THE RELATIONSHIP BETWEEN LIVE HOG SCORES AND ACTUAL CARCASS MEASUREMENTS

Thesis for the Degree of M. S.

MICHIGAN STATE COLLEGE

Edwin P. Margerum Jr.

1949

This is to certify that the

thesis entitled

"RELATIONSHIP BETWEEN

LIVE HOG SCORES AND CARCASS MEASUREMENTS"

presented by

Edwin P. Margerum, Jr.

has been accepted towards fulfillment
of the requirements for

Master of Science degree in Animal Husbandry

L. J. Bratzler

Major professor

Date August 24, 1949

O-169

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Submitted to the School of Graduate Studies of Michigan State College of Agriculture and Applied Science in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE

Department of Animal Husbandry

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Introduction

In the period before the United States became one of the worlds largest producers and marketers of pork and pork products, the intricacies of our present economic and marketing agencies were not the pressing concern that they are today. In those years when this country labored and produced as a colony of Great Britain, farmers bred, raised, and fed what might be described for the majority, as a non-descript or "run of the mine" type hog. Turning his pig crop or his fattened gilt or barrow into cash was more than a slight problem to the farmer of the 18th century. Cash was hard to come by, and scarce. So the earliest system of marketing hogs in this country was the barter method.

Pure exchange of the live hog or of a ham or side of cured and smoked bacon for some neighbor's produce was never too convenient nor satisfactory. Some producers were located close to cities, or areas later to become known as market centers, thus they were able to secure cash for their hogs---a boon to those producers who found it advantageous to buy their needs with cash. Prevailing custom of that period dictated that all livestock be purchased by the head, a certain price being paid for each individual animal.

Under the system of price per head, no premium

was provided for the hogs of higher quality---though some variance of price could be established for hogs of heavier weights. The hogs that a farmer might drive to the city for sale at that time would be those individuals which were no longer suitable for breeding purposes---or barrows that had been fattened for market. It is easily seen, therefore, that market hogs consisted of sows, boars, and barrows, all lard type hogs, whose carcasses would yield large percentages of lard, and questionable amounts and qualities of edible lean meat. Hogs that yielded large percentages of lard for cooking and baking were popular because of the fact that the consumer demand for animal shortening was strong.

With the evolution of our country's development, our growth westward, population shifts, the increase of trade based on our own internal revenue, and the establishment of a transportation system and livestock centers, slaughter houses and packing plants, more stringent requirements were placed upon farmers to raise a type hog that was acceptable to the packer as well as to the ultimate consumer. This was brought about by cognizance of weights, quality and sex as evidenced in the live hog. These weight groups, sex, and quality price differentials, were not established arbitrarily---but as a direct result of consumer preferences and packer experiences. By setting up well defined weight and grade limits for which prices are paid for hogs, meat packers have been able to influence the type of hog raised and marketed. The early

preferences for the extreme lard type hog have given way to an intermediate type hog which will yield upon slaughtering a fair amount of lard as well as a reasonable percentage of lean meat.

Work by various agencies and organizations in breeding and feeding experiments has had a good deal to do with the improvement of swine herds, and the subsequent placing on the markets of a hog which is not so extreme in weight and excessive in the amount of back fat thickness and lard content of the lean meat cuts.

From the producers viewpoint, the production of pork has (except for certain years of unfavorable corn-hog ratios) proven to be an excellent means of marketing the farm raised grains. Few other forms of farm enterprise have offered to all producers the rapidity of gains, velocity of turnover, and such an invaluable means of increasing the value of a grain crop, as passing it through marketable hogs. To this end, the tendency has been excessive---in that hogs have been fattened to the extreme weights before they have been sent to the packers. That such individuals as 400 pound hogs are favorable enterprises to a farmer cannot be denied, so long as there is a demand for lard and large, fatty cuts of pork.

In past years lard enjoyed a monopolistic position for use as a shortening and cooking fat. But with increases in surplus lard stocks, and the increasing competition from vegetable oils and lard substitutes, the demand for heavy,

short, chuffy, lardy hogs at the slaughtering points has decreased greatly. From about 1920 and up to the present day, except for war periods when lard was greatly in demand and commanded a high price, there has always been a lard surplus in this country--- a surplus that has not been appreciably reduced by home consumption or our exports to Latin America or Europe. With these large surpluses on hand, it is the natural economic result that lard is a low value product of the process of hog slaughtering and pork production. With this price differential in mind, and knowing that of the live hog weight, usually less than 50 percent of the hog is made up of Boston butt, picnic, loin, bacon, and ham--- while from 20 to 30 percent is fat trimmings or lard stock---not enough attention has been devoted to production and marketing of a hog which possesses a greater percent of the lean cuts, and a smaller percent of the less valuable lard.

With the present marketing system of purchasing hogs on a weight and yield basis, an individual farmer receives little incentive to produce hogs of superior quality or of greater lean meat percent. Instead, he is still intent in marketing as much of his grain crop through heavyweight fat hogs as possible. The fundamental question in the present system of hog marketing revolves about the law of averages under which hogs are marketed, where all hogs of equal or the same weights command the same price except

for instances of hogs with obvious defects.(4) This system of marketing does not take into consideration fundamental variances between hogs.

All hogs can be roughly classified under three headings or types:

(a) The lard type hog which is generally applied to those which are favored by most farmers. A hog relatively short and thick bodied, low set, a good feeder and rapid gainer, producing large amounts of lard, and cuts which are fat.

(b) The bacon type hog which is leaner, longer bodied, lacking in width as compared to the lard type, and may be a slow gainer. This hog produces a smaller percentage of lard, and leaner cuts than the lard type hog. The lard type hog is largely of stocks developed in this country while the bacon type hog is largely of stocks or breeds developed in England.

(c) The intermediate type hog falls midway between the bacon and lard type, being a rapid gainer with plump and firm cuts, and desirable length of side and depth of body. Usually it possesses sufficient fat covering to give quality to the carcass.

Much of the controversy as to what kind of hog will yield a dressed carcass high in percentage of lean cuts has centered around the question of type. Type has been a long time controversy.

In 1898 Professor Shaw (1) of the Minnesota station stated, "No question pertaining to the growing of livestock is attracting so much attention today in the United States as that of the bacon pig. Nor is there any question in livestock circles that is provoking so much controversy." At that time Professor Shaw was one of the men urging that the hog of that period be modified to resemble more the bacon type hog, to meet the demands of the domestic consumer.

Though much has been said about type, and specific recommendations made as to which type is most profitable to raise and market, radical and sudden changes in the type hogs produced in the United States would meet much opposition from certain hog breed associations, and would take quite some time to bring about. Should changes in breeding programs be innaugurated --- and this would appear unlikely without some motivating influence being supplied which would cause such a change --- it would still require an estimated seven to ten years to bring the product of such breeding onto the markets in any appreciable quantities.(1)

Much improvement has been effected in market hogs since the 19th century when heavy, fat hogs were favored on the markets of the United States. Though economically and ideologically, to provide the markets with an "ideal" hog suitable in all respects to a specified purpose, there would still be much room for improvement of type.

Many studies have been conducted at the Agricultural Experiment Stations in the country, studies relating to type and performance as well as carcasses. The conclusions in almost every case are that there is a positive difference in hog performances and compositions for extremes in type --- and there are even differences within the breeds. Within a breed the type varies from a small, economical, rapid gaining fat type, to a large boned, rangy and often a slower gaining hog. These two variations must be fed to different weights (heavier by a minimum of 50 pounds in the case of

the large, rangy hog) to produce carcasses of comparable quality. Reports of the investigations at Idaho, Illinois, Iowa, and Beltsville indicate that in general the intermediate type hog is most suitable to the standards of both consumer and producer. (1)

Some experimental work has been inaugurated with cross bred hogs to produce a hog yielding a more desirable carcass---more economically, but such studies are not sufficiently conclusive to warrant any definite statements or cause the banishment of present day breeds. (34)

Type is a variable character as breeders well know---resulting from the expression of many complex interactions of genes or hereditary factors. Thus the producer of even a purebred swine herd is continually faced with the problem of which type hog or which breed he should raise, and at what weights he should market hogs that are not strictly homogeneous even within his herd. He must market his hogs to grade sufficiently high for his investment, but finish, the deciding factor in grading, fluctuates widely due to feeding practices.

The problem of feeding hogs to a desirable market weight and quality is not so dependent upon individual skill as formerly. There has been sufficient experimental work performed to guide even a beginner, and by adapting the knowledge of accepted feeding practices to individual conditions, there is some assurance that a farmer or hog producer can raise his pigs to a satisfactory market condition. The kinds

of feeds a hog receives prior to market and during its growing and fattening period are not the great influencing factors, providing those few feeds which produce soft pork are not used.

The main concern as regards feeding practices among producers, involves the question of to what weights should hogs be fed for market?

For most producers the practice is to feed to as heavy a weight as possible, but for the best interests of the consumers and packers, the hogs should be fed to lighter weights. If the national average market hog weight were reduced from 275-300 pounds to 225-250 pounds, or better yet 200-225 pounds, then we would see many new and benefical results. By marketing lighter weight hogs, much feed would be saved, the period of most economical gains in weight would not be offset by the later period of more expensive gains, and the hogs marketed at lighter weights would yield greater percentages of higher quality lean cuts.

Much comment has been made of our system of buying hogs on the basis of live weight and yields. When marketing in this manner, too much consideration is taken of average dressing percentages, for though all parts of the hog are eventually proposed to be merchandised, the largest portion of the actual value of the hog carcass is derived from the five primal cuts previously mentioned---ham, loin, belly, picnic and Boston butt. Thus less than 50 percent of the live hog contributes far more than 75 percent of the value

of the hog carcass. These cuts are of common concern to both consumer and packer. The packer because he benefits by securing a high percentage of these cuts, and the consumer because he desires and expects, quality, juiciness, flavor, tenderness and palatability.

Studies by the National Live Stock and Meat Board (1) which have a bearing on the fat content of either individual cuts or the hog carcass show that bacon loses from approximately 54 to 79 percent of its weight in cooking, the amount of loss depending upon the degree of fatness of the bacon, and the method of cooking. The losses due to the degree of fatness show that lean bacon, containing 60 percent lean and 40 percent fat, lost 65 percent of its weight in frying, and fat bacon, containing 40 percent lean and 60 percent fat, lost 79 percent of its weight in frying.

With the present emphasis when buying hogs, on the dressing percentage and not the value or percent of primal cuts, as has been illustrated, the producer is primarily interested in placing weight on his hogs, disregarding consumer wants or the uneconomical aspect of producing lard which is already declining in value and piling up in warehouses throughout the country. Were there a price differential between hogs of the same weight when there are differences in the percent of primal cuts each will yield upon slaughtering, the hog producers of the United States would be influenced to produce the type hog which would

consistently yield the greater percentage of primal cuts, and thus assure themselves of the higher market prices for quality hogs. In most cases the farmers would be eager to cooperate in producing a hog of improved quality---one with a carcass that is more satisfactory to the trade or one that dresses out a higher yield of the more valuable cuts, if he were to receive a higher price for such efforts.

Other countries---England, Canada, Denmark, and Sweden (6) (7) have been buying hogs on the basis of carcass yield and quality for many years. In these countries the standards for hogs are based on the carcass weights and grades, rather than on the live weights and yields as is the practice in the United States. The grades in the aforementioned countries are based on Wiltshire sides, the only acceptable form of pork carcass to the British market. Wiltshire sides consist of half of a pork carcass, usually a Yorkshire hog, from which the feet, head, backbone, and aitch bone have been removed. The Wiltshire side is subjected to a mild cure (39) and then shipment to consumer markets. These sides are considerably leaner in composition than sides of pork produced in the United States.

Wiltshire sides of pork are designed for export from Canada, Denmark, and Sweden to the British market. In former years, nearly 100 percent of the pork exports of the three former countries were contracted for by Great Britain. By being assured of a market for their exports, the three

countries could afford to take extra steps to satisfy their customer. The cost involved in carcass grading for the export trade is largely absorbed by the governments of the exporting countries.

In Canada, where the rail-grading of hog carcasses has been in effect for eleven years, (6) the farmers appear satisfied with the compulsory nature of carcass grading when they market their hogs.

On the Canadian market, prices for hogs are quoted on a basis of the dressed carcass according to grade. The farmer receives the grade price multiplied by the weight of the hog carcass. In the marketing proceedure the hogs are handled much the same way as they are in the United States, except that no attention is given to live weight. (7)

All hogs when received at the market or on the farm, are tatooed on the shoulder with an indelible ink--- thus identifying the hog and producer through the entire packing operation.

All hogs are slaughtered together, and the carcasses pass over an electric scale which stamps the weight automatically and in duplicate, on a heavyweight tag. The tag is attached by the scales operator to the carcass.

As the carcasses progress down the processing line, they pass before a Dominion grader, who grades each carcass and puts the grade on the tag. An assistant records the tatoo number and grade on the lower half of the tag and sends this half to the accounting office for payment. The upper half

of the tag remains on the carcass as a double check should it be necessary to refer back to the carcass.

All grading is done by a government hired, trained, and supervised employee. This fulfills the need of a disinterested party.

The statement returned to the farmer shows the number of hogs in each grade, reasons for the undergrades, price paid for each grade, the amount of condemnation insurance, trucker's charge, premium paid by the Dominion government, and the amount due the farmer from the packing company. Checks are usually in the mail within 24 hours following receipt of the hogs.

Under live grading in 1922, only about 2 percent of Canada's hogs were in the top grade, but by 1946 when the compulsory system of rail-grading had been operating for eight years, more than one-third of all hogs marketed were of the top grade. (6)

Canada does not have a problem of a lard surplus as does the United States. In 1943 Canadian officials were alarmed when their lard stocks reached 8 million pounds. In September 1947 the United States had some 202 million pounds of lard in factories and warehouses.

Rail grading has had help from two sources in Canada. One is the government bonus of $2 for grade A hogs, and $1 for grade B1 hogs. The other factor has been the price differential between grades. Both have persuaded the

farmers to produce the kind of pork desired for export trade.

Table I

Prices Paid For Hogs*

Grade	Weight	Price
A	140-170	$20.40
B1	135-175	20.40
B2	125-134	19.75
B3	176-185	19.25
C	120-185	18.75
D	185 down	18.50
Light	119 down	18.50
Heavy	186-195	16.25
Ex. Heavy	196 up	15.00
Ridgling		14.00
Sow		15.00
Stag		11.00
Cripple	3 cents under mkt. price for grade	

*At Winnipeg, Manitoba, August 1947. (6)

In the United States, hog carcasses are broken down at the packing plant into their component wholesale portions---hams, loins, bellies, shoulders, and lard---these in turn being sold to the retailer for resale to the consumer.

In any program designed to set up standards for uniform grading of hog carcasses, the relative values of each portion of a hog carcass must be defined. In the case of hog carcasses in the United States the wholesale cuts and fat trimmings differ widely in value---hams, loins, picnics, butts and bellies being the high in value wholesale cuts, and lard the principal low value product. Considering the value of lard in relation to the bulk of the hog carcass, any standard of values for grading hog carcasses should place a premium on those possessing greater percentages of the lean cuts. Inversely the overfat, overfinished, wasty type hog carcass should be discounted because of its low percentage of lean meat and high percentage of lard. The more valuable carcasses to the packer and consumer both, are those carcasses which could be termed light in the cheaper trimmings and high in expensive meats. The two possible extremes of finish in hog carcasses should receive proportionate discounts, the underfinished or thin carcasses because the wholesale cuts will be decidedly lacking in quality and those properties sought by the consumers in retail trade. Overfinished carcasses will yield cuts that require much trimming,

and in general the cuts will not find favor with the consumer because of their large size and wastiness.

These vague descriptions of over and under finished carcasses are not sufficient basis upon which to establish permanent hog carcass grades. Specifications or actual limits of measurement must be employed to provide an objective set of standards for each grade.

The George A. Hormel packing company of Austin, Minnesota, (15) is a United States organization that has set up a buying system similar to that followed in countries where hogs are marketed on a carcass yield and grade basis. At this packing company, hogs are purchased by the present system of live weight and grade, but an alternative plan is also in operation. A producer who markets hogs that he feels are above the regular market run in quality, and will yield a higher primal cut percentage than the average hogs, may send his hogs to George A. Hormel for sale under the carcass yield and grade method. When the hogs reach the packing plant they will be weighed and slaughtered. Contrary to usual practices, the hogs are not paid for until after slaughter, when the carcasses are run over an automatic scale to be weighed and then they are graded. The hogs have not lost their identity, for as soon as they are received at the plant they are tatooed with a number identifying the producer. When the carcasses are graded by a company employee, it is then possible to compute the price to be paid to the producer. If the hogs are

above average in quality and yield, the producer will receive a correspondingly higher price, if they yield lower than average or grade low, he will be penalized and receive less than average for his hogs. Thus the system pays premiums for hogs above average, and also inflicts penalties for hogs of lower yields and lower grades.

The hogs bought under this plan are divided into five grades. A number one carcass is average, and is the base from which the other four grades are determined. A number 1 plus is a premium carcass, 2 is a carcass with an excess of fat, 3 is an underfinished or thin carcass, and 4 is a cull. These grades are quoted on good and choice live hogs. If a load of hogs were marketed under the carcass yield and grade system, and the yield is average, grade 1, then the net sale would be exactly the same as though the load were sold under the live weight method. (15)

To grade as number 1, a carcass must yield a certain percentage of its live weight as salable pork. This qualification is made in order that it be worth the price customarily paid per hundred pounds live weight. Normally heavy hogs yield more than light hogs, therefore a graduated scale of standard yields from 63.5 to 72.5 is used. The 63.5 percent yield being applicable to light hogs, and 72.5 percent to heavy hogs.

The George A. Hormel company used this system prior to World War II on a voluntary basis as regards the

producer, and has returned to the system following the war. They are of the opinion that it provides an incentive to the farmer to produce hogs of higher quality, to feed better, and to market his hogs with less fill. Data on condemnations, disease, and bruises are returned to the producer so that he may improve his system of husbandry---a service lacking when marketing hogs by live weight and grade. (1)

Some of the questions of type, and of feeding practices for hogs will continue to be unsettled so long as there is no pressure brought to bear on the producers to raise and market hogs that will find favor in the eyes of the consumer. The present marketing system based on averages provides too great a hedge. It compensates for hogs that dress low and grade low, with hogs that dress out high and grade high. Both are bought for the same price when marketed by live weight and yield.

Were the producers compensated for extra efforts, or penalized for faulty practices and low quality hogs, as is possible when rail-grading is employed, then the price differential would operate to the benefit of all concerned in the marketing process.

The problems concerned with instituting such a carcass yield and grade system are not as great as would first be imagined. Problems of delay in payment for hogs, identification of hogs, and of regulating the receipts of hogs with the slaughter facilities can be solved to everyone's satisfaction. Our packing industry facilities are

such that they can be adapted to a system that does not involve any radical renovation of processing lines. Market competition would still exist, but greater emphasis would be placed on production of higher quality hogs whose carcasses would yield greater percentages of acceptable pork cuts.

Both systems of hog marketing are necessary only so long as it is necessary to make a change, without seriously disturbing the normal market.

There has been no guarantee that the rail-grading system would work in the United States, where regulations of the type required could possibly work heavy penalties against producers of low quality pork. Never-the-less, the feeling that some system of accurate appraisal is needed, be it for live grades or carcass grades, is growing, and being expressed by experiment station workers, farmers, and packers.

Review of Literature

Loeffel, Derrick, and Peters at the Nebraska Agricultural Experiment Station, (35) investigated the question of hog carcass qualities when marketed, as affected by hog weights, in 1943. Their study concluded that by modifying the live market weights of hogs, pork production could be increased or decreased. Through feed lot tests they determined that the medium to large type hogs made their greatest average daily gains between 150-175 pound weights. Following this period the average daily rate of gain decreased. The greatest daily corn consumption per hog occurred in the 275-300 pound period. The intake of feed supplements was greatest from 175-200 pounds. Thus the amount of feed required to produce one hundred pounds of gain in the live hog increased with the increasing weights. Heavier weight hogs in the Nebraska study yielded higher dressing percentages, but only 10 percent higher at 400 pound weights compared to 150 pound weights. The fat cuts, such as the clear plate, leaf lard, fatback, jowel, and belly increased from 29 percent of the 150 pound pig, to 46 percent of the 400 pound pig. Average thickness of fatback alone increased from 0.69 inch to 2.44 inches. Lean meat cuts of the carcasses decreased correspondingly. Firmness of back fat when tested by the refractive index did not show any appreciable increases in firmness with increasing weights of hogs.

Cooking tests at Nebraska with cuts from the

carcasses of the experimental hogs showed little difference in palatability of roasts from hogs of differing weights, and it did appear that roasts from the heavier hogs were richer in juice (increased drippings due to increased fatness), though coarser in texture.

In 1930, the United States Department of Agriculture, Bureau of Agricultural Economics, Livestock Meats and Wool Division, issued a tentative schedule for the grading of slaughter hogs at receiving markets. (36) The study was initiated as early as 1917, for the purpose of setting up descriptive grades for live hogs. Through this study the United States Department of Agriculture hoped to promote greater uniformity of hog grading at the principal livestock market centers. An attempt was made---though not binding on any parties, nor enforceable by legal procedures---to sort hogs into market groups, to define and limit the requirements of each group, and to establish a group name which would come to have greater significance than the terms in use.

Hogs were divided into classes or groups: Barrows, Gilts, Sows, Boars and Stags. Classes were divided into subclasses of: Slaughter Hogs, Feeder Hogs, and Stocker Hogs. The subdividing and grouping progressed toward the purpose of separating hogs according to essential differences and in doing so, to make market exchanges more readily, quickly, and economically.

Each group established was proposed to have certain standards, but uniformity or absoluteness of standards was not possible due to individual differences of hogs. Since no mechanical measurements were required for qualification of a hog in a certain group, variations in such factors as finish, conformation and quality could be expressed in greater or lesser combinations of degrees within the same grouping among varying individuals. Each of the factors of quality, finish and conformation was to be ascertained and the degree of all three averaged for the final determination of grade. If a hog was perceptably shorter in length than the standards for a certain grade allowed, it must be correspondingly thick in body to maintain the proportions and ratios required for that grade. The system was one of descriptive relativity.

Type was considered and in the final analysis, the suggested standards were those applicable to an intermediate type hog. This decision was consistent with the fact that perhaps some 85 percent of the hogs produced in the cornbelt in 1930 might be designated as intermediate type hogs.

Following World War I many hog carcass research projects were conducted by both meat packers and the Agricultural Experiment Stations.

A study conducted by Ellinger and Wentworth (1) in 1925 concerned the cut-out value of two groups of hogs,

each group averaging a bit over 200 pounds. For this study they selected for type using the criterion of body-length. They were selected as short and long bodied hogs, and carcass results showed a dressing percentage margin of 1.6 percent in favor of the long bodied hogs. Also they showed that the long bodied hogs were worth approximately 46 cents per hundred weight more than the short bodied hog group. The long bodied hogs gained their advantage by having 47.9 percent of their live weight in hams, bellies, loins, picnics and Boston butt---while these same cuts in the short bodied group made up an average of 45.5 percent of their live weight. As was expected, the fatback, belly, and lard yield of the short bodied group was greater than in the long bodied group.

Hankins and Ellis, (1) as well as McMeekan and Hammond (1) have made tests of the composition and nutritive value of pork as related to weights of hogs---and the studies showed that as the weight of the hog is increased, the total edible meat per unit of weight increased. Thus, if the individual cuts of pork were equally acceptable, a 250 pound hog would be worth 5 percent more than a 175 pound hog.

The difference in these studies was due to an increase in the fat content of the cut---a matter of questionable value in the eyes of the consumer. This increase in fat content merely means excessive trimming for the meat retailer, and increased shrinkage when the consumer cooks the cuts.

In a study conducted by the University of Minnesota, (4) by Engelman, Dowell, Ferrin and Anderson, hog carcasses were studied at the George A. Hormel and company, packing plant, Austin, Minnesota, for a one year period. Each hog carcass was carefully measured for average back fat thickness, length of body, length of ham, thickness through the shoulders, thickness through the hams, and belly pocket thickness. A determination of the percentages of wholesale cuts and trimmings was made after measurements were recorded, and the carcasses cut. After various statistical analyses were made, the combined percentage of the high value cuts and the fat trimmings was termed the "index of lean".

The explanation of the variations in the index of lean was best explained first by the single measure of average back fat thickness. Body length was the second best measure in explaining the variations in the index of lean---the other measures did not prove as valuable or as informative. Knowing a carcass weight, and back fat thickness they were able to evolve a set of standards for hog carcass grading. Some improvement was possible using carcass weight, back fat thickness, and body length, but not sufficient to warrant it's use in their study. The table on the following page shows the tentative hog carcass standards established by these researchers.

Using these standards, grade 10 is presumed to be the most desirable. Grades 8 and 9 are carcasses carrying

Table 2

Suggested Hog Carcass Grade Standards Based on Backfat Thickness and Carcass Weight. (4)

Carcass Weights Pounds	Equiv. Live Wts. Appro.	Grade 8		Grade 9		Grade 10		Grade 11		Grade 12	
		Index of Lean*	Backfat Thickness	Index of Lean*	Backfat Thickness	Index of Lean*	Backfat Thickness	Index of Lean*	Backfat Thickness	Index of Lean*	Backfat Thickness
110-140	165-205	64.1	2.0-2.3	67.0	1.7-2.0	70.0	1.4-1.7	72.9	1.1-1.4	75.8	0.8-1.1
140-180	205-260	64.1	2.1-2.5	67.3	1.8-2.1	70.0	1.5-1.8	72.7	1.2-1.5	75.5	0.9-1.2
180-220	260-310	64.4	2.2-2.6	67.4	1.9-2.2	70.0	1.6-1.9	72.6	1.3-1.6	75.6	0.9-1.3
220-270	310-375	64.2	2.4-2.7	67.1	2.0-2.4	70.0	1.7-2.0	72.8	1.3-1.7	75.7	1.0-1.3

*Percent

larger proportions of lard and thus receive discounts. Grades 11 and 12, though having large percentages of lean cuts, are discounted because they lack sufficient finish in hams, bellies, and loins to give them quality.

In this study the difference in the actual carcass values was determined for the various carcass grades. The differences were based upon, "(1) the expected average carcass composition within each of the different carcass weight and grade groupings, and (2) the relationship of the prices of the various wholesale cuts and trimmings to each other."(4) Though prices were fluctuating widely during their study, it was agreed that the wider the margin between lard and lean cut prices, the greater the penalty or discount for the over finished grades and carcasses. On the following page is a table from their study showing the differing prices for grades 8, 9, and 10, of various weights, based on the theory of discounts for the heavier carcasses and cuts within the grade. This study tended to illustrate that if hogs were to be graded in carcass form, in opposition to the present live weight and yield basis, a more accurate appraisal of the value of a hog could be secured.

One of the more unique hog marketing plans set up in the United States, was that of the Fayette Producers Company, Washington Court House, Ohio, in 1921.(9) It was proposed by this organization (a producer's cooperative marketing association) to sell their hogs direct to Eastern slaughterers by description.

Table 3

Composite Carcass Values for Several Carcass Grades.(4)

Carcass Weight (pounds)	Equivalent Live Weight (approx. pounds)	Carcass Grades				
		8	9	10	11	12
L10-140	165-205	$39.82	$40.63	$41.39	------	------
140-160	205-232	39.31	40.09	40.71	------	------
160-180	232-260	39.04	39.58	40.02	------	------
180-200	260-285	38.41	38.76	39.10	------	------
200-220	285-310	37.91	38.13	38.29	------	------

Under the name of the Eastern States Company, Columbus, Ohio, they sold the hogs produced by members in the eastern corn belt region, directly to the packers in the east on the basis of a guaranteed dressing percentage or yield. On receiving orders from the packers for a specified number of hogs which would yield a requested dressing percentage, the Eastern States Company relayed said order to a local shipping point. At these local shipping points large numbers of hogs were assembled, sorted and graded by the local managers. After grading, the local managers would load double-deck railroad cars with those hogs they estimated as being able to fulfill the contract. They estimated the dressing percentages of hogs so that the carload average would be as ordered by the eastern packer. If upon arrival at the packing plant the hogs yielded higher dressing percentages than called for in the contract, the packer paid the increased value, but if the average dressing percent was lower, the difference was deducted from the contract price.

The movement grew until 1930 and thereafter started to decline. Its principal objectives were to reduce marketing costs and provide a system whereby producers were paid for their hogs in accordance with the amount of carcass.

Failure of the movement may be attributed to several causes as follows: (1) The dressed weights were not checked by a member of the Eastern States Company (which was succeeded by the National Order Buying Company) or by

a disinterested party, (2) Hostility of other marketing agencies, (3) Difficulties of satisfactory agreement with the packer as to the guaranteed yield, (4) Inability of local managers to accurately estimate the yield of a load of hogs, (5) Failure to return to the individual producers payment for the exact weight of carcasses delivered.

Although this marketing system did not succeed it must be considered a movement to surmount or improve upon an unsatisfactory marketing system that existed. Had they been able to pay each producer for exact weights instead of allowing producers of quality hogs to be penalized for poor hogs of other producers, and had the local managers been better able to estimate yields the plan might have succeeded.

It may still be the basis for a successful marketing program if its more favorable aspects were developed and its weaknesses improved upon. Dowell and Bjorka (3) suggested that it might have been successful had it been patterned more closely along the lines of carcass weight and grade marketing.

Bull, Olson, Hunt and Carroll (37) in 1935 conducted a study with hogs, relating to the question of type, and how effectively the various types of hogs meet the market demands. Knowing that the demand for lard and extremely fat hogs was on the decline, they studied hogs which they qualified under the headings of, "Very Chuffy, Chuffy,

Intermediate and Rangy."

For this experiment they fed 14 Chuffy hogs to a slaughter weight of 170 pounds, 14 similar Chuffy hogs, 10 Rangy, 10 Intermediate, and 10 Very Chuffy hogs were fed to slaughter weights of 200 pounds.

In the feeding trials they found that there were no significant differences in either rate or economy of the gains between the Rangy, Intermediate, and Very Chuffy type hogs. The Very Chuffy and Chuffy hogs as well as the Rangy hogs were purebred Poland China hogs from the University of Illinois herds. The Intermediate hogs were grade Poland China's from the same source.

Though the Very Chuffy hogs dressed higher than the other types, there were no significant differences in the dressing percentages that could be attributed to type.

In cut out tests of the hogs, the Very Chuffy hogs cut out higher percentages of heads, leaf fat, clear plates, bellies, trimmings, and back fat and lower percentages of feet, bones, shoulders, loins and hams than did the other types. The Rangy hogs had a lower percentage of cut-out in leaf fat and clear plates than either the Intermediate or Chuffy carcasses. Hams from the Chuffy and Intermediate hogs slaughtered at 200 pounds were the most desirable. The Very Chuffy hogs cut out to 40 percent more lard stock than did the other carcasses. This was the conclusion throughout, that the Very Chuffy hogs cut out greater percentages of the

less valuable cuts, and not enough of the high value lean cuts. For an ideal hog the authors required a composite of all the types, including only the most favorable points of each. To meet the market demand their ideal hog would possess the early maturity of the Chuffy hog, the quality and plumpness of the Intermediate type and the length of the Rangy type.

At the Iowa Agricultural Experiment Station, (1) Mr. Culbertson estimated the total costs of raising and feeding hogs to 225 pounds and 250 pounds, using feed and market prices for July, 1947. It would cost approximately $48 to get a 225 pound hog to market, and $22 more to put on another 100 pounds. When hogs weighing between 225-275 pounds are selling at approximately the same price per 100 pounds, most farmers will take advantage of the situation and feed to the heavier weight. Knowing this, it should be recognized that some adjustments are called for to get the producer to market the lighter weight hogs when less fat and lard are desired by the market.

C. E. Hughes (34) in a periodical article, commented on some of the breeding experiments that have been conducted at the Minnesota Agricultural Experiment Station. According to Hughes, the progeny of various hog crosses developed at that station are coming closer to being the solution to the high value primal cut hog than most others that are being produced.

Of the 13 experimental crosses they have developed, some consistently produce carcasses of quality and high yields in primal cuts. One cross between an inbred Poland China boar and a Minnesota number 1 sow produced a carcass with one-third less fat and lard than the trimmest hog in the demonstrational exhibit at the National Barrow Show the previous year. Of the total live weight, 47.2 percent consisted of primal or lean cuts.

On the average, three litters of this cross required just 340 pounds of feed per hundred pounds of gain, and 157 days to reach a weight of 200 pounds.

Other crosses performed even better in the feed lot but produced slightly larger percentages of lard. A Minnesota number 2 boar mated to a Minnesota number 1 sow produced a litter that reached 214 pounds in just 145 days.

Some doubts have been raised as to whether the Minnesota number 1, when crossed with other breeds, produces a carcass with any less lard than is found in the standard breeds. Minnesota breeders claim that it depends greatly upon the type hog that is used in the mating. If the mating is with a short chuffy hog, they don't expect to secure any great improvement in the conformation of the litters.

As is the case with most breeds of hogs, Minnesota breeders advise not feeding over 225 pounds for market weights.

More work is to be conducted at Minnesota in

crossbreeding, with the hopes of securing a combination of matings that will consistently produce litters that will yield superior carcasses at market weights.

Bratzler and Farwell, at Michigan State College, (38) investigated the use of the trimmed loin-fat back ratio as a useful means of estimating hog primal cut out percentages. The study was conducted with the carcasses using the trimmed loin, belly, skinned ham and the New York style shoulder.

Based on work by McMeekan (1941), and Hammond and Murray (1937) the rough loin was selected as the most accurate and simplest measure for primal cut yields.

Using 478 hogs of known breeding (nine cross-breeds and eight purebred strains) the chilled carcasses were cut by packing house employees. Each primal cut was carefully identified by a tatooed number, and following the cutting each primal cut was weighed to the nearest ounce.

The total weights of the trimmed loins, bellies, skinned hams, and New York style skinned shoulders were divided by the cold carcass weights for each carcass to obtain primal cut percentages. The trimmed loin-fat back ratio was secured by dividing the trimmed loin weight by the total trimmed loin and fat back weight. A highly significant correlation coefficient of + .820 was found with a standard error of .0150.

A highly significant correlation coefficient of + .561 was also found between the trimmed loin-fat back ratio and the percentage of primal cuts from the live weight.

Bratzler and Farwell concluded that the trimmed loin-fat back ratio is a reliable means for estimating primal cut yield of hog carcasses.

Crampton (1) (1938), reported the results of Canadian testing stations working with a study of five traits related to the size of the loin-eye muscle. The traits studied were rate of gain, size of ham, evenness of back fat, size of shoulder and depth of shoulder fat. Only 20 percent of the differences found in the eye of lean was accounted for by these traits. Size of ham was found to be much more closely related to eye of lean than the other factors. Size of ham accounted for about half of the total difference. The two factors of size of ham and eye of lean increased together, whereas size of eye of lean decreased as the other factors increased.

Hankins and Ellis (1) (1935) studied composition of hams as regards type of hogs. In hogs of 225 pounds live weight they reported that the hams decreased about 2 pounds as hog type went from large to small type. Weight of separable fat in the hams was found to increase approximately 1 pound as type varied from large to small. The percentage of fat to lean in the hams increased proportionately from large to small.

Hog fat content studies in England, by McMeekan and Hammond, (1) show that fat increases from 5 percent at birth weight to 43 percent in a 220 pound hog. The percentage of lean progresses from 39 percent at birth to 49 percent at 16 weeks, and returns to 39 percent at a weight of 220 pounds live weight.

Differences between light and heavy hogs were reported in 1940 by Arthur of the Iowa Agricultural Experiment Station. (1) He reported that 180-220 pound hogs had 71 percent of their value in the lean cuts and 21 percent in fat and lard in 1928. In 1940 these hogs had 78 percent of their value in lean cuts and 16 percent in fat and lard. Hogs weighing 270-300 pounds had 53 percent of their value in lean cuts and 40 percent in fat and lard in 1928, and 65 percent of their value in lean cuts and 28 percent in fat and lard in 1940. Value of carcasses accounted for by hams increased 7 percent from 1928 to 1940.

Hankins and Ellis (1) selected hogs weighing 225 pounds and of the intermediate type, for a study of the nutritive value of their carcasses. Average measurements of the hogs were: 30.9 inches long (aitch bone to the first rib), fat back 1.6 inches, and length of hind leg 22.8 inches (aitch bone to toe).

Later studies at the Iowa station (1) in which carcasses were graded, scored, measured and cut, resulted in their suggesting to the Swine Breeding laboratory (1943)

that 225 pound hogs should have carcasses which measure 30-31 inches long from aitch bone to first rib, and that back fat thickness taken over the seventh rib should be 1.2 to 1.5 inches. Subsequent studies at Iowa bore out this contention. Of 187 carcasses (3 weight groups), all except three were graded choice, and the measurements were very similar for all weight groups. Average measurements reported for 101 hogs whose live weight was 216-230 pounds are reported as follows: 30 inches in length, back fat over seventh rib 1.36 inches, flank end of bellies 0.9 inches, length of hind leg 23.3 inches. The hogs had an average dressing percentage of 80, and yielded 49 percent of live weight in primal cuts.

The live hogs weighing 216-230 pounds were also measured, and average measurements were as follows: 42 inches from point between ears to base of the tail, 10.6 inches wide behind the shoulders, foreleg from elbow to toe 12.1 inches.

Dr. Craft, Director of the Regional Swine Breeding Laboratory, United States Department of Agriculture, Ames, Iowa, and a member of the graduate faculty of the Iowa State College, later commented that he believed these measurements were the upper limits for hogs of the intermediate type.

Hankins (1) proposed that the standards for an "ideal hog" be set at 210 pounds slaughter weight, a primal cut yield of not less than 50 percent, and the average thickness of fatback not less than 1.5 inches nor more than

1.75 inches.

Minnesota projects (1) with 225 pound hogs show 48 to 52 percent and 68.5 to 71 percent of cold carcass weight was made up by the five primal cuts. Carcass measurements averaged 30-31 inches in length, and 1.5 inches back fat thickness.

Butz (5) reported the results of the National Barrow Show at Austin, Minnesota in 1947, where a demonstration of 4 barrows was given to impress visitors of the difficulty of estimating the actual carcass value of a hog. All four hogs weighed 213-217 pounds, and would have graded good to choice, medium-weight butcher hogs. If sold under our present marketing system, they would have all brought the same price. Actually one hog was worth $3.59 per hundred-weight more than the poorest of the four hogs, as was demonstrated when the hogs had been slaughtered. Butz reported the percentages of various cuts and their values as shown in the table on page 37. (5)

Table 4

Carcass Yields From 1947 National Barrow Show Exhibit

Primal Cut	Hog Number 1	2	3	4
Skinned Hams	10.8	12.0	12.5	10.1
Picnics	5.7	6.1	6.2	6.2
Boston Butts	4.7	4.6	4.8	4.8
Loins	8.3	8.7	9.5	8.2
Bacons	10.4	11.6	12.8	10.8
Total Primal Cuts	39.9	43.0	45.8	40.1
Total Lean Meat	31.3	33.2	34.5	30.5
Total Fat for Lard	23.3	18.8	19.0	19.4
Dressing Percentage	70.9	68.7	72.2	65.6
Length of Body	26.9	29.12	29.75	29.5
Back Fat (incnes)	2.5	1.75	1.87	1.7
Live Value Cwt.	$29.02	29.85	31.62	28.03

These figures and percentages operate to show why No. 3 barrow was worth $3.59 a hundredweight more than No. 4, $2.60 a hundred more than No. 1, and $1.77 a hundred more than No. 2.

Object of the Study

In order to determine the ability of an individual to accurately estimate the percent of primal cuts that a hog will yield, a study was initiated using live hogs at the Detroit Packing Company, Detroit, Michigan. Hogs were selected, weighed, judged, slaughtered, cut into primal cuts, weighed and recorded at the packing plant. This project was made possible through the cooperating efforts of the Detroit Packing Company, the Farm Credit Administration, the Ohio State Agricultural Experiment station, and the Michigan State College.

Methods of Proceedure

Selection of hogs for test

Hogs used in this test came from several producers, and were of varied but known breeding. A total of 683 hogs were used, representing 15 crossbred strains, 7 purebred strains, and one group each of Grade and Mine Run hogs. It was originally intended to secure 30 individuals of all groups, all weighing 200-220 pounds, but difficulties in securing sufficient hogs of the specified weights and breeds caused the tests to be conducted with 24 breeding samples, and three weight groups.

This method of selection was carried out in order to obtain as representative a sample as possible of the breeding, weights and types usually found on the Detroit market. Table 5 shows the number of hogs of each breed and weight group that were originally included in this study.

Table 5

Original Hog Count by Breeds

Breeds	Number of hogs in weight group			
	181-200 pounds	201-220 pounds	221-240 pounds	Total
Minnesota X Hampshire	9	30	8	47
Minnesota X S P C	2	5	1	8
Minnesota X Poland China	4	2	-	6
Minnesota X Duroc	-	40	9	49
Minnesota X Berkshire	1	2	2	5
Minnesota X O I C	-	8	-	8
Minnesota X Hamprace	12	8	2	22
Minnesota X Chester White	8	11	3	22
Minnesota X Hamprace X Chester	-	13	-	13
Minnesota Crosses	8	3	1	12
O I C	12	40	18	70
Hampshire	10	30	8	48
Spotted Poland China	7	30	4	41
Poland China	23	30	9	62
Yorkshire	6	4	4	14
Berkshire	24	33	5	62
Duroc	23	35	13	71
Chester White	7	30	5	42
S P C X Duroc	2	1	-	3
Yorkshire X Hampshire	-	1	-	1
Poland China X Chester White	3	3	-	6
Grade Hogs	11	18	5	34
Mine Run	3	33	-	36
Minnesota	-	1	-	1
Total	175	411	97	683

Selection and Functions of Judges

To fulfill the purpose of this investigation three persons were selected, one from each of the participating organizations; the Detroit Packing Company, the Ohio State Agricultural Experiment station, and the Michigan State College. All three were men whose vocation qualified them to score the hogs in this experiment. For purposes of brevity they will be referred to hereafter as the Judges, or as Judge A, Judge B, or Judge C. The Judges were present and supervised the operations throughout the investigation, from the original weighing of each hog, to the time they scored each hog. The carcass data were obtained by other members of the cooperating agencies.

Weights of Hogs

The hogs were divided into 3 market weight groups of 181-200 pounds, 201-220 pounds, and 221-240 pounds. 175 hogs weighing 181-200 pounds, 411 hogs weighing 201-220 pounds, and 97 weighing 221-240 pounds were studied. Of these 683 hogs, 5 were later discarded because they had weighed 180 pounds and not the required 181 pounds. One hog was discarded because it weighed heavier than the 240 pound maximum established. Another 3 hogs were omitted from the tabulated results for lack of accurate measurements of primal cuts. Thus the starting number of 683 was reduced to 674 hogs.

Weighing of Hogs

On each day throughout the duration of the study

that hogs were received at the Detroit Packing Company, the live hogs used in the study were run over a platform beam scale individually, and the weight recorded in the presence of the three judges.

Identification of Hogs

Following the recording of each weight, the hog was tattooed with an identification number on both left and right side over the ribs. This tattoo was made with a hand operated apparatus using indelible ink, for the purpose of maintaining the identity of each hog after slaughter.

Scoring

Immediately after weighing and tattooing each hog was driven off the scale onto a platform where it was in full view of the three judges. It remained on this platform until all judges had marked their score sheets to their satisfaction. It was at this time that the judges, knowing and having recorded the breed, the tattoo and weight, estimated the length of side, thickness of fat back, and the primal cut yield.

Units for Scoring

The unit used for estimating length of side was based on a series of numbers from 1 to 5, a number 3 was an average length for the weight, a number 4 was slightly longer and 5 an extremely long hog. Number 2 was shorter than average and a number 1 hog was extremely short sided. Units for estimating the thickness of back fat, or finish, were the same. A number 3 indicated that the hog carried a

desirable thickness of back fat, number 4 that it carried more than was desirable, and number 5 indicated an undesirable, excessive thickness of back fat. Number 2 was used to indicate the hog was slightly thin in back fat covering, and number 1 that it was an undesirably underfinished back fat thickness.

These units of from 1 to 5 for estimating both length of side and thickness of back fat allowed the judges to express their estimates of relative degree, rather than absolute values.

Estimate of the primal cut yield of each hog was made to the nearest half percent, without any maximum or minimum limits being established.

Methods of Slaughter

Slaughtering of the hogs was carried out in the regular packing house manner, by the employees of The Detroit Packing Company. The carcasses were then placed in a chill room for 24 hours. Following the chill period, the carcasses were measured and weighed.

Method of Measuring

All carcass measurements and weights were taken by members of the cooperating agencies. Measurements were made with steel tapes graduated in millimeters, and taken to the nearest millimeter. The length of the carcasses was measured from the anterior edge of the aitch bone to the anterior edge of the first rib. The thickness of back fat was

measured at a point over the seventh rib, not including the thickness of the skin.

Carcasses were then broken into the five primal cuts; Boston butt, picnic shoulder, trimmed loin, belly and skinned ham, which were weighed to the one-tenth pound. All cutting of the carcasses was done in the regular packing plant manner by the packing company employees.

Analysis of Data

The statistical formulae used in the analysis of the data gathered at The Detroit Packing Company, are as follows: (34)

$\bar{X} = \frac{\Sigma X}{N}$ = the mean

$s = \sqrt{\frac{\Sigma X^2}{N} - \left(\frac{\Sigma X}{N}\right)^2}$ = the standard deviation

$s_{y.x} = s_y \sqrt{1 - r^2}$ = the standard error of estimate of $\hat{Y}$

$$r = \frac{\Sigma XY - \frac{(\Sigma X)(\Sigma Y)}{N}}{\sqrt{\Sigma X^2 - \frac{(\Sigma X)^2}{N}} \sqrt{\Sigma Y^2 - \frac{(\Sigma Y)^2}{N}}}$$ = coefficient of correlation

$$b_{yx} = \frac{\Sigma XY - \frac{(\Sigma X)(\Sigma Y)}{N}}{\Sigma X^2 - \frac{(\Sigma X)^2}{N}}$$ coefficient of regression (b of regression equation)

$\hat{Y} = a + bX$ = regression equation

Tabulation of Data

Due to previous commitments, all three judges were

not able to be present for the live scoring of all 683 hogs. For purposes of tabulating the data, those hogs which were scored alive by only one or two judges were omitted. This reduced the total number of hogs to 434, distributed in weight groups as follows:

181-200 pounds----------110 hogs

201-220 pounds----------265 hogs

221-240 pounds---------- 59 hogs

For ease of machine calculation, the actual measurements of length were coded by the subtraction of 680 from all measurements. Scoring units of 1 to 5 for length were not coded. The measures and scores for back fat thickness were not coded. Actual percent primal cut yields were coded by the subtraction of 41 from all yields, and the scores or estimates of primal cut yields by the judges were coded by the subtraction of 44 from all estimates. The correlation coefficients as well as the standard deviations and ranges are not affected by this coding operation.

It must be remembered in observing the results, that all statistics for estimated length of side and back fat thickness are in score units, and not absolute values or measures.

Results of Study

The tabulated data for estimated and actual length of side (table 6) show that the judges were able to estimate length of side from the live hogs to a significant degree.

Table 6

Relationship Between Estimated and Actual Length of Side

Weight Group	Number of Hogs	Actual Range (mm.)	Standard Deviation of Estimate*	Correlation Coefficient of Estimate
		Judge A		
181-200	110	691-809	.806	+ .657++
201-220	265	691-830	.316	+ .390++
221-240	59	725-861	.624	+ .181
All wts.	434	691-861	.774	+ .459++
		Judge B		
181-200	110	691-809	.655	+ .566++
201-220	265	691-830	.648	+ .423++
221-240	59	725-861	.547	+ .145
All wts.	434	691-861	.632	+ .463++
		Judge C		
181-200	110	691-809	.678	+ .599++
201-220	265	691-830	.655	+ .291++
221-240	59	725-861	.894	+ .125
All wts.	434	691-861	.7	+ .344++

* In score units

\+ Significant at the 5 percent level
++ Significant at the 1 percent level

For all groups from 181-200 pounds to all weights, Judge A had a range for r from +.181 to +.657, Judge B +.145 to +.566, and Judge C +.125 to +.599, showing a somewhat wide spread of correlation coefficients. All the judges were able to estimate the length of side to a greater significance for the lightweight hogs, than for the heavyweight hogs. The standard deviations of the estimates of length are fairly consistent for the actual standard deviations. (Standard deviations of estimates are in score units.)

Figure 1a is a scatter diagram showing the relationship between the estimated length of side made by Judge A, and the measured length (in millimeters) of each hog carcass.

The equation for establishing the regression line is, $\hat{Y} = 16.4 X + 707.47$, and the standard error for $\hat{Y}$ is .687 score units.

Figure 1b is a scatter diagram showing the relationship between the estimated length of side made by Judge B, and the measured length (in millimeters) of each hog carcass.

The equation for establishing the regression line is, $\hat{Y} = 19.8 X + 694.07$, and the standard error for $\hat{Y}$ is .559 score units.

Figure 1c is a scatter diagram showing the relationship between the estimated length of side made by Judge C, and the measured length (in millimeters) of each hog carcass.

The equation for establishing the regression line is, $\hat{Y} = 13.96 X + 715.83$, and the standard error for $\hat{Y}$ is .657 score units.

Figure 1a.
Relationship Between Estimated and Actual Length of Side.

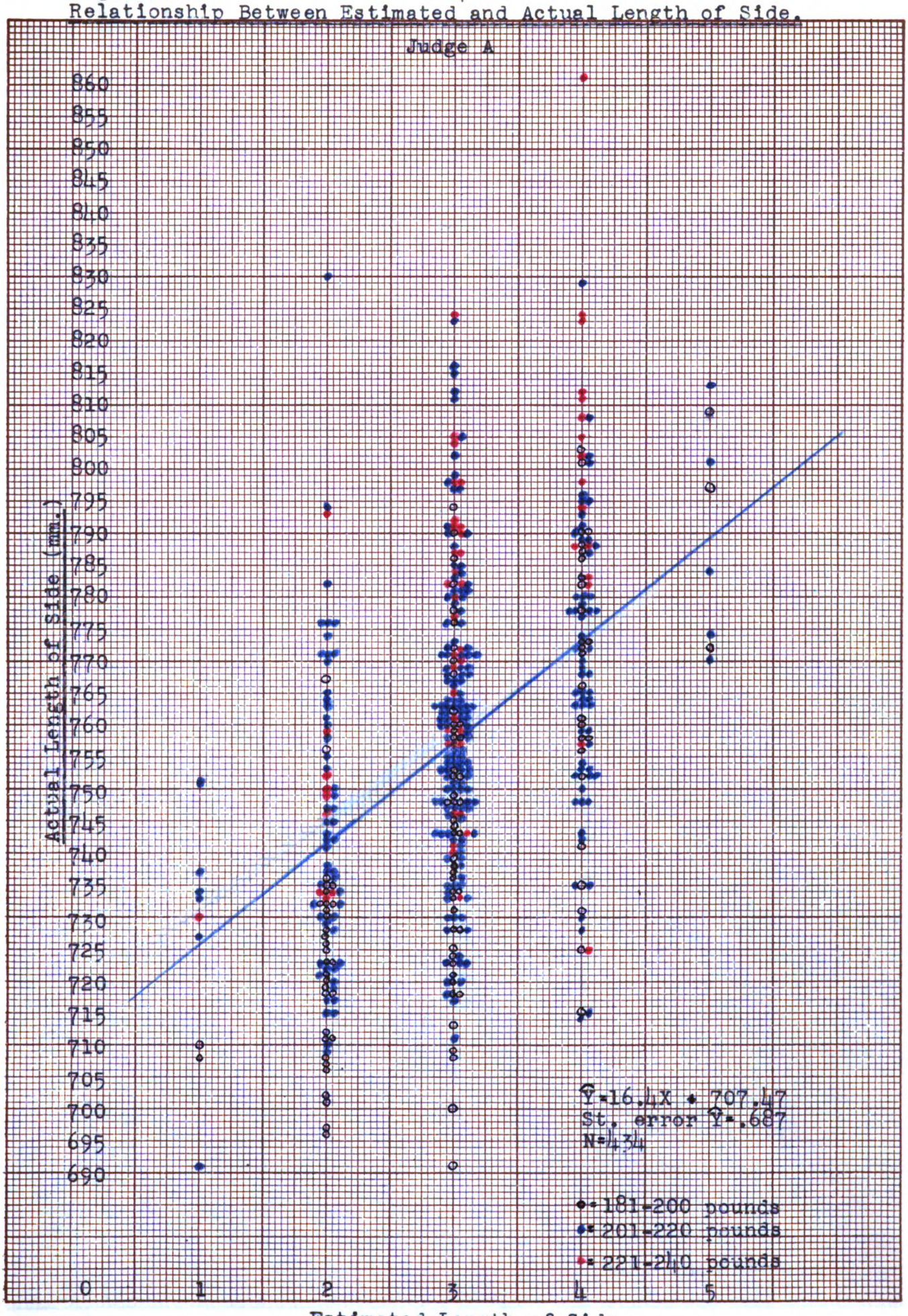


Figure 1b
Relationship Between Estimated and Actual Length of Side.

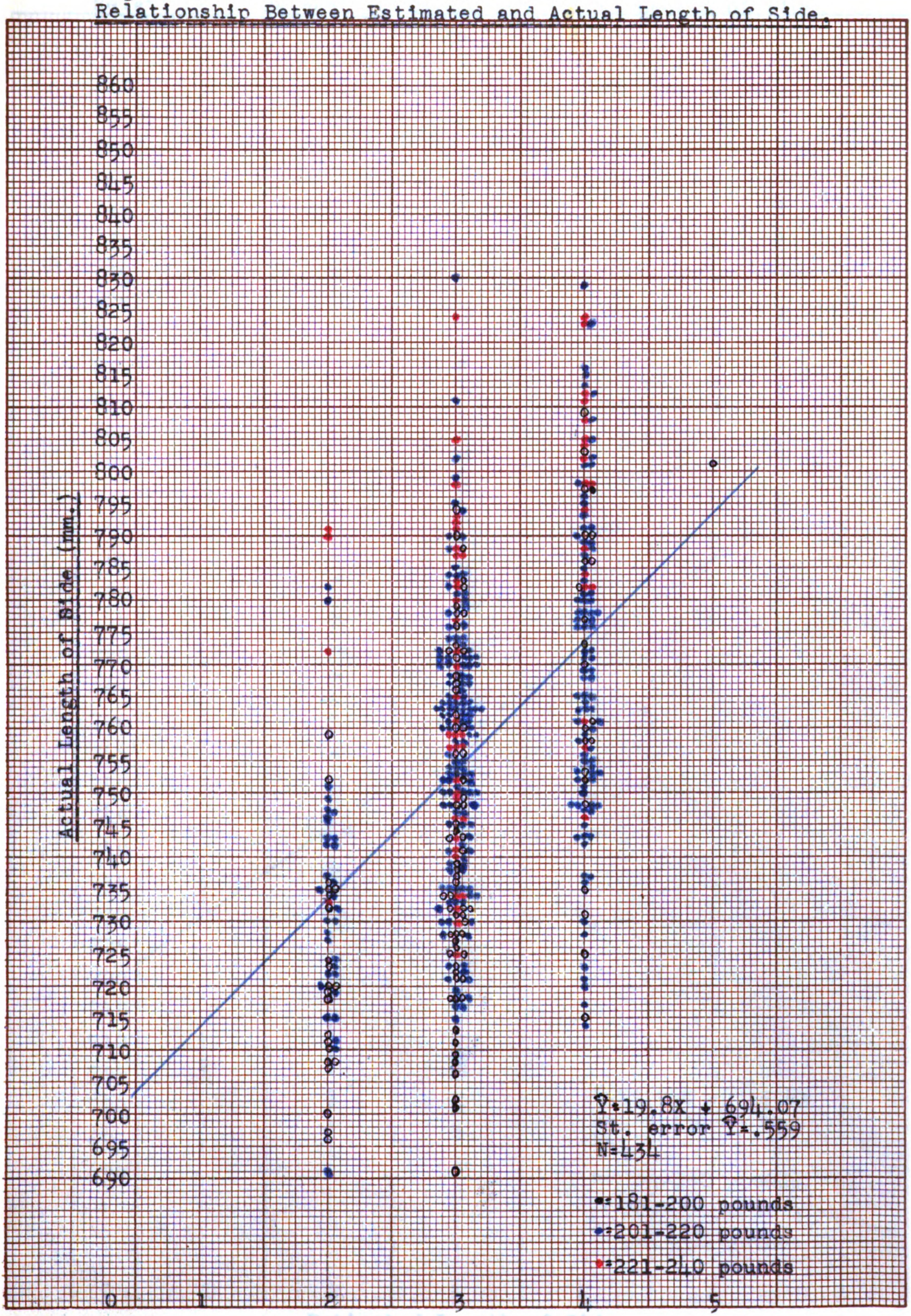
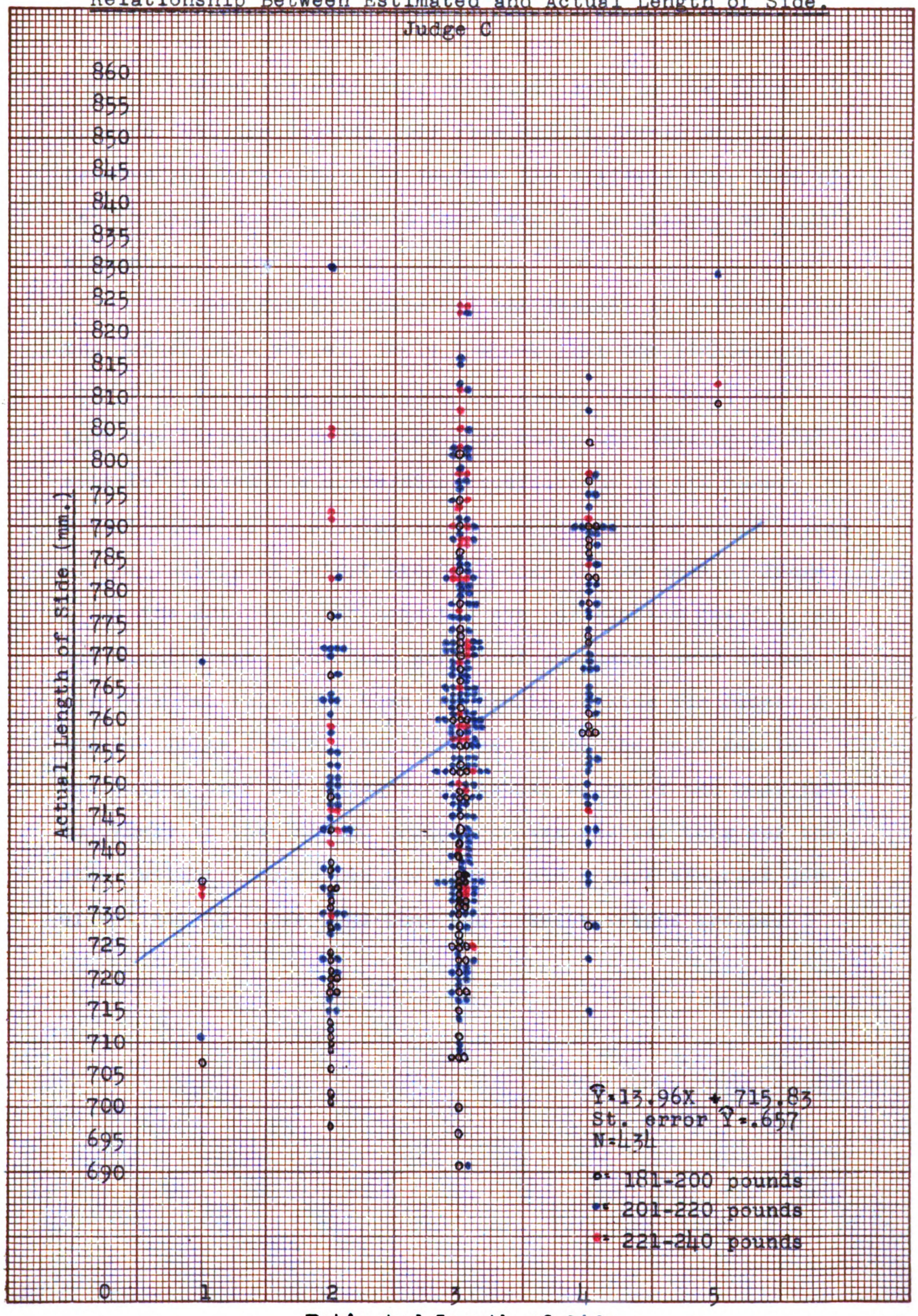


Figure 1c.
Relationship Between Estimated and Actual Length of Side.
Judge C



From the estimates of length made by the judges it appears that the greater body size and thickness of the heavyweight hogs tended to depress the estimate they made of length below what it should have been to be classed as highly accurate.

Back fat thickness was the easiest to estimate for the judges as a whole. Table 7 shows that the lightweight hogs were easier to judge than the heavyweight hogs, and that the increased numbers of hogs under the heading of "all weights" raised the correlation coefficient in all cases, except Judge A, to a point above the correlation coefficients of the individual weight groups. Only in the case of Judge A for the 221-240 pound hogs was the correlation coefficient not significant. Standard errors of estimates were higher for back fat thickness than for length of side for Judges A and B. Judge C consistently proved to be the best man in estimating back fat thickness. Actual range of the back fat thickness in the 181-200 pound hogs was smaller than for the other weight groups, but the judges did a more accurate job of estimating these hogs than the heavier weight groups.

Table 7

Relationship Between Estimated and Actual Back Fat Thickness

Weight Group	Number of Hogs	Actual Range (mm.)	Standard Deviation of Estimate*	Correlation Coefficient of Estimate
		Judge A		
181-200	110	22-50	.714	+ .469++
201-220	265	23-61	.721	+ .420++
221-240	59	29-58	.663	+ .209
All wts.	434	22-61	.761	+ .467++
		Judge B		
181-200	110	22-50	.632	+ .482++
201-220	265	23-61	.655	+ .424++
221-240	59	29-58	.624	+ .292+
All wts.	434	22-61	.761	+ .577++
		Judge C		
181-200	110	22-50	.854	+ .522++
201-220	265	23-61	.911	+ .495++
221-240	59	29-58	.707	+ .375++
All wts.	434	22-61	.921	+ .627++

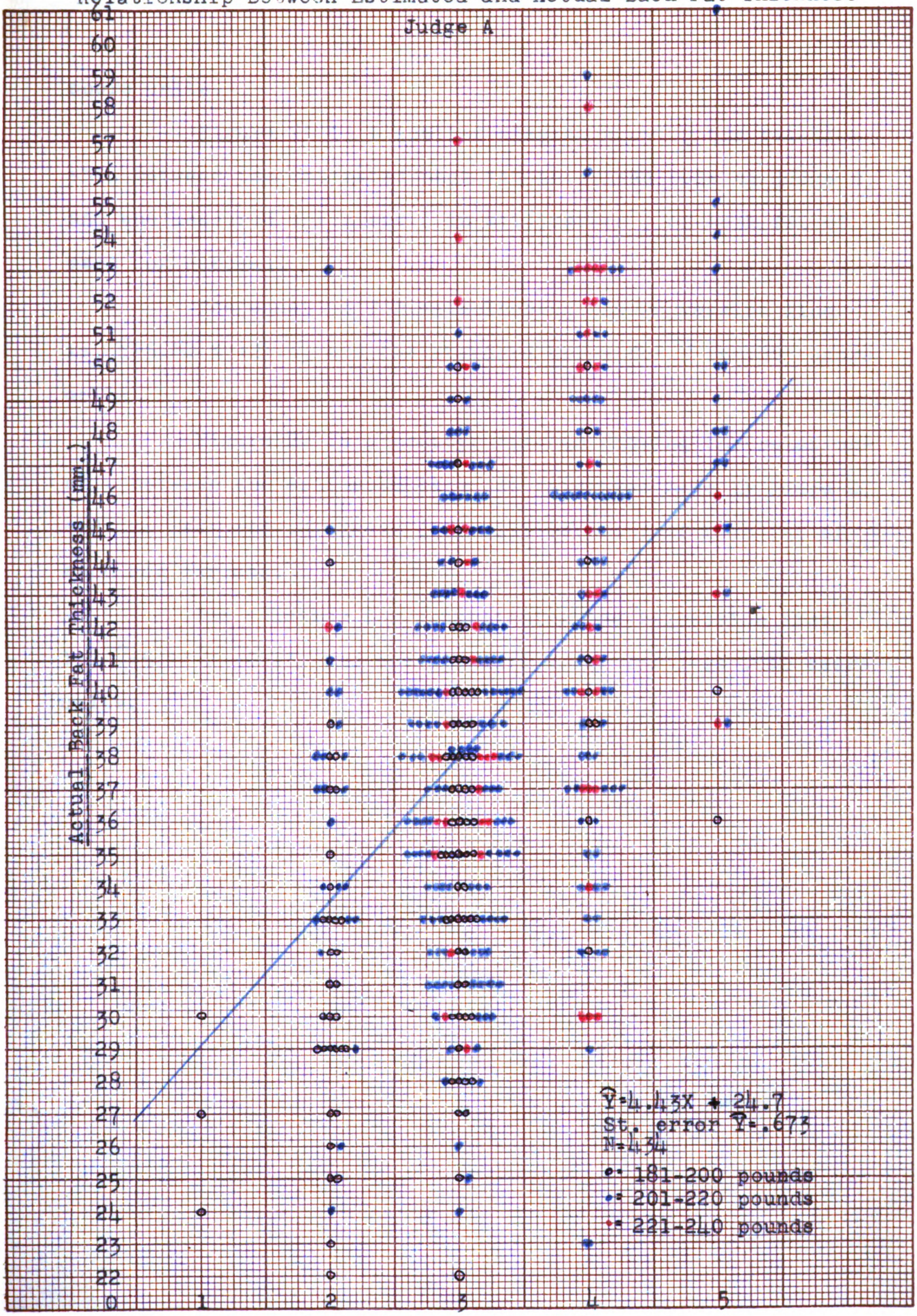
* In score units

\+ Significant at the 5 percent level
++ Significant at the 1 percent level

Figures 2a is a scatter diagram showing the relationship between the estimated back fat thickness made by Judge A, and the measured thickness (in millimeters) of back fat of each hog carcass.

The equations for establishing the regression line is, $\hat{Y} = 4.43 X + 24.7$, and the standard error for $\hat{Y}$ is .673

Figure 2a
Relationship Between Estimated and Actual Back Fat Thickness



score units.

Figure 2b is a scatter diagram showing the relationship between the estimated back fat thickness made by Judge B, and the measured thickness (in millimeters) of back fat of each hog carcass.

The equation for establishing the regression line is, $\hat{Y}=5.40\ X\ +21.6$, and the standard error for $\hat{Y}$ is .621 score units.

Figure 2c is a scatter diagram showing the relationship between the estimated back fat thickness made by Judge C, and the measured thickness (in millimeters) of back fat of each hog carcass.

The equation for establishing the regression line is, $\hat{Y}=5.17\ X\ +22.3$, and the standard error for $\hat{Y}$ is .682 score units.

Figure 2b.
Relationship Between Estimated and Actual Back Fat Thickness

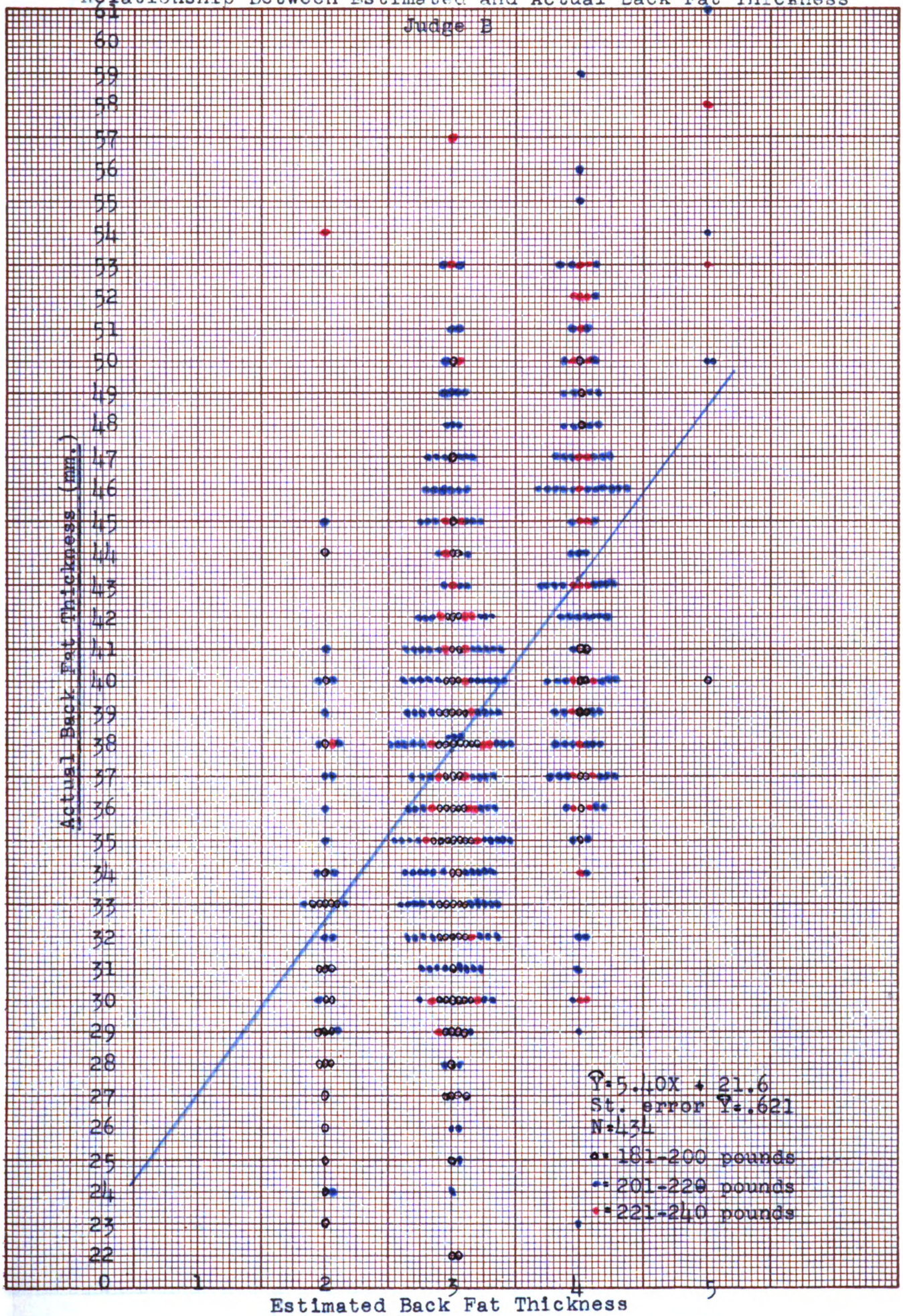
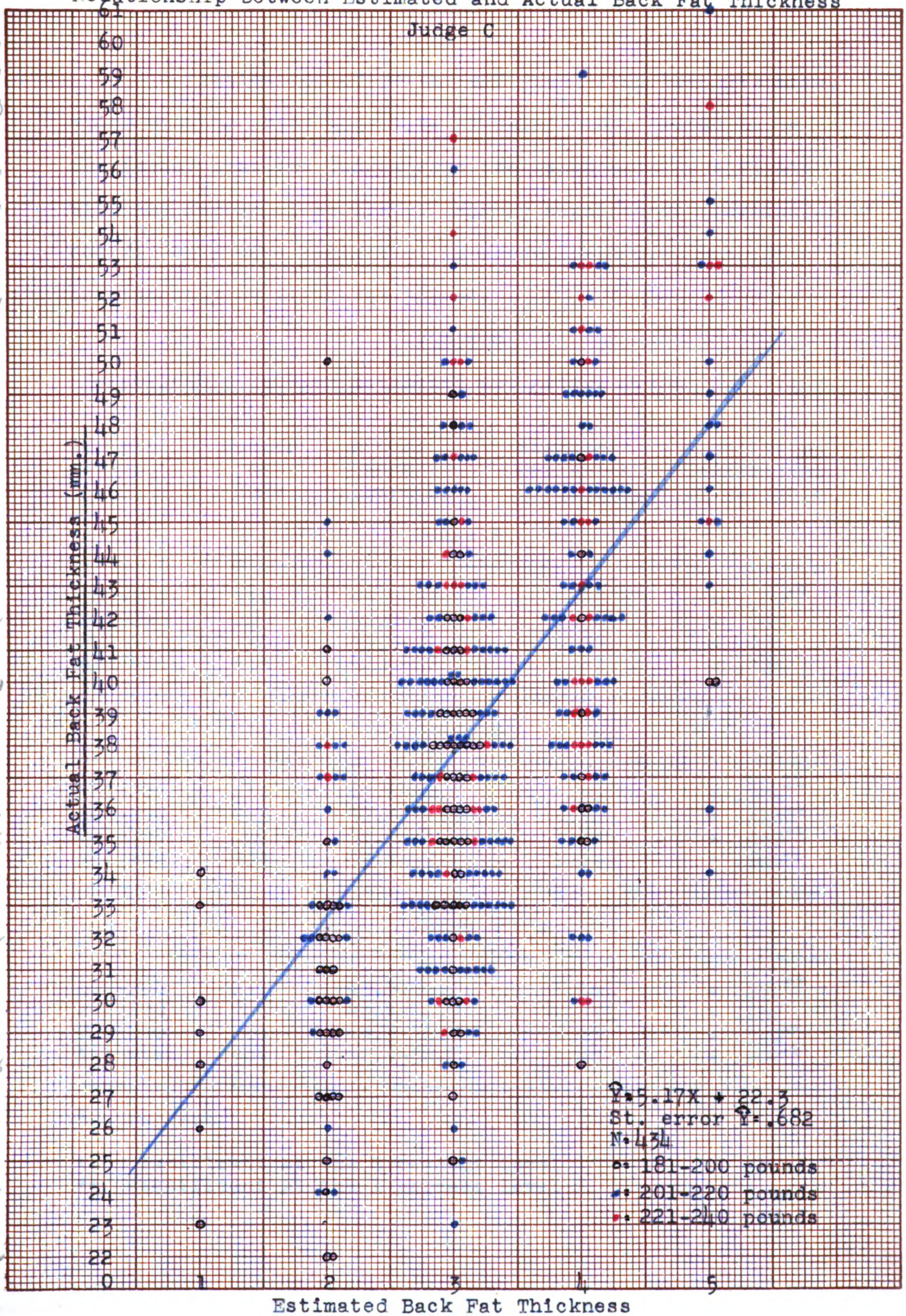


Figure 2c
Relationship Between Estimated and Actual Back Fat Thickness



Estimation of primal cut yield from the live hogs, which was the prime objective of this study, proved to be the factor that the judges were the least able to estimate with any degree of accuracy. Highly significant correlation coefficients were registered in seven instances, but not consistently by all three judges.

Table 8

Relationship Between Estimated and Actual Primal Cut Yield

Weight Group	Number of Hogs	Actual Range (percent)	Standard Deviation of Estimate*	Correlation Coefficient of Estimate
		Judge A		
181-200	110	43.8-52.7	1.43	+ .222++
201-220	265	42.2-51.9	1.58	- .083
221-240	59	43.3-51.7	1.36	+ .096
All wts.	434	42.4-52.7	1.47	+ .022
		Judge B		
181-200	110	43.8-52.7	.92	+ .304++
201-220	265	42.4-51.9	1.21	+ .216++
221-240	59	43.3-51.7	1.24	+ .340++
All wts.	434	42.4-52.7	1.14	+ .260++
		Judge C		
181-200	110	43.8-52.7	1.16	+ .288++
201-220	265	42.4-51.9	1.34	+ .132+
221-240	59	43.3-51.7	1.23	+ .350++
All wts.	434	42.4-52.7	1.28	+ .207++

* Percent

\+ Significant at the 5 percent level
++ Significant at the 1 percent level

Judge B, with correlation coefficients ranging from +.216 to +.340, for the weight groups from 181-200, to all weights, was the only judge to estimate primal cut yields with a regular degree of accuracy.

Figure 3a is a scatter diagram showing the relationship between the estimated primal cut yield by Judge A, and the actual (in percent of live weight) yield of primal cuts from each hog carcass.

The equation for establishing the regression line is, $\hat{Y}$=.0264 X +46.09, and the standard error for $\hat{Y}$ is 1.46 percent.

Figure 3b is a scatter diagram showing the relationship between the estimated primal cut yield by Judge B, and the actual (in percent of live weight) yield of primal cuts from each hog carcass.

The equation for establishing the regression line is, $\hat{Y}$=.4007 X +27.96, and the standard error for $\hat{Y}$ is 1.10 percent.

Figure 3c is a scatter diagram showing the relationship between the estimated primal cut yield by Judge C, and the actual (in percent of live weight) yield of primal cuts from each hog carcass.

The equation for establishing the regression line is, $\hat{Y}$=.2831 X +33.62, and the standard error for $\hat{Y}$ is 1.16 percent.

Figure 3a.
Relationship Between Estimated and Actual Primal Cut Yield

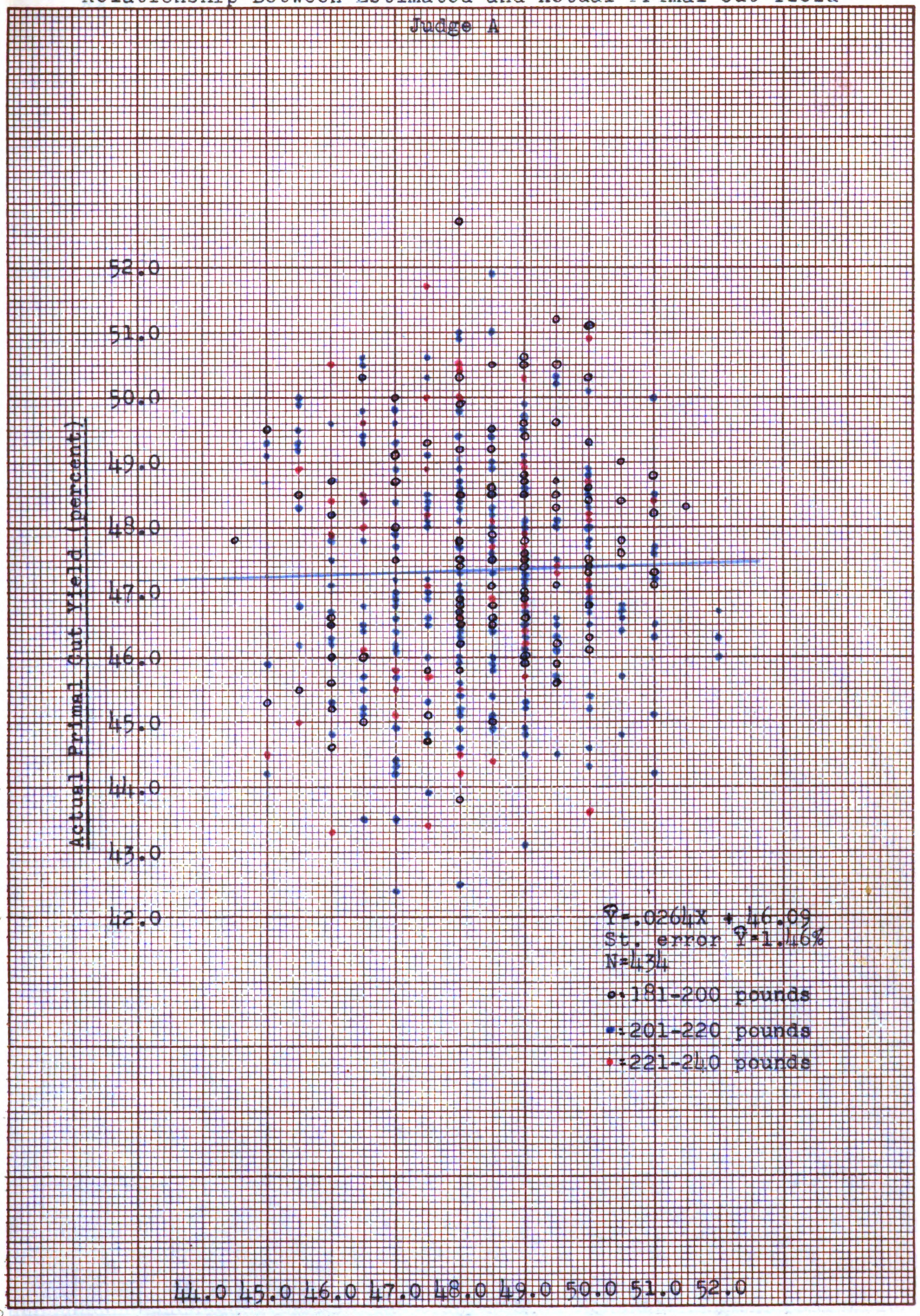


Figure 3b
Relationship Between Estimated and Actual Primal Cut Yield

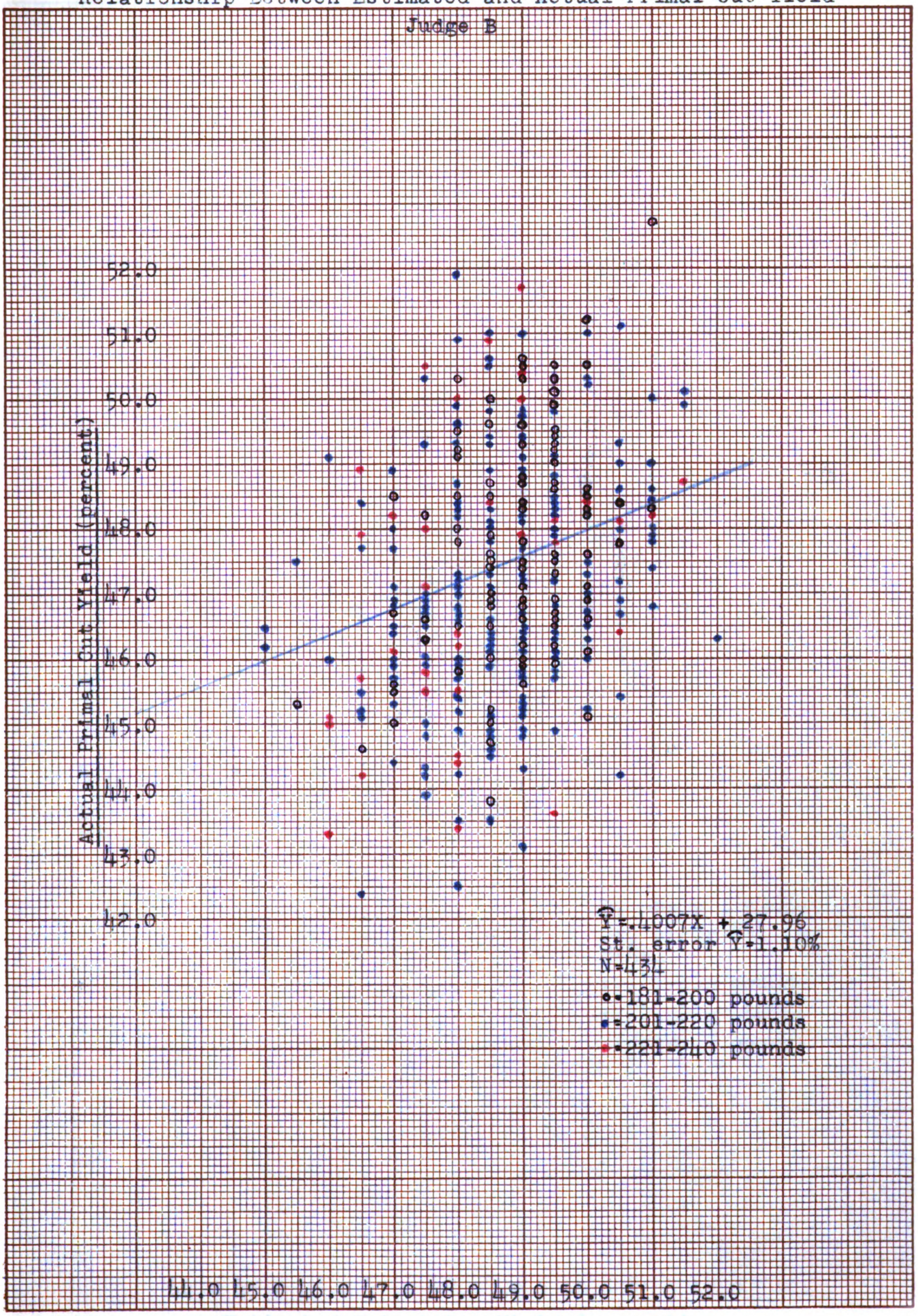


Figure 3c.
Relationship Between Estimated and Actual Primal Cut Yield

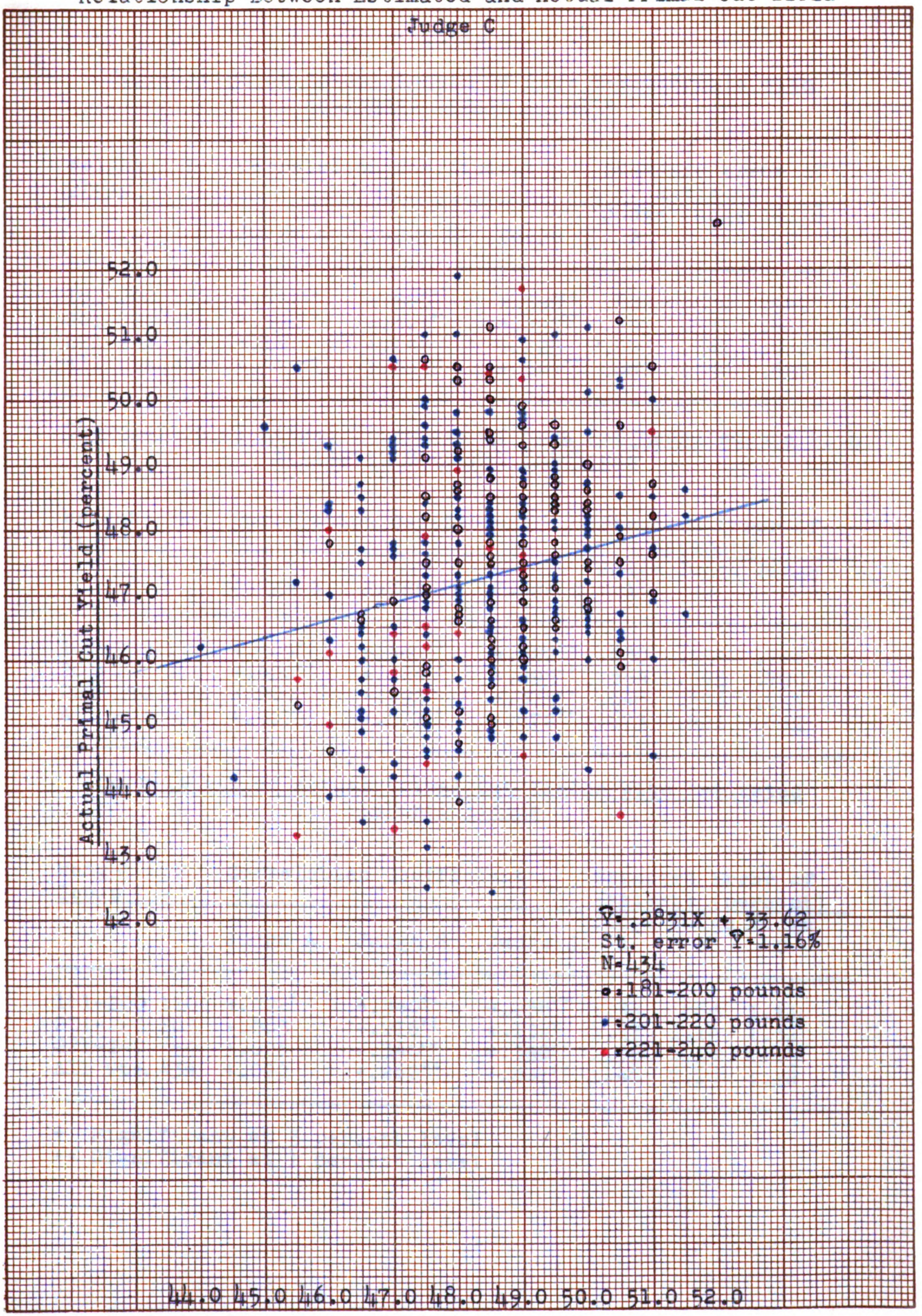


Table 9

Correlation of Actual Length of Side Measurements With Estimated Length of Side

Weight Group	N	Correlation Coefficient			Standard Error of Estimate		
		Judge A	Judge B	Judge C	Judge A	Judge B	Judge C
181-200	110	+.657++	+.566++	+.599++	.607	.539	.542
201-220	265	+.390++	+.423++	+.291++	.291	.587	.627
221-240	59	+.181	+.145	+.125	.613	.541	.886
All wts.	434	+.459++	+.463++	+.344++	.687	.559	.657

Correlation of Actual Thickness of Back Fat Measurements With Estimated Back Fat Thickness

Weight Group	N	Correlation Coefficient			Standard Error of Estimate		
		Judge A	Judge B	Judge C	Judge A	Judge B	Judge C
181-200	110	+.469++	+.482++	+.522++	.630	.554	.728
201-220	265	+.420++	+.424++	+.495++	.654	.593	.790
221-240	59	+.209	+.292+	+.375++	.648	.596	.655
All wts.	434	+.467++	+.577++	+.672++	.673	.621	.682

Correlation of Actual Primal Cut Yields With Estimated Carcass Yields

Weight Group	N	Correlation Coefficient			Standard Error of Estimate (percent)		
		Judge A	Judge B	Judge C	Judge A	Judge B	Judge C
181-200	110	+.222+	+.340++	+.288++	1.34	.865	1.11
201-220	265	-.083	+.216++	+.132+	1.57	1.18	1.32
221-240	59	+.096	+.340++	+.350++	1.35	1.17	1.15
All wts.	434	+.022	+.260++	+.207++	1.46	1.10	1.16

\+ Significant at 5 percent level
++ Significant at 1 percent level

Estimation of primal cut yields from the live hogs is the most difficult of the three estimates tested. Reasons for its being the most difficult are not without understanding. One of the prime factors which influences the primal cut yield of any hog is its dressing percentage. If the dressing percentage is low, then the estimate of primal cut yield will of necessity be scaled downward. If the estimate is not scaled to the dressing percentage expected, then the correlation coefficient will be greatly affected adversely. When hogs are marketed with large amounts of fill under the present system of marketing, few judges of livestock will usually take sufficient cognizance of the effect on the dressing percentage to a degree necessary for accurate appraisal of primal cut yield. The quality of a hog also affects its primal cut yield, though not to the degree that dressing percent does. Heavy and coarse bones, thick skin, lack of muscular development, heavy heads and feet are signs of the lack of quality in a hog---but are difficult to evaluate in terms of their effect on primal cut yield.

In order to consistently and accurately estimate the primal cut yield of a hog or groups of hogs, buyers must be able to see the expressions of the factors of fill, dressing percent, and quality, and interpret them in terms of the degree to which they depress the percentage of live weight in primal cuts.

The factors of type (1) and feeding practices (35)

must also be considered when appraising a hog for yield of the higher value lean cuts.

It is of interest to note, that even though one judge saw the carcasses between judging or scoring sessions, and the other two judges did not, the correlations between actual and estimated primal cut yield are no higher than shown. All three judges in this study had ample time to estimate the factors which could adversely affect the primal cut yields of each individual hog, and yet the correlation coefficients for the weight group that is most desirable, and yields the highest quality cuts (37) was the weight group in which the judges were the least accurate. For the weight group 201-220 pounds the correlation coefficients were +.083, +.216, and +.132 for Judges A, B, and C respectively.

Table 10

Summary of Measurement Data

Weight Groups	N	Range of Length (mm)	Mean Length (mm)	Range of Back Fat Thickness (mm)	Mean Back Fat Thickness (mm)	Range of Primal Cut Yield (%)	Mean Primal Cut Yield (%)
181-200	110	691-809	743.49	22-50	34.74	43.8-52.7	47.72
201-220	265	691-830	758.82	23-61	39.92	42.4-51.9	47.22
221-240	59	725-861	775.61	29-58	42.08	43.3-51.7	47.38
All wts	434	691-861	756.87	22-61	38.90	42.4-52.7	47.36

	Standard Deviation of Length	Standard Deviation of Back Fat Thickness	Standard Deviation of Primal Cut Yield
181-200	27.09	6.04	1.65
201-220	24.46	6.76	1.81
221-240	28.35	7.26	1.97
All wts	27.62	7.14	1.78

Conclusions

1. The three judges were most accurate in their estimates of back fat thickness. An aggregate picture of the correlation coefficients shows them to be higher in significance than for the other factors judged.
2. Primal cut yield from live hogs was the lowest of the estimates made by all three judges.
3. Judge B was on the whole, the best judge, followed by Judge C, and Judge A.
4. Estimate of length for all weights, and especially the heavyweight hogs was lower than expected for a measure so unaffected by other factors.
5. Primal cut yields could not be estimated by the judges with sufficient accuracy for economical value in the commercial field---or to a point likely to prove beneficial to the consumer.

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A P P E N D I X

Length of Side

N - 434		Actual X*	Estimate of Judge** A	B	C
Sum		33,365	1,306	1,379	1,278
Sum of Squares		2,896,383	4,190	4,563	3,964
Products	XA	104,664			
	XB		109,596		
	XC			101,054	
r	XA	+.459			
	XB		+.463		
	XC			+.344	

* Coded by X - 680
** In Score Units

Back Fat Thickness

N - 434		Actual X	Estimate of A	B	Judge* C
Sum		16,885	1,385	1,393	1,393
Sum of Squares		678,889	4,664	4,721	4,841
Products	XA	54,969			
	XB		55,546		
	XC				56,111
r	XA	+.467			
	XB		+.577		
	XC				+.672

* In Score Units

Primal Cut Yield

N - 434		Actual X*	Estimate of A	B	Judge** C
Sum		2,764.50	1857.00	2070.50	1967.00
Sum of Squares		18,934.67	8856.00	10440.75	9626.25
Products	XA	11852.75			
	XB		13418.90		
	XC			12730.80	
r	XA	-.022			
	XB		+.260		
	XC			+.207	

* Coded by X - 41
** Coded by X - 44