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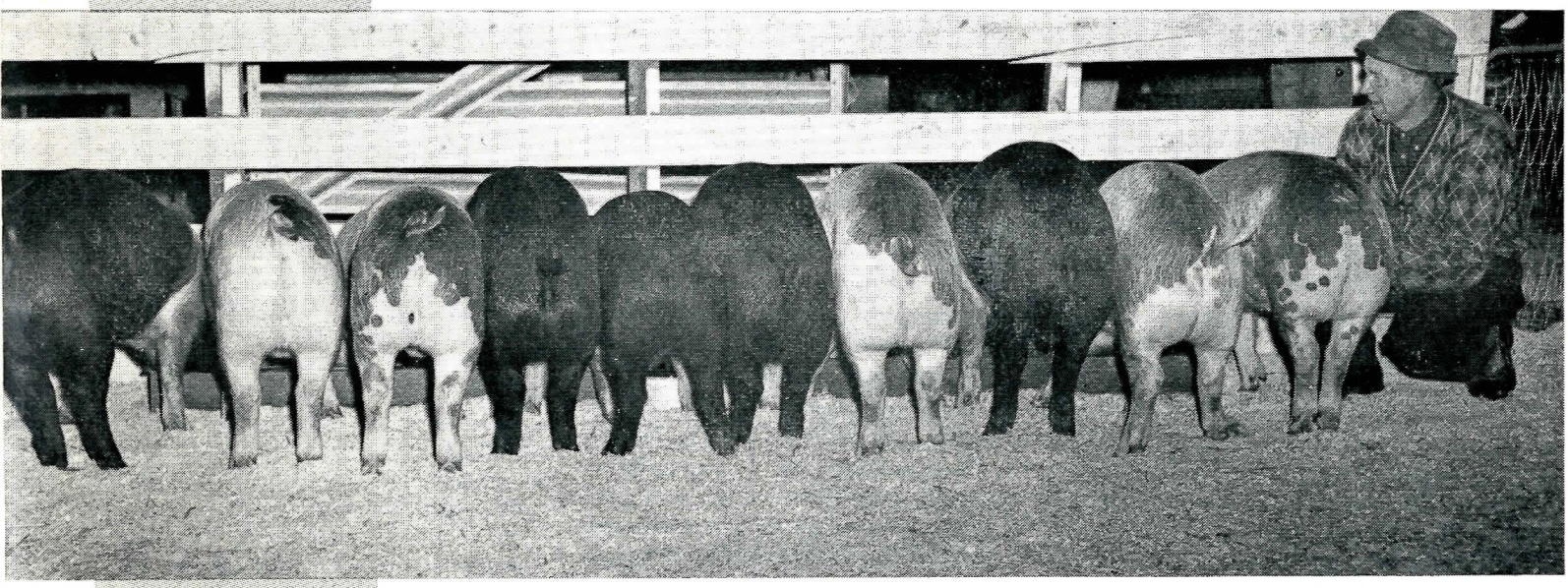
SELECTION and CROSSBREEDING *for the Pork Producer*



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Selection and Crossbreeding for the Pork Producer

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(Swine)

What Crossbreeding Can Do

★ Increase size of litter at farrowing (crossbred sows farrow larger litters)
★ Increase litter size at weaning (livability)
★ Increase growth rate

What Selection of Superior Performing Parents Can Do

★ Increase growth rate and efficiency of gain
★ Increase meatiness

What Selection and Crossbreeding Cannot Do

★ Overcome poor management
★ Replace sound nutrition and feeding
★ Replace good sanitation and disease control

Introduction

The goal of the commercial producer is to produce quality lean pork economically (Fig. 1). By selection of superior breeding stock and by crossbreeding, profits can be increased. This circular discusses procedures necessary for the producer to receive full benefits from his breeding program.

Three general areas of decisions will determine the effect of breeding in your herd. These are:

1. Breeding program (crossbreeding).
2. Boar selection.
3. Gilt selection.

Only by making accurate decisions in each area will the full benefit of your breeding program be obtained. *A half-program is no better than none at all.*

Crossbreeding

Crossbreeding is rather *commonplace* on most Nebraska hog farms. Ninety percent or more of the pigs marketed today are crossbred in one form or another. However, even with the large amount of crossbreeding being done, only a small percentage of producers are realizing the full benefits.

Crossbreeding is the mating of genetically different lines or breeds. The resulting increase in performance is called *hybrid vigor* or *heterosis*. It is measured as the percent superiority of crossbred offspring over the *average* of their parents.

Crossbreeding has several advantages over purebreeding, particularly for traits with low heritability estimates (Table 1):

1. *In the individual pig,* hybrid vigor increases growth rate and survival.

2. *In the crossbred sow,* hybrid vigor increases fertility, conception rate, litter size and survival of pigs.

However, crossbreeding will not materially increase:

1. *Feed Efficiency:* Feed efficiency is 35% heritable and can be improved by selecting boars with superior records of feed conversion.

2. *Meatiness of Pigs:* Carcass traits are highly heritable and can be improved by selecting parents with superior meatiness.

Caution: Crossbreeding swine in itself will not make your operation successful. Remember, all phases of hog production are necessary for success. Many producers fail with their crossbreeding program because of one of the following factors:

[1] The author wishes to acknowledge the help of the Cooperative Extension Services of Iowa State University and the University of Minnesota for the illustrations used in this circular. The cover picture showing the Crossbred Grand Champion load at the 1965 International at Chicago is courtesy of Roy B. Keppy, Davenport, Iowa.

1. No system of crossbreeding.
2. Select inferior breeding stock.
3. Poor choice of breeds.

Systems of Crossbreeding

To realize the full benefits from a crossing program, you must follow a well planned system of breeding. You may use one of several crossbreeding programs. These programs vary in the number of breeds used, or in the rotation of breeds involved. Success with crossbreeding depends on the superiority of the parent stock regardless of breed.

Several systematic crossing programs can be used successfully. These include a single cross between two breeds, continuous two-breed cross and rotational cross of three or more breeds. Generally, a three-breed cross is recommended over other crosses if superior boars of three breeds are available.

Single Cross Between Two Breeds

A single cross is made by crossing two breeds. For example, Duroc sows mated to Hampshire boars or Yorkshire sows mated to Poland China boars. When replacement females are needed, purebreds are either produced by the sows in the herd or are purchased from another breeder.

Pigs produced from the single cross exhibit hybrid vigor, but this system does not take advantage of hybrid vigor on sow productivity from crossbred sows. You may partially overcome this by selecting sows for good mothering and milking ability.

This system is not generally recommended for the commercial producer because it requires the purchasing of purebred gilts. In the long run, if you select female replacements from your own herd, genetic improvement will be made with less risk of introducing disease problems.

Two-Breed Cross

The two-breed cross uses purebred boars of two different breeds in alternate generations (Fig. 2). Crossbred gilts are selected each

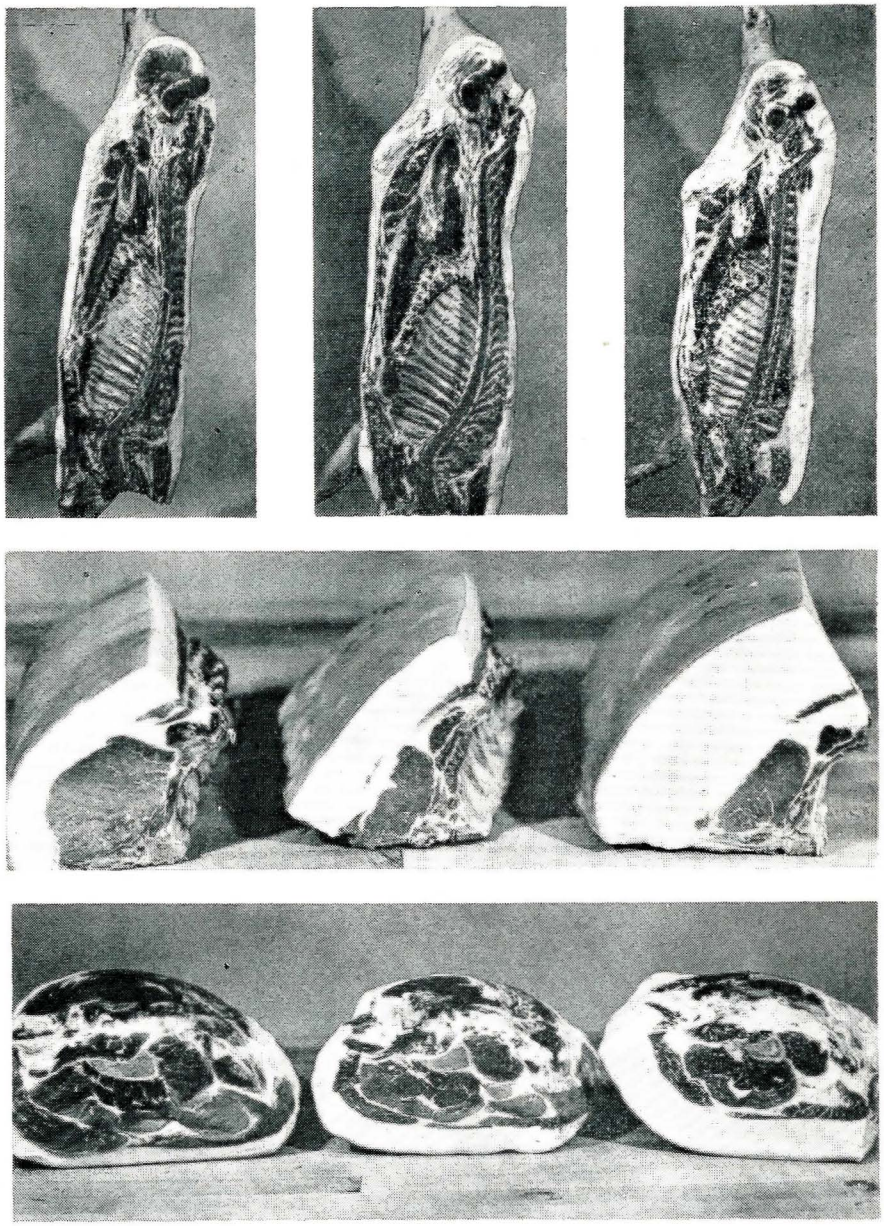

Figure 1. Three types of pork carcasses from 200-pound hogs shown with the cross-section of untrimmed loins and hams. From left: Meat Type— 60.4 pounds ham and loin, loin eye area 6.28 square inches, fat trim 13 pounds. Meat-Less Type—50.6 pounds ham and loin, loin eye area 2.23 square inches, fat trim 13 pounds. Fat Type—49.8 pounds ham and loin, loin eye area 3.44 square inches, fat trim 22 pounds.

Table 1. Heritability Estimates.

Level of heritability	Trait	Average percent
High	Carcass Length	65
	Percent Ham (based on carcass weight)	60
	Backfat Thickness	50
	Loin Eye Size	50
Medium	Percent Lean Cuts (based on carcass weight)	35
	Feed Efficiency	35
	Growth Rate (weaning to market)	30
Low	Weaning Weight	15
	Number farrowed	10
	Number weaned	10
	Birth weight	5

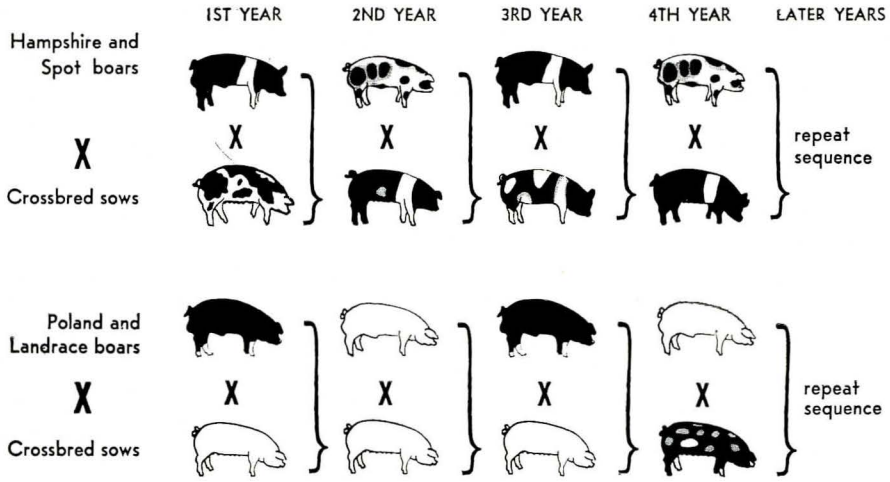

Figure 2. Examples of how purebred boars are used on crossbred sows in two-breed rotation.

generation or year and mated to one of the parent breeds. The boar should be selected from the breed having least relationship to crossbred females.

Under this system, both sows and gilts are crossbred after first crossing, and will yield more hybrid vigor in sow production traits than the single cross. Hybrid vigor should result in increased litter size, livability and growth rate.

Three-Breed Cross

The three-breed cross is the most widely used and recommended system for crossing. This system has the advantage over two-breeds in slightly increased vigor for certain performance traits (Table 2). However, it is easier sometimes to find top performing boars of two breeds than three.

This system uses three different breeds of boars in rotation on crossbred gilts and sows produced in the program (Fig. 3). It is a continuous rotation of boars from three breeds. Gilts and sows each generation are mated to boars of the breed that is least represented in the females. A three-breed cross using superior performing boars on performance selected females is the generally recommended program for most pork producers.

A three-breed cross may be expanded to four or more breeds; however, no added hybrid vigor should be expected over a three-breed cross. The primary disadvantage of more than three breeds is the difficulty in finding superior performing boars in four or more breeds.

Specific Three-Breed Cross

Some commercial companies offer a crossbred female, usually a cross of two breeds, and a boar of a third breed for sale. This program allows you to obtain hybrid vigor in the sow and pig in the first cross. The system permits the breeder to select replacement animals on the basis of their specific crossing ability. The producer may wish to continue his crossing program by selecting replacement gilts from his stock or by returning to the company for a new group of gilts and boars after the original sows fail to maintain high reproductive efficiency.

Contrary to the general opinion, crossbreeding programs do not lose their hybrid vigor. If superior parents are selected and a systematic crossbreed program followed, the program can run continuously.

Breed Selection

Selection of breeds to be used in the crossing program is important. Breeds should be selected to complement each other in addition to using breeds available locally.

Normally, when starting a program, females should be selected from a rapid, efficient gaining breed with superior carcass merit. When available, superior crossbred females may be used and mated with a boar of a different breed. This procedure allows you to obtain the hybrid vigor in the pig and from the sow in the first generation.

To help you select breeds, the breeds have been divided into three groups based on their performance. The basis for the division is available performance data.

1. Breeds rated high on mothering and milking ability; Yorkshire, Landrace, Chester White.
2. Breeds rated high on carcass traits; Hampshire, Poland.
3. Breeds rated high on growthiness; Duroc, Spotted Swine.

In selecting breeds for a three-breed cross, one breed should be selected from each group if superior performing boars of those breeds are available. When two breeds are used, you have the choice of selecting a breed from two of the three groups. It would not be generally recommended to select all breeds from one group.

How About Hybrid Boars

Several commercial companies offer "hybrid" breeding stock for sale. Most of these companies have specific breeding plans to follow. If you plan to use hybrid breeding stock, follow the specific recommendations of the company. *Don't*

Table 2. Performance Traits.

Trait	Percent increase over purebred		
	Two-breed cross between purebreds	Three-breed cross	Four-breed cross
Litter Size	0	12	12
Number Weaned	19	20	20
Weaning Weight			
Pig	7	10	11
Litter	28	40	41
Post Weaning			
154 day weight	14	14	14
Feed Efficiency	negligible	negligible	negligible
Meatiness	0	0	0

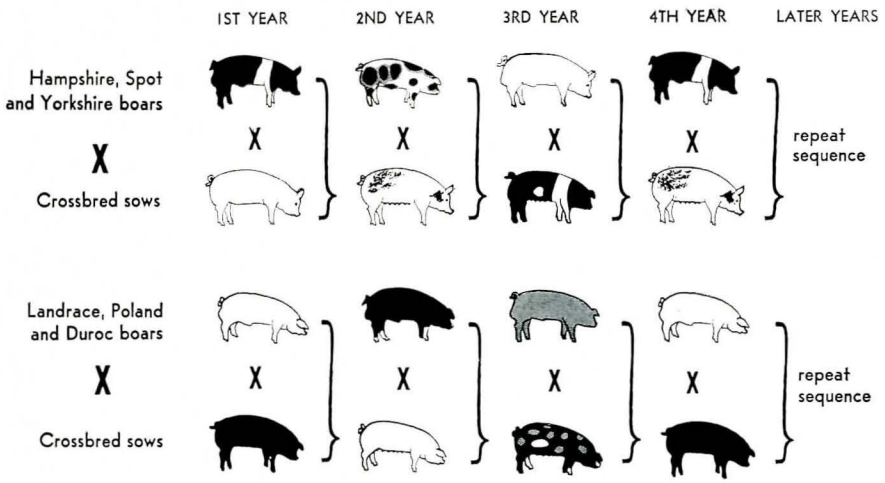

Figure 3. Examples of how purebred boars are used on crossbred sows in three-breed rotation.

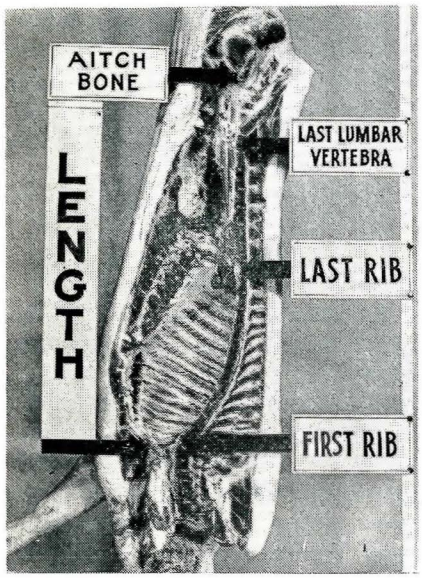

Figure 4. Carcass length and backfat thickness measurements. Length is measured from the lower point of the aitch bone to the forward edge of the first rib. Backfat is measured opposite the first rib, last rib, and last lumbar vertebra. The average of the three backfat measurements is used.

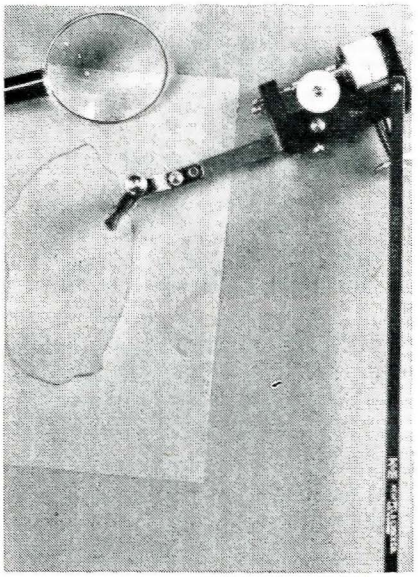

Figure 5. A plainimeter is used to measure loin eye area between the 10th and 11th ribs after the carcass has chilled correctly for 24 hours. The loin is cut at an exact right angle and the short end of the loin is set on a table with the newly exposed loin eye at the top. A piece of acetate paper is then placed over the exposed loin eye and the main muscle is traced.

jump back and forth from hybrid to purebred boars and expect to get good results. Keeping records on performance and carcass leanness and quality will be your best guide for determining the value of your program.

Selection of Breeding Stock

The key to selection of superior breeding stock is your record of performance and carcass leanness. These records enable you to make more accurate decisions on the selection and purchase of breeding stock. Records should measure those traits which are of economic value to the pork industry—sow productivity, rate of gain, feed efficiency and meatiness. Carcass length, backfat thickness, percent ham and loin, and loin eye area are four of the criteria used to determine carcass value (Figs. 4, 5, 6, 7).

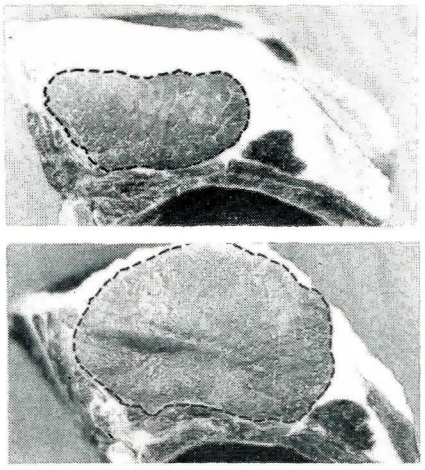

Figure 6. Top picture: an approximate 2.90 square inch loin eye area, actual size. Bottom picture: an approximately 6.50 square inch loin eye area, actual size. Notice the soft, watery appearance.

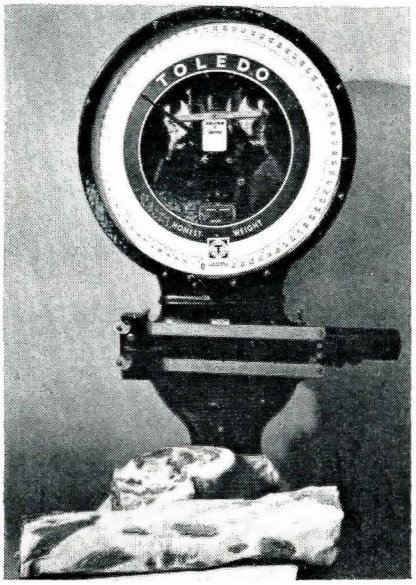

Figure 7. Weighing ham and loin. Ham and loin as a percent of the chilled carcass will vary from 28 percent in extreme fat type to 44 percent in the very outstanding meat type.

Purchasing Boars

Many programs are available to the purebred breeder to aid him in obtaining information. Breed certification, on the farm testing, test stations and ultrasonic measurements are now used by many breeders. These programs provide information for you to determine which boar you should select (Table 3).

Records identify the genetic potential of the boar. It gives you a good idea of what he can or cannot do for you. Buying and selecting your boar each year is probably the

Table 3. Suggested Minimum Standards for Selection of Boars.

Litter Size	7 raised
Growth Rate	200 to 225 pounds at 5 months
Feed Efficiency	Less than 300 lbs. of feed per cwt. gain
Probed backfat at 200 lbs.	1.0 inches or less
Nipples	12 or more—none inverted or abnormal
Feet and legs	sound with good bone
Carcass cut-out of relatives	
a. Ham and loin (percent of carcass wt.)	40% or more
b. Backfat	1.4 inches or less
c. Length	29.0 or more inches
d. Loin Eye area	4.0 square inches or more
Ultrasonic Reading of Loin Eye area on individual boar	4.75 or more square inches between 190 and 230 pounds

Table 4. Suggested Standards for Selecting Replacement Gilts.

Litter Size	7 raised
Growth Rate	175 lbs. and above at 5 months
Feed Efficiency	Less than 325 pounds
Probed backfat at 200 lbs.	1.4 inches or less; preferably under 1.2 inches
Nipples	12 or more evenly spaced, functioned nipples
Feet and Legs	Sound with good bone
Carcass cut-out on relatives	Same as boar
Ultrasonic reading of loin eye area on gilt	4.50 sq. inch or above (190–230 pounds)

most important decision you make regarding your swine operation. Don't be afraid to pay the necessary money to buy superior boars; it may be one of the best investments you make.

Selecting Gilts

Making the correct decision on gilt replacement is one of your necessary jobs to receive full benefit from your breeding program. You must select the fast gaining meaty gilts and cull the slow gaining fatter gilts. The following program is suggested. For more information, contact your county Extension office or write to Animal Science Extension, University of Nebraska, Lincoln, Nebraska.

At Farrowing Time

1. Identify pigs at birth by ear notches.
2. Record litter birth date.

At 175 to 225 Pounds

1. Make initial selection on gilts from herd on basis of size and soundness. Select at least 50% more than needed.
2. Weigh gilts accurately and correct to constant age (Fig. 8).
3. Probe gilts for backfat and correct to 200 lbs. (Fig. 9.) Your county agent will help you probe your hogs.
4. Select gilts with low backfat and high gain with visual evidence of meatiness (Table 4).

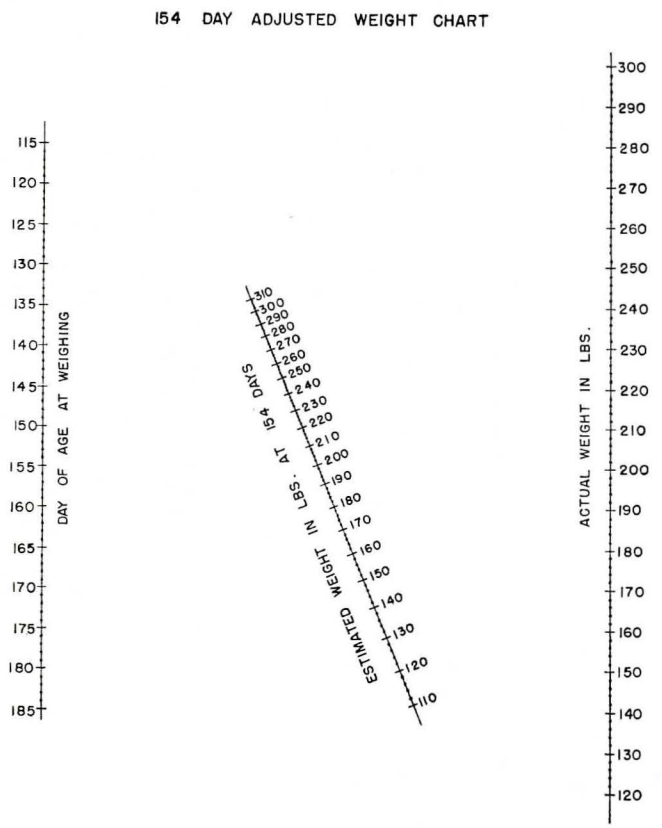

Figure 8. Chart for estimating weight at 154 days of age. Lay a ruler or straight edge from a point on the left scale which represents the age of pig when weighed, to a point on the right scale which represents actual weight of pig. The intersection of the line on the center scale shows the estimated weight in pounds at 154 days of age.

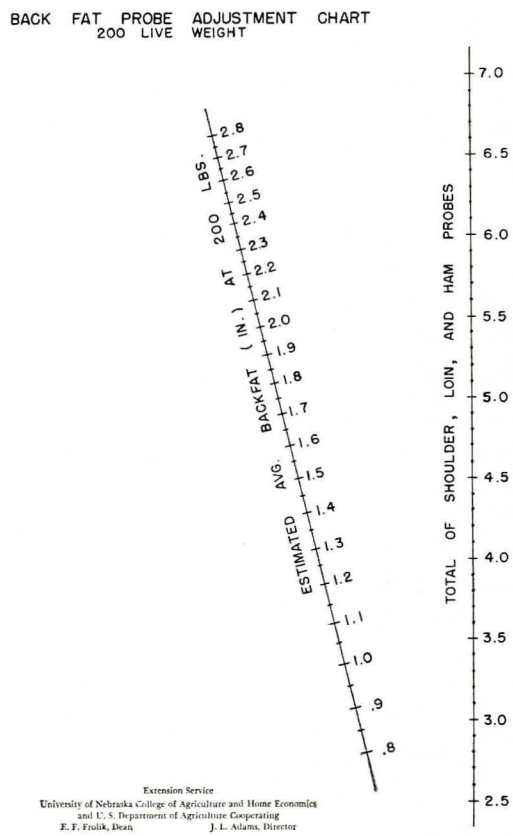

Figure 9. Backfat probe adjustment chart, 200 pounds live weight. Lay a ruler or straightedge from a point on the left scale which represents the weight of the pig when probed, to a point on the right scale which represents the total of the three probes. The intersection of this line and the center scale shows the estimated average backfat thickness at 200 pounds.