MECHANICAL MEASUREMENT OF FATNESS AND CARCASS VALUE ON LIVE HOGS

E. A. KLINE
IOWA STATE COLLEGE

Efforts to improve carcass value in hogs by genetic means have been handicapped for lack of a rapid and accurate method of measuring carcass value in prospective breeding animals. Visual estimates and linear body measurements are not sufficiently accurate (Phillips, et al., 1939, and Hetzer, et al., 1950). They also have an additional disadvantage in that the most accurate external criteria of high carcass value are narrow, shallow middles and long bodies and legs. Direct carcass measurements which require slaughter of the individual can provide information for selection between sires or families, but these are likely to lengthen generation interval and are too laborious to apply upon a large scale.

The purpose here is to describe a simple and rapid "probing" method of measuring backfat thickness on live hogs. The method causes little discomfort to the pigs, and four measurements per pig can be taken in one minute. Correlations between the measurements of backfat on live hogs and carcass backfat measurements, percentage of primal cuts, and cross-sectional area of lean in the loin and in the ham are given to indicate the accuracy of the method as a criterion of carcass value.

METHODS AND DATA

Measurements were taken on 96 pigs fed in Record of Performance trials at the Iowa Agricultural Experiment Station in cooperation with the Regional Swine Breeding Laboratory, during the fall and winter of 1950-51. The pigs were single crosses and three-breed crosses of inbred lines of Poland, Landrace, Duroc, and Chester White. Four pigs of each litter were fed as a group in a small concrete pen from weaning to a weight of about 215 pounds. Forty-eight litters were self-fed a ration of shelled corn and protein supplement free choice. The first and third pigs of each litter to reach a weight of 215 pounds were slaughtered. The pigs were taken off feed but had access to water 24 hours prior to slaughter.

Live Animal Measurements

The pigs were restrained by looping one end of a small rope around the upper mandible and the other end around a post or other stationary object. Incisions about 1/4 inch deep and 1/2 inch long were made with a scalpel or lancet through the skin. A narrow metal ruler with a blunt end was pressed through the soft fat to the firm tissue underneath. Sufficient resistance is encountered when the ruler reaches the juncture of the fat and firm tissue to indicate that the ruler has passed through the fat. Pressure on the ruler is relaxed for an instant and the reading marked at skin level with the thumb nail or a sliding metal clip on the ruler.

There is practically no danger of penetrating the well-defined muscles of the body which are covered with a definite layer of connective tissue, such as the longissimus dorsi or muscles of the shoulder or ham, particularly if the incisions in the skin are made transversely to the underlying muscle fibers. Penetration may occur between the longissimus dorsi and the scapula if incisions are made directly over the shoulder.
In preliminary trials, an injection of local anesthetic at the site of the proposed incision caused greater discomfort to the pigs than an incision made without anesthesia. Shaving the hair at the site of the incision and applying antiseptic proved to be unnecessary in preventing infection; no noticeable ill effects have occurred among the many animals retained under observation after they were measured. Hence the technique in use at the time the present data were collected was a relatively simple one involving four steps; (1) Restraining the pig; (2) making incisions at the chosen sites; (3) measuring the fat from the skin to the underlying firm tissue, and (4) recording the measurements.

The actual sites of the measurements in this study were chosen more or less arbitrarily after some preliminary experimentation. Three of the sites were about 1/2 inches after the midline of the body above the longissimus dorsi. The first of these was immediately behind the shoulder; the second was the middle of the back, while the third was the middle of the loin. The fourth site was the middle of the loin over the exact midline of the body.

**Carcass Measurements**

The carcasses were split immediately after slaughter and were chilled for 72 hours at a temperature of approximately 34°F. Thickness of backfat was measured to the nearest one-tenth inch at the first, seventh and last thoracic vertebrae, and at the last lumbar vertebra. The right half of each carcass was cut as described by Hankins and Hiner (1937). Maximum length and maximum width of the longissimus dorsi were measured from the trimmed loin cut at the last thoracic vertebra. Maximum length and maximum width of the lean area of the face of the untrimmed ham were measured. About 1/4 inch of fat was left on both loin and ham after trimming. The belly was trimmed above the teat line and squared at the shoulder and flank ends. The shoulder was removed at the third thoracic vertebra and divided into the picnic ham and Boston butt. Weights were taken on all cuts to the nearest one-tenth pound.

**TABLE 1. MEANS AND STANDARD DEVIATIONS OF VARIABLES**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Average</th>
<th>Standard deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age at slaughter (days)</td>
<td>151.7</td>
<td>10.3</td>
</tr>
<tr>
<td>Shrunken live weight at slaughter (pounds)</td>
<td>211.3</td>
<td>5.3</td>
</tr>
<tr>
<td>Average of 4 carcass backfat measurements</td>
<td>1.61</td>
<td>0.14</td>
</tr>
<tr>
<td>Individual live hog backfat measurements</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Behind shoulder (inches)</td>
<td>1.73</td>
<td>0.23</td>
</tr>
<tr>
<td>Middle of back (inches)</td>
<td>1.59</td>
<td>0.19</td>
</tr>
<tr>
<td>Middle of loin over longissimus dorsi</td>
<td>1.26</td>
<td>0.18</td>
</tr>
<tr>
<td>Middle of loin over vertebra (inches)</td>
<td>1.37</td>
<td>0.17</td>
</tr>
<tr>
<td>Average of 4 live hog backfat measurements</td>
<td>1.43</td>
<td>0.17</td>
</tr>
<tr>
<td>Lean loin area (square inches)</td>
<td>6.34</td>
<td>0.89</td>
</tr>
<tr>
<td>Lean ham area (square inches)</td>
<td>19.02</td>
<td>1.39</td>
</tr>
<tr>
<td>Primal cuts (percent of shrunken live weight)</td>
<td>47.77</td>
<td>1.66</td>
</tr>
</tbody>
</table>
The particular carcass measurements studied were as follows: (A) average of the four backfat measurements; (B) loin area as measured by the product of maximum length and maximum width; (C) lean ham area as measured by the product of maximum width and maximum length, and (D) percentage primal cuts as measured by the combined weights of five cuts, loin, ham, bacon, picnic shoulder and Boston butt, divided by the shrunk live weight taken immediately before slaughter.

RESULTS AND DISCUSSION

The pigs grew rapidly, reaching slaughter weight at slightly less than five months of age (table 1). The average depth of backfat on the carcasses was 1.61 inches at the four sites measured. Although this is near the accepted optimum for fatness, there was considerable variation between individuals, particularly with reference to breed-group differences. The computations were made on an intrabreed-group basis to eliminate breed differences in fatness and conformation. The primary effect of this was to decrease slightly the correlations between any two measures of fatness and to increase slightly those between measures of fatness and leanness. Seventeen of the 96 pigs were gilts, most of which were in two of the breed-groups. Hence the intrabreed-group analysis eliminated most of the sex difference.

Depth of fat was greater at the carcass locations than at the live-hog locations most nearly corresponding to them. The average of the four carcass measurements was 1.61 inches while the average of the four live-hog locations was 1.43 inches (table 1). The carcass measurements were made from

| TABLE 2. CORRELATIONS BETWEEN BACKFAT THICKNESS AND LOIN AREA, HAM AREA AND PRIMAL CUTS |
|-----------------------------------------------|---------------------------------|---------------------------------|
| Variable                                      | Lean loin area                  | Lean ham area                   | Percentage primal cuts         |
| Average of 4 carcass backfat measurements     | -.414                           | -.427                           | -.450                          |
| Average of 4 live hog backfat measurements    | -.442                           | -.538                           | -.499                          |
| Individual live hog backfat measurements      |                                 |                                 |                                |
| Behind shoulder                               | -.483                           | -.468                           | -.468                          |
| Middle of back                                | -.321                           | -.455                           | -.391                          |
| Middle of loin over longissimus dorsi         | -.412                           | -.560                           | -.446                          |
| Middle of loin over vertebra                  | -.332                           | -.462                           | -.449                          |

the skin to the top of the vertebra while three of the live-hog measurements were made from the skin to the top of the longissimus dorsi.

The correlations between the average backfat thickness on the carcass and the individual live-hog measurements at the four sites were as follows: Behind shoulder, .79; middle of back, .59; middle of loin over longissimus dorsi, .67; middle of loin over vertebra, .73; and average of the four live-hog measurements, .81. The location behind the shoulder was the most accurate single indicator of carcass fatness. That correlation is significantly greater than those involving the middle of the back and the middle of the loin over the longissimus dorsi. Because the average of the four carcass measurements is common to all of the correlations, the value 

\[
(\frac{r_{1} - r_{2}}{n-3})/2(1-r_{1})(1-r_{2})
\]

which is distributed approximately as t, was used as suggested by Hotelling (1940) in making the tests of significance.
All of the correlations involving backfat measurements and the measures of carcass value are negative (table 2). Surprisingly, the average of the live-hog measurements appears to be a more accurate indicator of leanness and carcass value than does the average of the carcass backfat measurements. The difference between the two correlations involving lean ham area (-.427 and -.538 in table 2) is statistically significant and the smaller differences between the correlations involving lean loin area and percentage primal cuts point in the same direction. The only logical reason for this seems to be that three of the live-hog measurements are made from the skin to the muscle instead of from the skin to the vertebra.

The middle of the back is definitely the poorer location for measuring backfat on live hogs. Correlations involving that location are lowest for the three measures of carcass value as well as for carcass backfat. The locations behind the shoulder and at the middle of the loin over the longissimus dorsi are most accurate if the measurements are to be used as indicators of carcass leanness. The former is significantly more accurate as a measure of lean loin area while the latter is significantly more accurate as a measure of lean ham area. This seems to be logical, since the latter location is much closer to the ham.

Considerably greater accuracy in measuring carcass value is possible than is indicated by the foregoing correlations. Chemical methods, as illustrated by the solubility of antipyrine in body water (Kraybill et al., 1951), may have greater accuracy than the probing technique described herein. However, the latter has considerably greater usefulness in being more rapid and easier to apply as well as in the fact that the results are immediately available. The latter consideration is of considerable practical importance because the animals should be measured at approximately market weight so those not selected for breeding can be sent immediately to market. There is also considerable likelihood that greater accuracy can be attained by refining and extending the probing technique. For example, there seems to be no reason why the fat covering of the shoulder and ham cannot be measured as easily as that over the back.

As far as the results of this study go, the preferred locations are over the longissimus dorsi about 1½ inches off the midline of the body just behind the shoulder and at the middle of the loin. Since little additional labor is required in making additional measurements, both sides of the body could be sampled at these locations. In this event, each location should be chosen as independently as possible of the others.

SUMMARY

A probing technique for measuring fat covering on live hogs is described. The method is very quick and easy to apply and causes little discomfort to the pigs. The correlation between the average of four backfat measurements taken on carcasses and on live hogs was .81. Measurements made on 96 live hogs were slightly more accurate as indicators of leanness and percentage primal cuts than were carcass measurements of backfat thickness. The most accurate locations were just behind the shoulder and at the middle of the loin about 1½ inches off the midline of the body.
LITERATURE CITED


MR. PEARSON: Are the locations quite exact or do you have quite a degree of latitude?

MR. KLINE: We have tested repeatability between individuals and within the same individual, taking these live animals, measuring on one side and on the other side, and we have found that they are quite repeatable and quite accurate. We come just behind the shoulder and go right over the small of the loin about an inch and a half to one side, so that we don't get right down over the back.

MR. HANKINS: Have you probed and held the animals for some time and then slaughtered some of them, or are the ones that you have held now in the breeding herd?

MR. KLINE: We have held them and put them back into the breeding herd. These animals may be probed two or three days before they come into the laboratory. We generally probe them 24 hours before they come in. We can see just a faint red line through the fat where the probe has made a mark. We haven't had any trouble yet.

MR. HANKINS: At Beltsville we have used this technique on quite a number of pigs -- several measurements spaced over a period of time on individual pigs, and on ultimate slaughter we have run into a lot of abscesses.

MR. BRATZLER: How long does it take the abscess to develop?

MR. HANKINS: I cannot answer that question because these pigs where we found abscesses have continued on feed, for several months perhaps.

MR. KLINE: Just small localized abscesses?

MR. HANKINS: Yes.
MR. HILLIER: Mr. Whatley isn't here, but he probes all of the females he is putting back in our swine breeding herd, actually all the animals he is considering for this purpose. He has done that for two seasons. As far as I know he has not had an abscess to date. He examined a good many of them before they went to the laboratory. Some of them were not slaughtered for a few days and there were no abscesses.

Do you have the ruler at right angles to the back or is it parallel with the back?

MR. KLINE: It is at right angles to the back as you go through the skin.

MR. HILLIER: In other words, it comes across the muscle instead of parallel with the muscle.

MR. KLINE: Yes.

MR. HILLIER: I think that this is the important factor. If you go down parallel to the muscle fibers you stand some chance of separating them.

MR. PIERCE: What correlation did you get on your back fat thickness with your probe?

MR. KLINE: It is above .8. It seems to me it is .8 or .82.

MR. PIERCE: The reason I ask is because Pat and I probed 66 last fall in our breeding program and we came up with a terrifically high correlation, something above .95.

MR. BLUMER: If you were comparing the back fat probe with the back fat measurement, that correlation will be higher.

MR. WILDER: We compared the probes with the back fat measurements, for instance, the shoulder probe with the seventh rib and the loin probe with the last rib. Then we did some repeatabilities on Pierce's and my work, and that is the reason we were so high. We were very high, higher than some others. We usually probed in the morning and slaughtered in the afternoon. Some hogs probed as a demonstration were slaughtered three weeks later. We had no abscesses whatsoever.

MR. BRATZLER: Have the animal breeding men used these probes as a reason for discarding or continuing animals in their herds?

MR. HILLIER: For the last two seasons, at Oklahoma, it has been incorporated in the index or the bases for keeping or discarding them.

MR. BRATZLER: At what weight do they probe?

MR. HILLIER: They are all probed between 210 and 215 pounds. If you let them go over 10 pounds more or less the probe does not mean so much.
MR. BRATZLER: The little marks we saw yesterday should be cross-wise shouldn't they?

MR. HILLIER: Yes. It is a fine way to teach the boys in swine judging which ones have the thick back fats. I use that indentification a good deal. We had one old hog last year with a broad back and they were a little surprised when they measured it.

MR. WILDER: We started some dam and daughter correlations in our breeding work and we are starting to probe all the gilts this year. We wanted to check last year on our technique and this year we have started to probe every gilt we have.

###