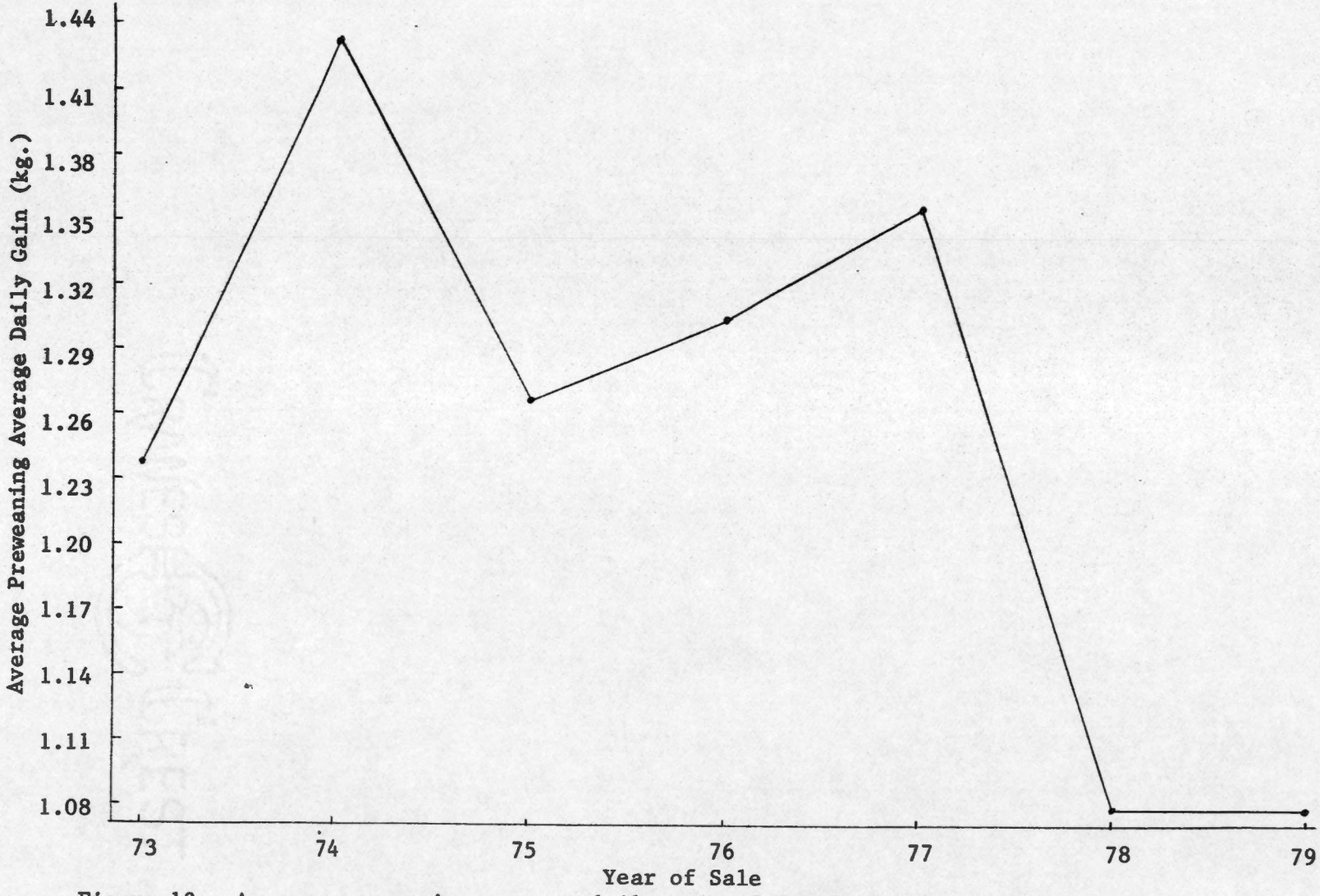


Figure 13. Average preweaning average daily gain of Hereford bulls across years.

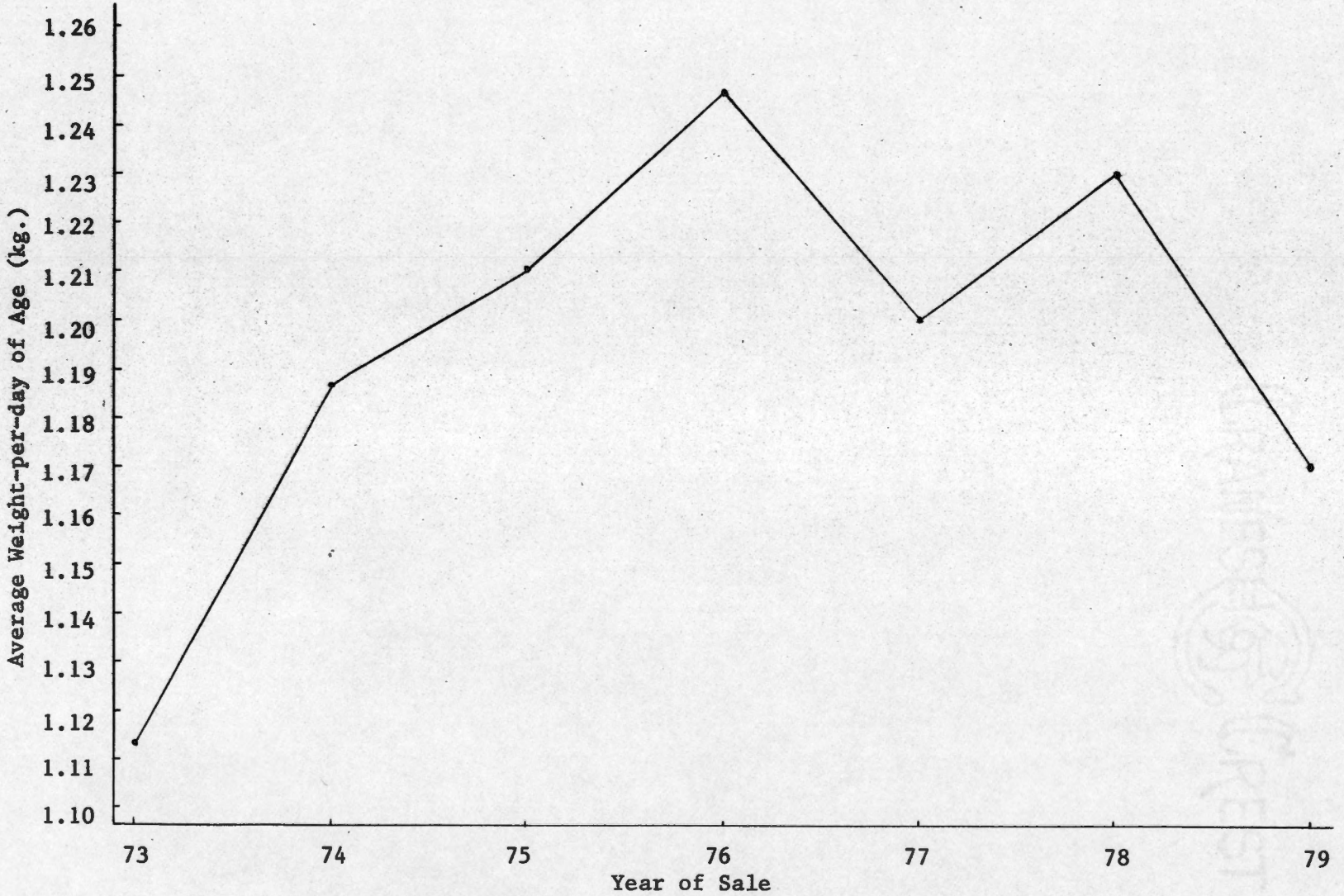


Figure 14. Average weight-per-day of age of Hereford bulls across years.

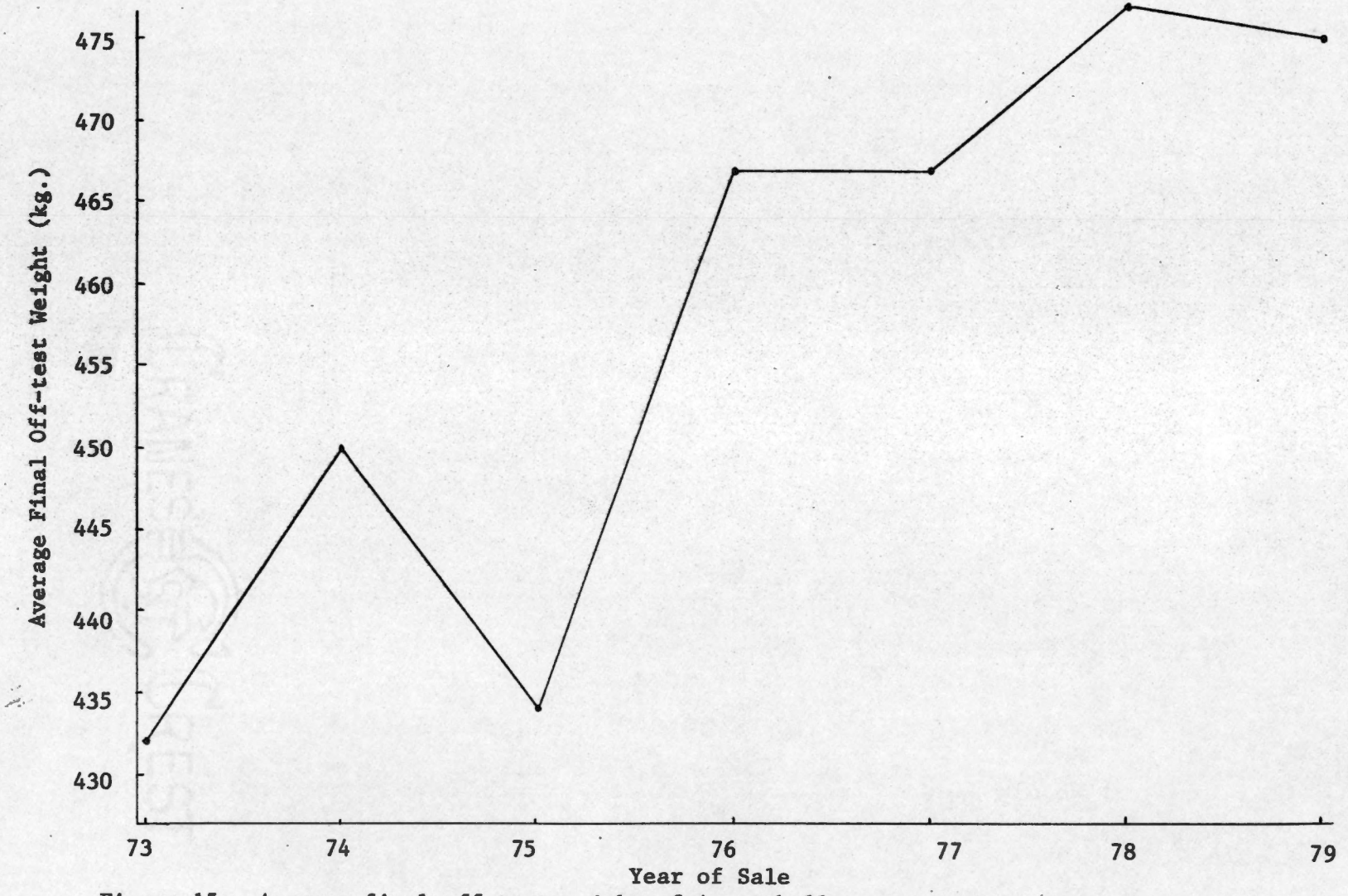


Figure 15. Average final off-test weight of Angus bulls across years.

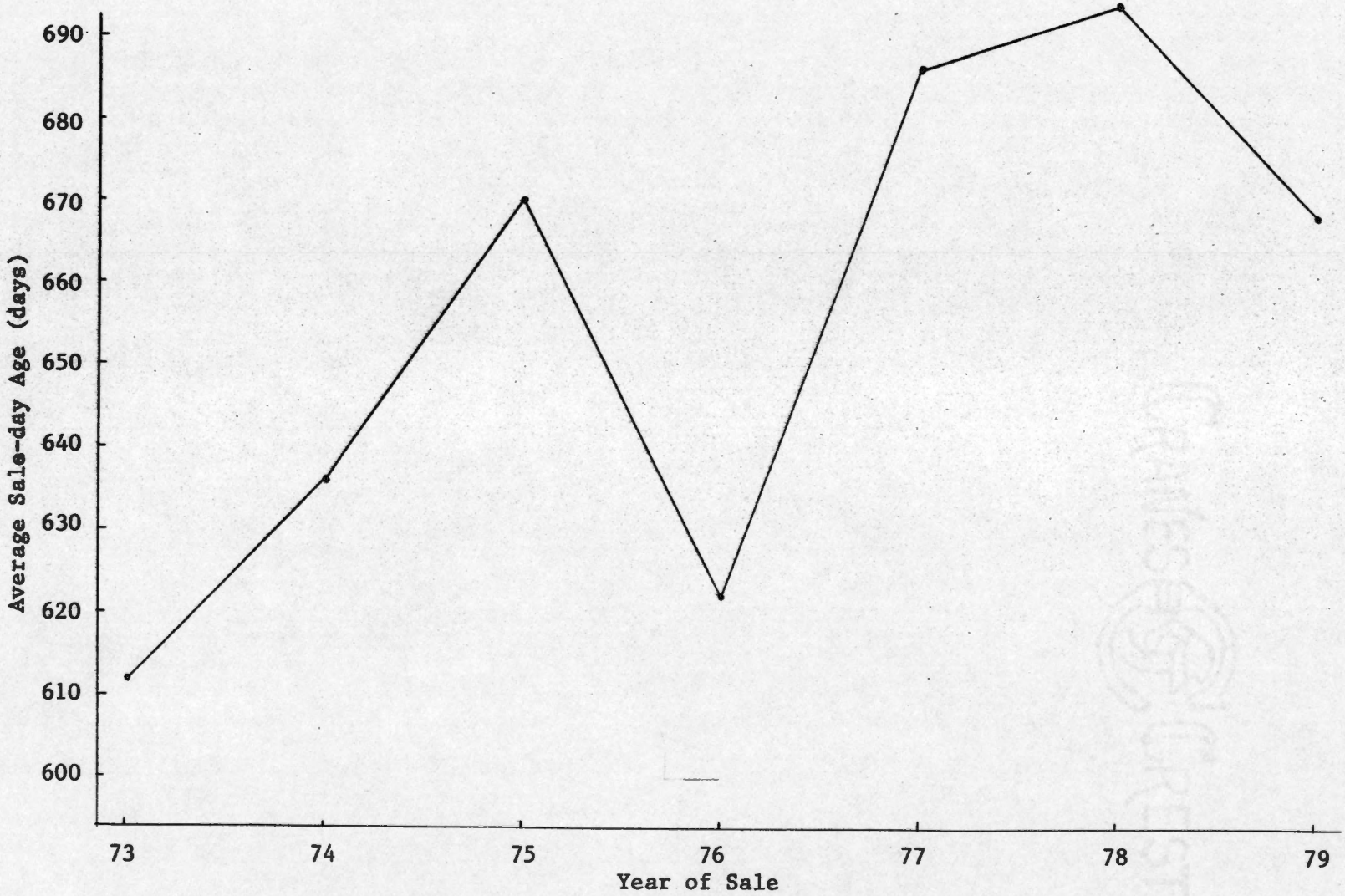


Figure 16. Average sale-day age of Angus bulls across years.

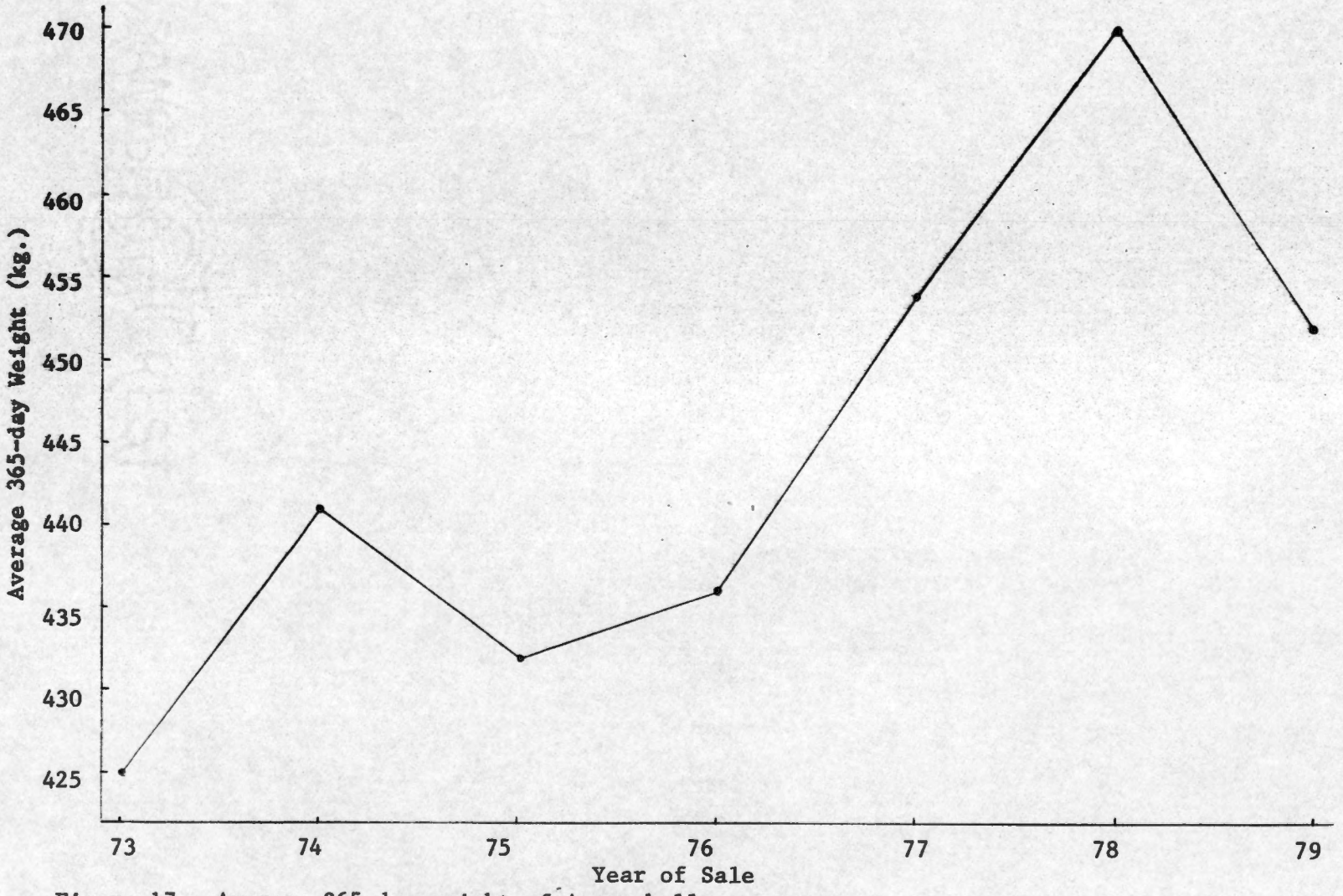


Figure 17. Average 365-day weight of Angus bulls across years.

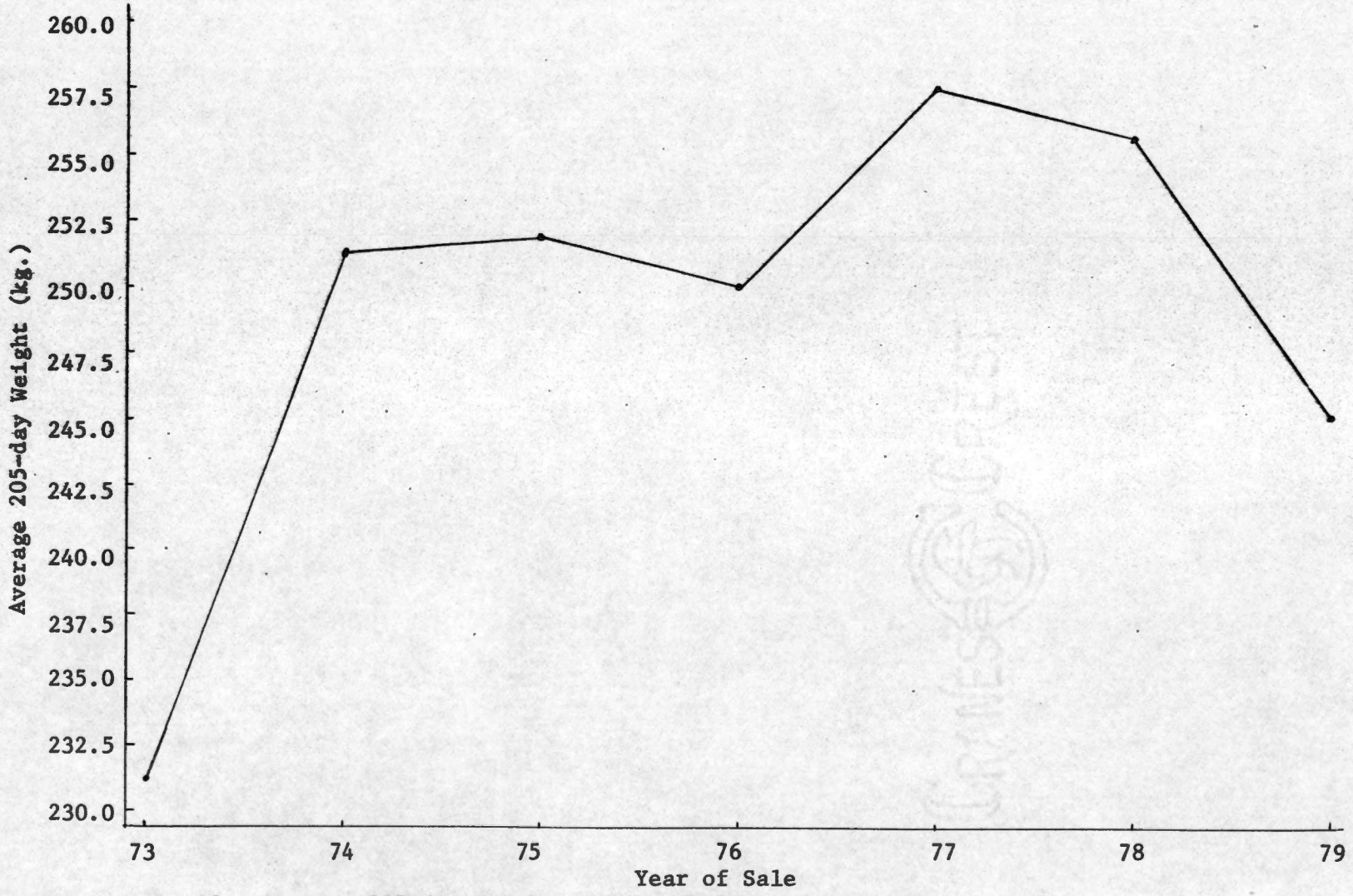


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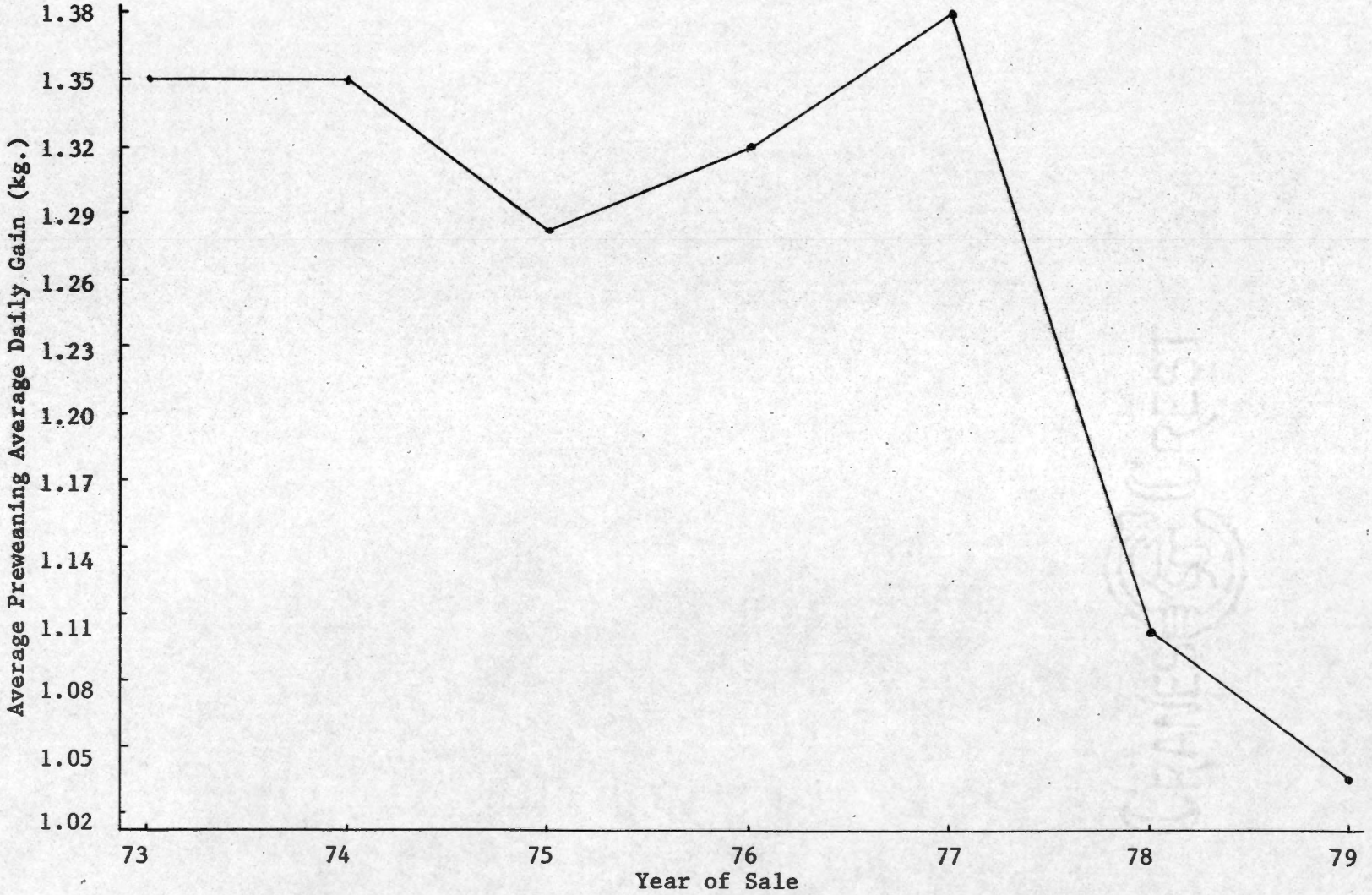


Figure 19. Average preweaning average daily gain of Angus bulls across years.

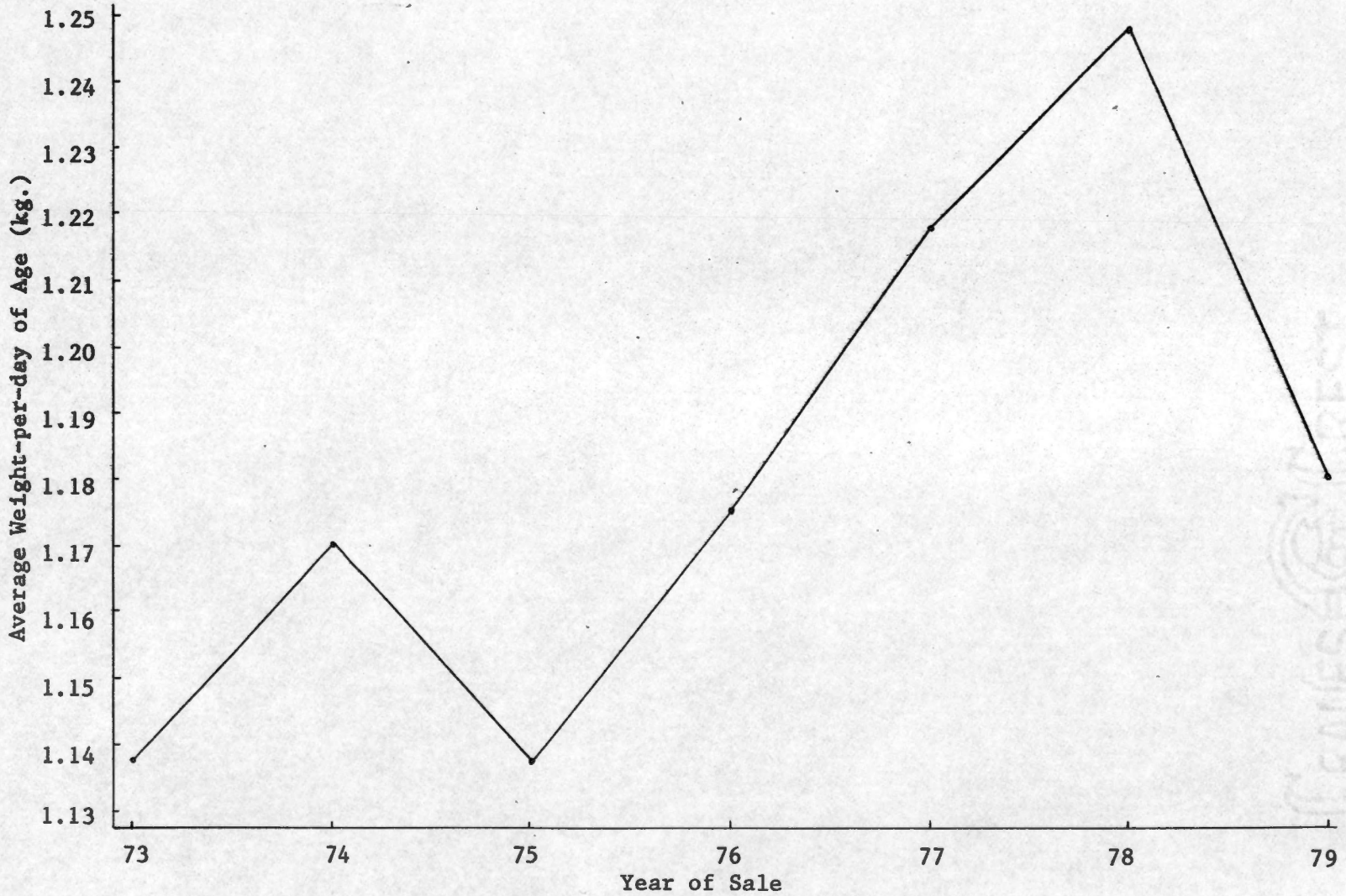


Figure 20. Average weight-per-day of age of Angus bulls across years.

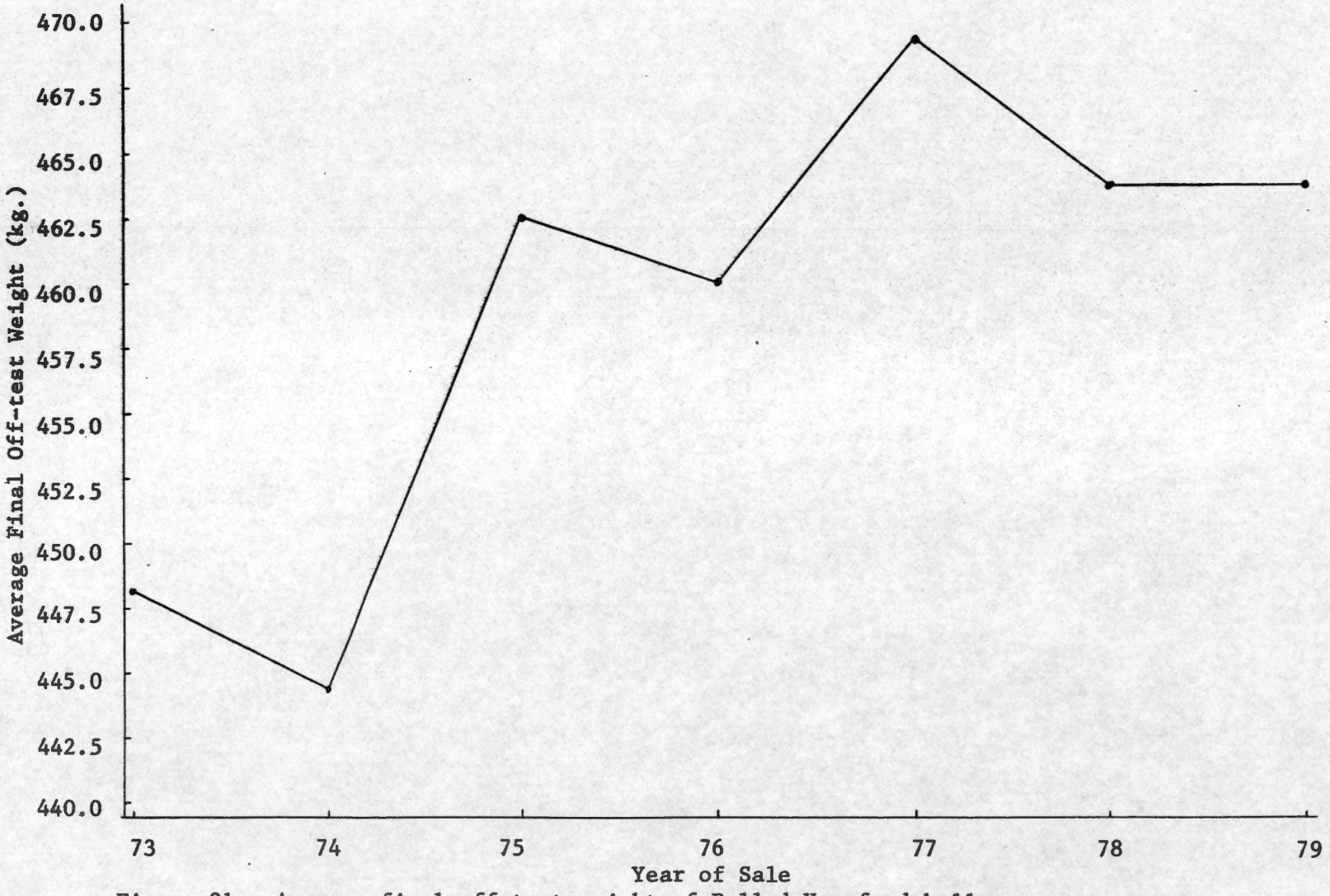


Figure 21. Average final off-test weight of Polled Hereford bulls across years.

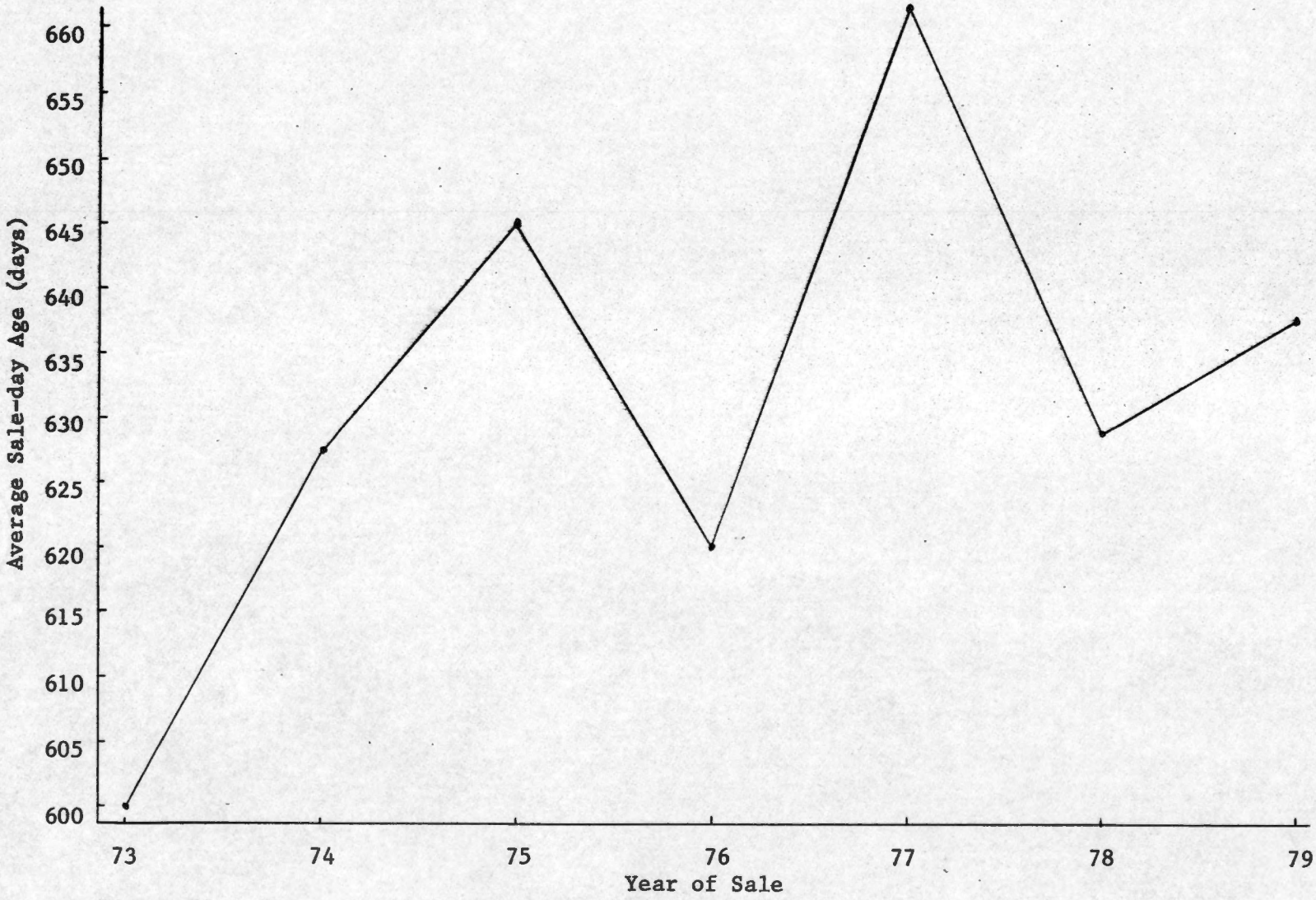


Figure 22. Average sale-day age of Polled Hereford bulls across years.

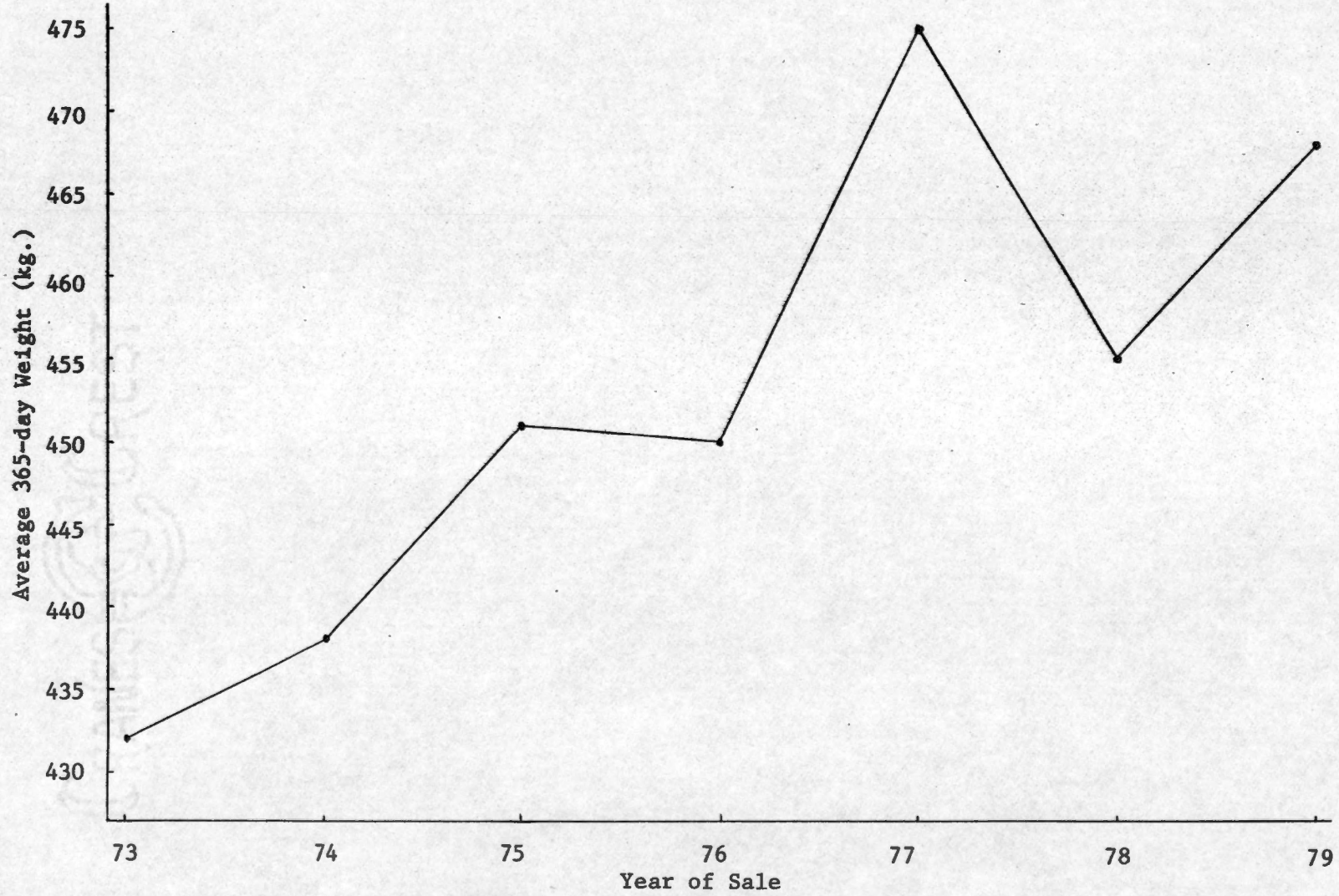


Figure 23. Average 365-day weight of Polled Hereford bulls across years.

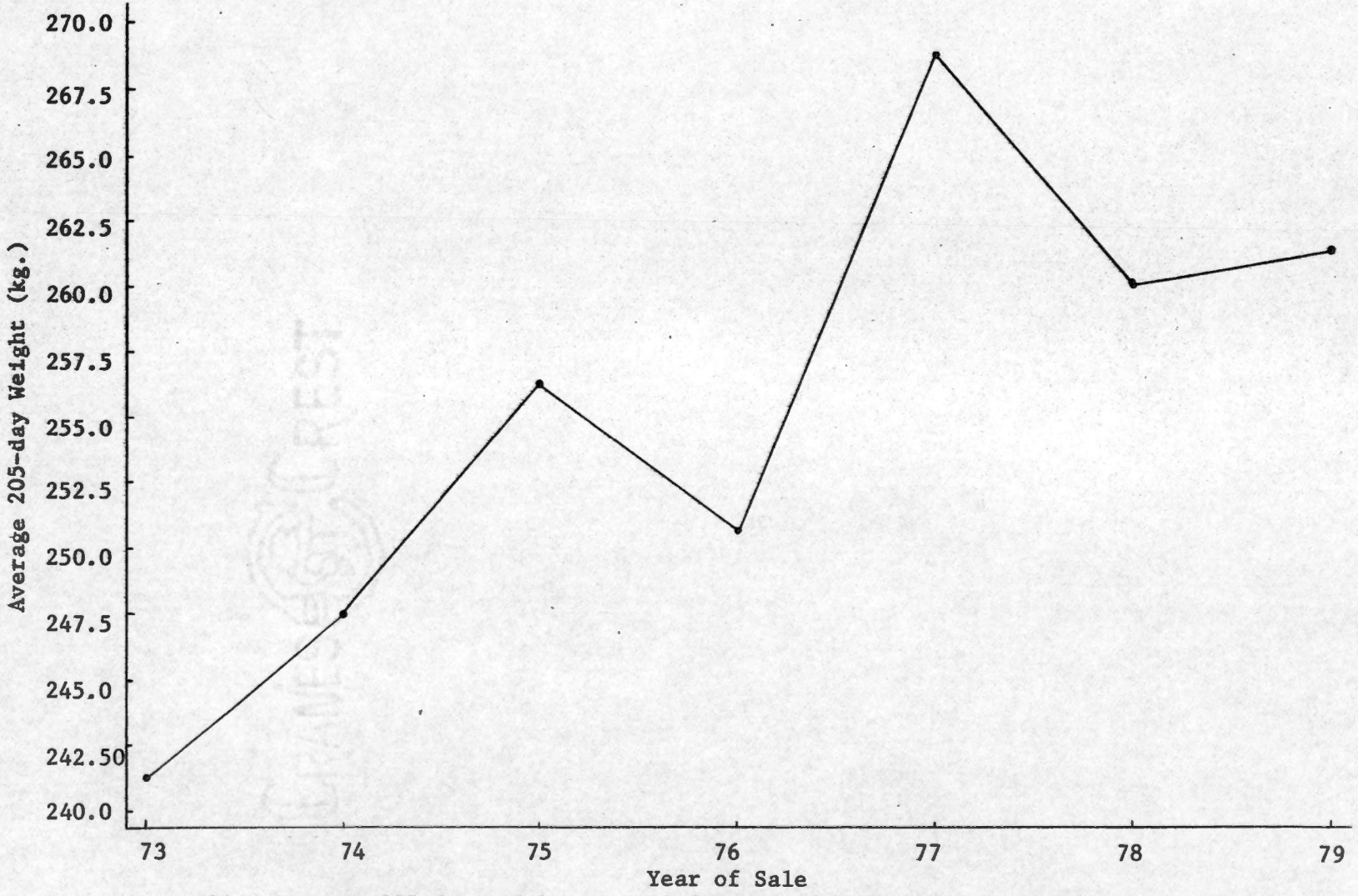


Figure 24. Average 205-day weight of Polled Hereford bulls across years.

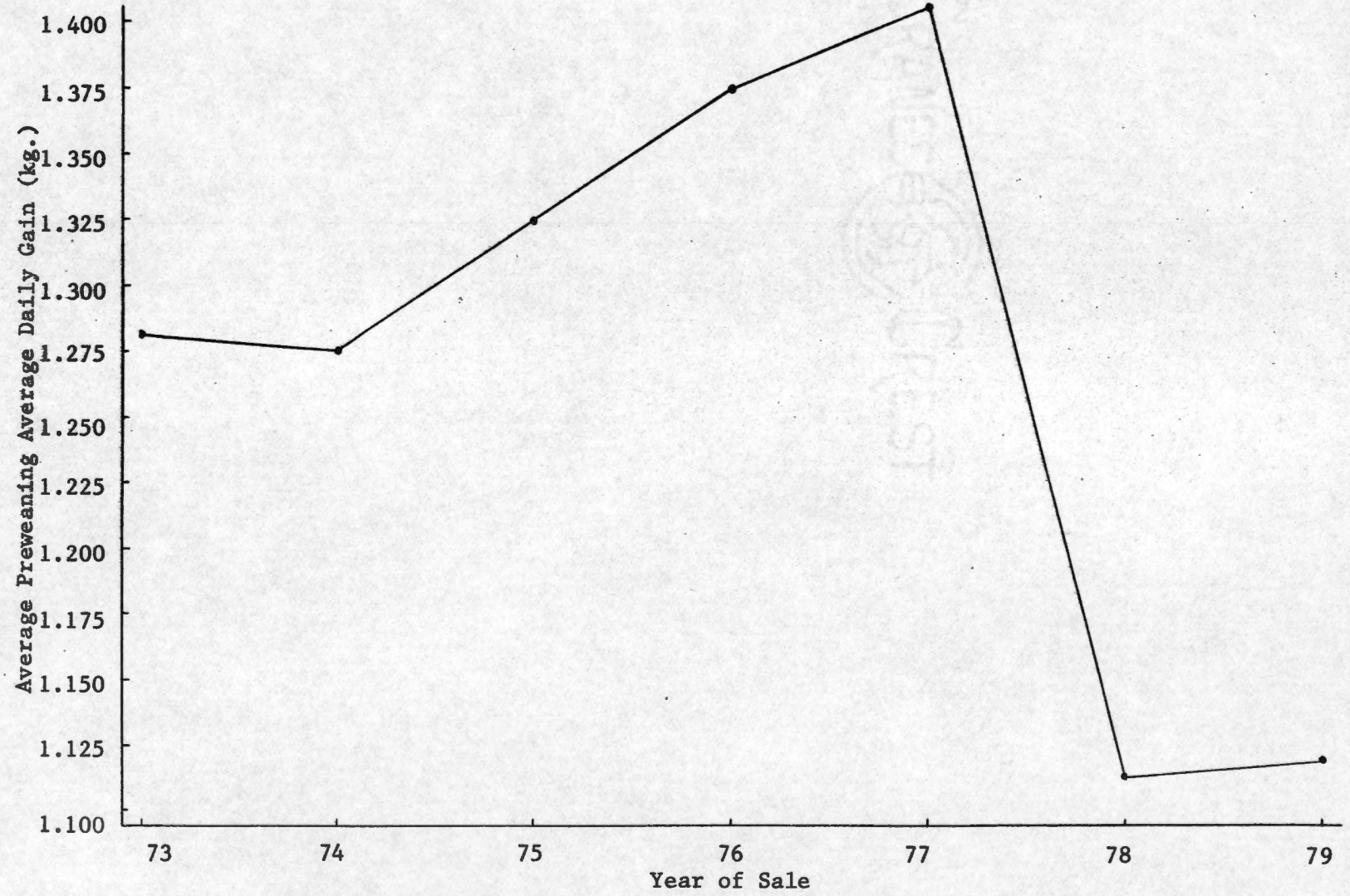


Figure 25. Average preweaning average daily gain of Polled Hereford bulls across years.

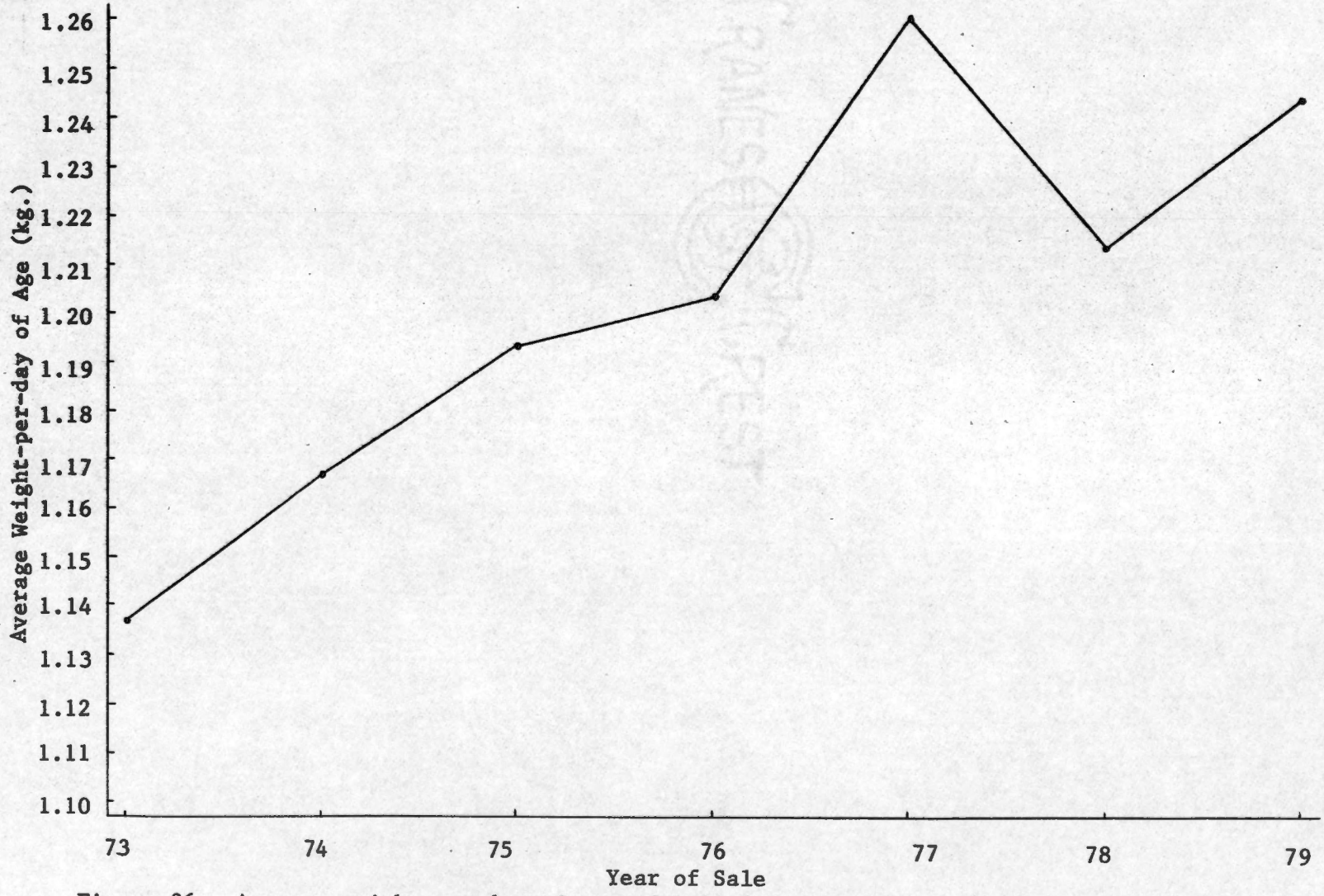


Figure 26. Average weight-per-day of age of Polled Hereford bulls across years.

VITA

Bobby Dennis Banks was born in Woodbury, Tennessee, April 17, 1957, the son of Bobby Neil and W T Banks. He received his elementary education from Woodbury Elementary School and graduated from Woodbury Central High School in 1975.

In August of 1975 he entered Middle Tennessee State University at Murfreesboro majoring in Animal Science and minoring in secondary education. He received the Bachelor of Science degree in Agriculture in May 1979. While attending Middle Tennessee State University he became a member of the Alpha Gamma Rho Fraternity and offices served included usher, chaplain, agricultural council representative and pledge trainer.

He was also a member of the collegiate livestock judging team and the Collegiate Future Farmers of America, where he served as Agricultural Council Representative as well as Vice President.

While enrolled at Middle Tennessee State University, he also became certified by the state of Tennessee to teach Vocational Agricultural Education.

Mr. Banks enrolled at the University of Tennessee at Knoxville in 1979 to begin a graduate program in animal science. While completing the program, he worked under the guidance of Dr. Haley M. Jamison in the Animal Science Beef Section of the University of Tennessee Extension Service.

He received the Master of Science degree concentrating in the area of animal breeding in August 1981.