August 2017

Corn of different degrees of hardness for pigs

C. C. Culbertson
Iowa State College

Arthur L. Anderson
Iowa State College

Joe L. Robinson
Iowa State College

W. E. Hammond
Iowa State College

Follow this and additional works at: http://lib.dr.iastate.edu/bulletin

Part of the Agriculture Commons, and the Animal Sciences Commons

Recommended Citation
Available at: http://lib.dr.iastate.edu/bulletin/vol33/iss375/1

This Article is brought to you for free and open access by the Extension and Experiment Station Publications at Iowa State University Digital Repository. It has been accepted for inclusion in Bulletin by an authorized editor of Iowa State University Digital Repository. For more information, please contact digirep@iastate.edu.
CORN OF DIFFERENT DEGREES OF HARDNESS FOR PIGS

C. C. CULBERTSON — ARTHUR L. ANDERSON
JOE L ROBINSON — W. E. HAMMOND

AGRICULTURAL EXPERIMENT STATION
IOWA STATE COLLEGE OF AGRICULTURE AND MECHANIC ARTS
R. E. BUCHANAN, Director

ANIMAL PRODUCTION SUBSECTION, ANIMAL HUSBANDRY SECTION
AMES, IOWA
## CONTENTS

Summary ................................................................. 253
Review of other work .................................................. 255
First experiment .......................................................... 256
   Animals used and duration of experiment ..................... 256
   Housing and range .................................................. 257
   Rations fed and method of feeding .............................. 257
   Feeds used ............................................................ 257
      Corn ............................................................... 257
      Crushing resistance .......................................... 257
      Water gained on soaking .................................... 258
      Chemical composition of corn ............................... 259
      Other feeds used ............................................... 259
   First experiment results .......................................... 260
Second experiment ...................................................... 261
   Animals used and duration of experiment ..................... 261
   Housing and range ................................................ 261
   Rations fed and method of feeding .............................. 261
   Feeds used ........................................................ 262
      Corn ............................................................ 262
      Crushing resistance .......................................... 262
      Water gained on soaking .................................... 264
      Chemical composition and moisture content ............... 265
      Other feeds used ............................................... 265
   Second experiment results ....................................... 265
Third experiment ...................................................... 266
   Animals used and duration of experiment ..................... 266
   Housing and range ................................................ 267
   Rations fed and method of feeding .............................. 267
   Feeds used ........................................................ 267
      Corn ............................................................ 267
      Crushing resistance .......................................... 267
      Water gained on soaking .................................... 268
      Chemical composition and moisture content ............... 269
      Other feeds used ............................................... 270
   Third experiment results ....................................... 270
SUMMARY

1. There were significant differences in the hardness of the varieties of the dent corns fed in these experiments.

Hardness of the corn was determined by a machine designed to find out the crushing resistance of the kernels. In the second and third trials, when three tests were made to determine actual crushing resistance, the means ranged from 24.16 pounds on the Special Reid Yellow Dent or soft corn to 41.46 pounds on the Krug. Average for these two trials showed that it required 27.8 pounds to crush the soft type, 30.3 pounds for the medium, Reid Yellow Dent, and 37.1 pounds to crush the hard type, Krug. The hard type corn was 25 percent harder than the soft type corn and 18 percent harder than the medium.

2. All three types of corn fed in the first and third trials were of approximately the same chemical composition. Unfortunately, the samples saved for analysis in the second trial were destroyed; these corns, however, were grown in the same field as those fed in the third trial. There is, therefore, no reason to believe that the composition of these corns would have varied materially from those fed in the third trial.

3. Hardness of the corn fed to the growing and fattening pigs had no appreciable effect upon the amount of grain consumed daily per pig. The palatability of any of the three types of corn, when fed as shelled corn, was apparently about the same.

4. Rapidity of the gains made by the pigs fed in these three trials was not affected by the type of corn. Apparently the harder type of corn was masticated and digested as well as the softer type of corn.
5. Hardness of the corns fed in these experiments did not have any significant effect on the feed requirements per unit of gain made by the pigs.

6. The three dent corns were of equal value for the growing and fattening of pigs fed in these experiments. Whether younger and lighter pigs would have made as good a showing on the harder type of corn it is not known. It seems, however, that growing and fattening pigs weighing 75 pounds or more can make as efficient use of one as another kind of corn within the range of hardness of the three types of corn fed.
Corn of Different Degrees of Hardness for Pigs

By C. C. Culbertson, Arthur L. Anderson, Joe L. Robinson and W. E. Hammond

Is there a relationship between hardness and nutritive value of dent corns? Can growing and fattening pigs efficiently use the harder types of corn, fed without preparation? Are the dent corns of the medium and soft types consumed in larger amounts than the hard type when all are self-fed free-choice? These are questions that are often raised by swine feeders.

Several kinds or strains of corn which even at maturity have different properties of density or hardness are included under the type, dent corn. Some varieties are definitely harder than others; yet within the so-called varieties, the force required to crush the kernels varies. The bulk of the dent corn grown in Iowa would be classed as medium in hardness. Some varieties would be classed as soft, however, and others as hard; actual differences in the crushing resistance can be noted. Corn of flinty texture is high in crushing strength while corn of floury texture can be crushed with less force.

Three experiments were planned and carried out by the Animal Production Subsection of the Iowa Agricultural Experiment Station to determine the value of hard, medium and soft types of dent corn for growing and fattening pigs.

The trials reported deal with dent corn of various degrees of hardness for pigs of different initial weights. Most of the corn fed to pigs in Iowa is not prepared by grinding or crushing, hence the corns were fed as shelled corn. If hardness of the corn affects completeness of mastication, it will be a factor in efficiency of feed conversion.

REVIEW OF OTHER WORK

Comparative feeding trials with dent corn of different degrees of hardness have not been reported. Dent corns used in these feeding experiments have varied much in crushing

1Project 41 of the Iowa Agricultural Experiment Station.
2The writers acknowledge the valuable assistance of H. D. Hughes, professor of farm crops, in selecting and making available the soft and hard types of corn.
resistance, but little attention has been paid to this variable, and little attempt has been made to measure it in terms of productive value. The first trial herein reported was in the nature of a pilot experiment and as it showed no definite trend, the technique was refined, the method of measuring crushing strength of the corn improved and two further trials conducted. The second trial also failed to answer completely the question of nutritive values of dent corn because of the rather small supply of proper corn available for feeding and the resultant short feeding trial.

**FIRST EXPERIMENT**

During the crop year of 1929, 300 bushels of Special Reid Yellow Dent (soft) corn and 250 bushels of Krug (hard) corn were grown from seed recommended by the Farm Crops Subsection. The corn was sorted after harvesting as all of the Special Reid was not soft and likewise some ears of the Krug were not as hard in texture as others.

**ANIMALS USED AND DURATION OF EXPERIMENT**

Thirty fall pigs of an average weight of 75 pounds were divided into six lots of five pigs each in this experiment. The
experiment started Jan. 14, 1930, and continued until the pigs in each lot reached an average weight of 250 pounds.

**HOUSING AND RANGE**

Each group of pigs was confined to a dry lot 26x90 feet in size and all lots except VI (a duplicate check lot) were housed in a 10x12-foot movable house. Lot VI had a special insulated movable house 6x8 feet in size which provided ample space for the five pigs.

**RATIONS FED AND METHOD OF FEEDING**

The rations fed to the six lots of fall pigs were as follows:

- **Lot I.** (Check.) *“Elevator Run” Corn*—Shelled corn, yellow, regular “elevator run,” self-fed; “Big 10,” 42.7 percent protein, supplemental mixture (meat meal tankage, 40; linseed oilmeal, 15; alfalfa meal, 12.8; cottonseed meal, 20; peanut oilmeal, 9; salt, barrel, 1; limestone, 98 percent calcium carbonate, 1.5; iron oxide, commercial, 0.198; wood ashes, 0.5; potassium iodide, 0.002; total 100 pounds) self-fed.

- **Lot II.** *“Hard” Corn*—Shelled corn, hard (Krug), self-fed; “Big 10” supplemental mixture (same as fed Lot I) self-fed.

- **Lot III.** *“Hard” Corn*—Same as Lot II.

- **Lot IV.** *“Soft” Corn*—Shelled corn, soft (selection from Reid Yellow Dent) self-fed; “Big 10” supplemental mixture (Same as fed to Lot I) self-fed.

- **Lot V.** *“Soft” Corn*—Same as Lot IV.

- **Lot VI.** *“Elevator Run” Corn, Special House*—Same as Lot I except pigs were housed in special winter type house.

**FEEDS USED**

**Corn**

Crushing Resistance

Hardness of the three types of corn used in this trial was determined. One hundred kernel samples of each type were crushed, and the pounds pressure to crush each kernel was recorded. The figure given in table 1 is the average for the 100 kernels.

The pounds of pressure to crush the kernels in this trial are relative but are not comparable with those in the later trials.
Fig. 2. Dry lots in which the pigs of the second and third experiments were fed.
as a different type of crusher was used. The pincher used in
this trial tended to pierce the kernel and in the later trials the
corn was tested by a different type of apparatus which crushed
the kernels.

**TABLE 1. PRESSURE TEST TO DETERMINE HARDNESS OF THE THREE TYPES OF DENT CORN.**

<table>
<thead>
<tr>
<th>Type of dent corn</th>
<th>Weight per bushel (pounds)</th>
<th>Moisture at time of test (percent)</th>
<th>Pressure to break kernel (Ave. 100 kernels) (pounds)</th>
<th>Probable error of the mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Special Reid Yellow Dent (soft)</td>
<td>51</td>
<td>10.8</td>
<td>44.03</td>
<td>±1.10</td>
</tr>
<tr>
<td>&quot;Elevator Run&quot; (Reid Yellow Dent predominated) (medium)</td>
<td>48</td>
<td>9.0</td>
<td>35.85</td>
<td>± .62</td>
</tr>
<tr>
<td>Krug (hard)</td>
<td>56</td>
<td>11.4</td>
<td>61.36</td>
<td>± .74</td>
</tr>
</tbody>
</table>

**Water Gained on Soaking**

Amount of water absorbed by the three types of corn in 1, 2 and 3 hours also was determined. Figures presented represent the percentage gain in weight of the corn on soaking.

As would be expected the soft corn was more pervious to moisture and the hard corn less pervious. If hardness is judged by the amount of water taken up by the corns, the

**TABLE 2. SOAKING TEST TO DETERMINE PERCENTAGE WEIGHT GAIN BY SOAKING.**

<table>
<thead>
<tr>
<th>Type of dent corn</th>
<th>1 hour</th>
<th>2 hours</th>
<th>3 hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Special Reid Yellow Dent (soft)</td>
<td>11.80</td>
<td>15.72</td>
<td>19.09</td>
</tr>
<tr>
<td>&quot;Elevator Run&quot; (Reid Yellow Dent predominated) (medium)</td>
<td>9.17</td>
<td>12.75</td>
<td>14.38</td>
</tr>
<tr>
<td>Krug (hard)</td>
<td>9.25</td>
<td>12.38</td>
<td>15.06</td>
</tr>
</tbody>
</table>
Krug was harder than the Special Reid but was practically the same as the elevator run, which is designated as medium. If hardness is judged by pounds of pressure required to crush we must consider the regular elevator run to be more floury than corn designated as soft.

**Chemical Composition of Corn**

Chemical composition of the various corns used was determined by J. A. Schulz, of the Chemistry Section, and is tabulated below on the basis of 14 percent of moisture, as it was charged against the pigs on that basis. As fed to the pigs, the soft corn contained 10.8 percent moisture, the hard 11.4 percent and the elevator run 9.0 percent.

**TABLE 3. CHEMICAL COMPOSITION OF THE CORN FED.**

<table>
<thead>
<tr>
<th>Corn type</th>
<th>Water</th>
<th>Dry matter</th>
<th>Crude protein</th>
<th>Carbohydrates</th>
<th>Ether extract or fat</th>
<th>Ash or minerals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Special Reid (soft)</td>
<td>14.00</td>
<td>86.00</td>
<td>7.85</td>
<td>70.70</td>
<td>2.36</td>
<td>3.79</td>
</tr>
<tr>
<td>Elevator Run (medium)</td>
<td>14.00</td>
<td>86.00</td>
<td>9.35</td>
<td>69.94</td>
<td>2.35</td>
<td>3.14</td>
</tr>
<tr>
<td>Krug (hard)</td>
<td>14.00</td>
<td>86.00</td>
<td>8.21</td>
<td>70.32</td>
<td>1.99</td>
<td>4.21</td>
</tr>
</tbody>
</table>

**Other feeds used.**

Listed below are the other feeds used in this trial together with the source of the feed and in the case of the protein feeds, the actual percentage of crude protein is listed.

- Peanut oilmeal, American Milling Company, Peoria, Ill...44.38
- Tankage, Swift and Company, Chicago, Ill.......................57.73
- Linseed oilmeal, Ankeny Linseed Mfg. Co., Des Moines, Iowa ........................................................................36.74
- Alfalfa meal, Triple X Brand, Denver Alfalfa Milling and Products Co., Lamar, Colo.................................14.48
- Cottonseed meal, Buckeye Cotton Oil Company, Little Rock, Ark .........................................................41.53
- Wood ashes, Hardwood Ashes, Murphy Products Company, Burlington, Wis.
Iron oxide, Tamms Silica Company, Chicago, Ill.
Potassium iodide, Mallinckrodt Chemical Company, St. Louis, Mo.

FIRST EXPERIMENT RESULTS

The averages by lots, of the days to reach the final weight (250 pounds), the daily gain, the daily feed consumption and the feed required for 100 pounds gain are included in table 4.

TABLE 4. WEIGHTS, GAINS, FEED CONSUMPTION AND FEED REQUIREMENTS OF PIGS IN FIRST EXPERIMENT.*

<table>
<thead>
<tr>
<th>Lot no.</th>
<th>No. of days required to reach 250 lbs.</th>
<th>Ave. daily gain (lbs.)</th>
<th>Feed used</th>
<th>Ave' daily feed consumed</th>
<th>Feed required for 100 lbs. gain</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>93.5</td>
<td>1.86</td>
<td>Shelled corn</td>
<td>6.44</td>
<td>1.20 7.64 346 65 411</td>
</tr>
<tr>
<td>II</td>
<td>99.5</td>
<td>1.75</td>
<td>Shelled corn</td>
<td>6.24</td>
<td>1.08 7.32 356 61 417</td>
</tr>
<tr>
<td>III</td>
<td>107.0</td>
<td>1.64</td>
<td>Shelled corn</td>
<td>6.18</td>
<td>1.17 7.35 378 71 449</td>
</tr>
<tr>
<td>IV</td>
<td>101.0</td>
<td>1.73</td>
<td>Shelled corn</td>
<td>6.17</td>
<td>1.19 7.36 357 69 426</td>
</tr>
<tr>
<td>V</td>
<td>100.5</td>
<td>1.74</td>
<td>Shelled corn</td>
<td>6.16</td>
<td>1.18 7.34 354 68 422</td>
</tr>
<tr>
<td>VI</td>
<td>102.0</td>
<td>1.71</td>
<td>Shelled corn</td>
<td>5.81</td>
<td>1.12 6.93 339 65 404</td>
</tr>
</tbody>
</table>

*Jan. 14, 1930, until each lot averaged 250 pounds; Experiment 331, dry lot feeding. Five pigs in a lot, averaging approximately 75 pounds at start.

The pigs in the two check lots (I and VI) show little difference in their response to the treatment. Apparently a smaller, insulated and warmer house was not particularly advantageous in this year.

Daily feed consumption ranged from 6.93 to 7.64 pounds per pig per day. Apparently the density of the corn had little effect on the palatability. Pigs that were housed in the warmest house ate less corn than those in any of the other lots. Feed requirement per unit of gain was likewise the least in this lot, although the difference was not significant.

Differences in rate of gain of the pigs in the lots fed the
different kinds of corn were not significant. Actually, the pigs in the groups fed the “elevator run” corn made the most gain, those in the group fed the “hard” corn made the least, while those fed the “soft” corn were intermediate. The same differences showed up in feed requirements per hundredweight of gain, that is, the requirement was the lowest in the groups fed the “elevator run” corn and the highest in the group fed the “hard” corn with the “soft” corn in between.

SECOND EXPERIMENT

Corn raised in 1931 was used in the second experiment conducted during the winter of 1931-32. The corn was grown on the same fields, but as yields were low because of drouth there was a limited supply, especially of the Special Reid Yellow Dent or soft corn. Regular Reid Yellow Dent was grown to furnish grain of medium hardness and as in the previous experiment Krug was the hard and Special Reid Yellow Dent was the soft corn.

ANIMALS USED AND DURATION OF EXPERIMENT

The pigs, averaging 169 pounds, were divided into three groups of 12 pigs each. Each group was divided into four lots, which were subjected to the same treatment with kind of corn fed as the variable. The experiment started Feb. 24 and was continued until April 20.

HOUSING AND RANGE

All lots were fed in dry yards. Each lot had a low shed-roof type of hog house. These were divided from the adjacent lots by solid wood partitions. The floor space was 6x8 feet and the house was insulated with composition board. Adjoining the house on the south was an outside yard space 8x12 feet. The self-feeders were built as a part of the hog house with the feeding troughs on the inside. Floors of both the house and yard were of concrete. A board overlay was used in the house.

RATIONS FED AND METHOD OF FEEDING

The 12 lots of fall pigs were divided into three series and fed as follows:
Series I, Reid Yellow Dent Corn, Medium Type Corn

Lot I—Shelled corn (Reid Yellow Dent) self-fed plus “Big 10” supplemental mixture (meat meal tankage, 40; cotton-seed meal, 20; peanut oilmeal, 9; linseed oilmeal, 15; alfalfa meal, 12.8; salt, flake, 1.0; limestone, 1.5; iron oxide, 0.198; wood ashes, 0.5; potassium iodide, 0.002; total 100 pounds) hand-fed P. M. feed dry, in trough, at rate of 0.6 pound per pig daily.

Lots II, III and IV—Same as Lot I.

Series II, Krug, Hard Type Corn

Lot V—Shelled corn (hard type) self-fed plus “Big 10” supplemental mixture hand-fed P.M. feed dry, in trough, at rate of 0.6 pound per pig daily.

Lots VI, VII and VIII—Same as Lot V.

Series III, Special Reid Yellow Dent, Soft Type Corn

Lot IX—Shelled corn (soft type) self-fed plus “Big 10” supplemental mixture hand-fed P.M. feed dry, in trough, at rate of 0.6 pound per pig daily.

Lots X, XI and XII—Same as Lot IX.

FEEDS USED

Corn

Crushing Resistance

An improved machine was used for determining the hardness of the corn in the second and third experiments. The crusher used in the first experiment tended to pierce rather than crush the kernel. The upper jaw of the improved machine was mounted on a ball and socket joint so the face of the jaw would bear completely upon the upper surface of the corn kernel. Both jaws were indented with cross-hatched grooves to prevent slipping of the kernels as the force was applied. The jaws were attached to a spring balance which had a recording indicator.

The kernel of corn was placed on its edge between the jaws, and pressure was applied by a screw device until the kernel was crushed. Pounds pressure recorded do not give actual breaking strength but rather are five-sixths of actual. Figures
given on crushing resistance are machine readings unless otherwise stated and for actual crushing resistance must be increased by one-fifth.

One hundred kernels of each kind of corn were crushed in this machine. Crushing tests were run Feb. 25, March 17 and May 6 on the corn as fed to the pigs. Although the trial terminated April 29, the last crushing test was not run until May 6. The results are reported in table 5.

**TABLE 5. MEAN CRUSHING RESISTANCE TEST OF CORN USED IN 1931-32 EXPERIMENT.**

<table>
<thead>
<tr>
<th>Type of dent corn</th>
<th>Moisture (percent)</th>
<th>Crushing resistance with probable error (pounds)</th>
<th>Moisture (percent)</th>
<th>Crushing resistance with probable error (pounds)</th>
<th>Moisture (percent)</th>
<th>Crushing resistance with probable error (pounds)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Special Reid Yellow Dent (soft)</td>
<td>20.0</td>
<td>22.55 ± .61</td>
<td>19.9</td>
<td>23.71 ± .67</td>
<td>16.1</td>
<td>23.41 ± .70</td>
</tr>
<tr>
<td>Reid Yellow Dent (medium)</td>
<td>21.8</td>
<td>23.85 ± .53</td>
<td>20.9</td>
<td>23.22 ± .67</td>
<td>17.4</td>
<td>28.36 ± .79</td>
</tr>
<tr>
<td>Krug (hard)</td>
<td>19.0</td>
<td>29.77 ± .60</td>
<td>18.2</td>
<td>30.23 ± .62</td>
<td>18.0</td>
<td>27.23 ± .58</td>
</tr>
</tbody>
</table>

Crushing resistance difference and probable error of the difference are indicated in table 6.

**TABLE 6. CRUSHING RESISTANCE DIFFERENCE IN POUNDS.**

<table>
<thead>
<tr>
<th>Difference between</th>
<th>Feb. 25</th>
<th>Mar. 17</th>
<th>May 6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medium and soft</td>
<td>1.30 ± .80</td>
<td>.49 ± .95</td>
<td>4.95 ±1.06</td>
</tr>
<tr>
<td>Medium and hard</td>
<td>5.92 ± .80</td>
<td>7.01 ± .91</td>
<td>1.15 ± .98</td>
</tr>
<tr>
<td>Hard and soft</td>
<td>7.22 ± .85</td>
<td>6.52 ± .91</td>
<td>3.82 ± .91</td>
</tr>
</tbody>
</table>

There is little difference in the pounds required for crushing the soft and medium corns. The hard corn was significantly harder to crush than medium or soft corn. Averaging the three tests, the hard corn was 20 percent harder than the soft corn and 14 percent harder than the medium corn.

Crushing tests also were run on samples dried to a uniform moisture content. The lowering of the moisture content increased the crushing resistance but did not alter the relative standing between the classes of corn tested.
### TABLE 7. MEAN CRUSHING RESISTANCE TEST OF CORN AFTER DRYING TO CONSTANT WEIGHT.

<table>
<thead>
<tr>
<th>Type of dent corn</th>
<th>Moisture (percent)</th>
<th>Crushing resistance (pounds)</th>
<th>Moisture (percent)</th>
<th>Crushing resistance (pounds)</th>
<th>Moisture (percent)</th>
<th>Crushing resistance (pounds)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Special Reid Yellow Dent (soft)</td>
<td>13.9</td>
<td>36.44 ± .91</td>
<td>13.6</td>
<td>39.81 ± .98</td>
<td>12</td>
<td>34.40 ± 1.03</td>
</tr>
<tr>
<td>Reid Yellow Dent (medium)</td>
<td>14.2</td>
<td>38.43 ± .79</td>
<td>14.0</td>
<td>43.02 ± 1.07</td>
<td>12</td>
<td>38.66 ± .93</td>
</tr>
<tr>
<td>Krug (hard)</td>
<td>12.9</td>
<td>46.85 ± .83</td>
<td>13.1</td>
<td>48.70 ± .96</td>
<td>12</td>
<td>42.43 ± .73</td>
</tr>
</tbody>
</table>

### Water Gained on Soaking

Soaking tests were made on the corn used in this experiment. Samples were tested on Feb. 25 and March 17, 1932. The amount of water absorbed in 3 hours and 20 hours was determined on the corn as fed. Samples were dried to approximately uniform moisture content and soaking tests again were run. These data are included in tables 8 and 9.

### TABLE 8. GAIN IN WEIGHT OF CORN SAMPLES ON SOAKING, FEB. 25, 1932.

<table>
<thead>
<tr>
<th>Type of dent corn</th>
<th>Moisture (percent)</th>
<th>Gain in weight on soaking</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Moisture (percent)</td>
<td>3 hours</td>
</tr>
<tr>
<td>Special Reid Yellow Dent (soft)</td>
<td>20.0</td>
<td>5.70</td>
</tr>
<tr>
<td>Reid Yellow Dent (medium)</td>
<td>21.8</td>
<td>5.30</td>
</tr>
<tr>
<td>Krug (hard)</td>
<td>19.0</td>
<td>5.36</td>
</tr>
</tbody>
</table>

### TABLE 9. GAIN IN WEIGHT OF CORN SAMPLES ON SOAKING, MARCH 17, 1932.

<table>
<thead>
<tr>
<th>Type of dent corn</th>
<th>Moisture (percent)</th>
<th>Gain in weight on soaking</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Moisture (percent)</td>
<td>3 hours</td>
</tr>
<tr>
<td>Special Reid Yellow Dent (soft)</td>
<td>19.0</td>
<td>12.50</td>
</tr>
<tr>
<td>Reid Yellow Dent (medium)</td>
<td>20.9</td>
<td>11.90</td>
</tr>
<tr>
<td>Krug (hard)</td>
<td>18.2</td>
<td>12.86</td>
</tr>
</tbody>
</table>
Hardness of the corn apparently had little influence upon rate of absorption or absorptive capacity for the differences are too small and irregular to be significant.

Chemical Composition and Moisture Content

Samples of the different kinds of corn were taken for chemical analysis, but they spoiled before being analyzed.

Moisture was determined on a composite sample of each kind of corn fed by monthly periods. Moisture content of the Special Reid (soft) was 19.2 percent in March and 18.7 percent in April; the Reid Yellow Dent (medium) was 19.2 percent and 18.8 percent, and the Krug (hard) 20.2 and 19.6 percent. Moisture content of corn is a factor affecting crushing resistance, but the differences between the samples are so little that they should not be a factor in this case.

Other Feeds Used

Feeds from sources other than those listed under the first experiment are enumerated and the guaranteed percentage of protein designated.

Linseed oilmeal, Archer-Daniels-Midland Co., Minneapolis, Minn. .................................................. 34
Tankage, John Morrell and Company, Ottumwa, Iowa..... 60
Iron oxide, Geo. S. Mephan Company, E. St. Louis, Ill.
Cottonseed meal, Proctor Gamble Company, Cincinnati.
Ohio ................................................................. 42

SECOND EXPERIMENT RESULTS

Weights, gains, daily feed consumption and feed requirements of the pigs are presented in table 10. Figures presented in each series are averages of 12 pigs fed in the four lots of three pigs each.

There were differences in the daily feed consumption of the pigs in the groups within a series; the differences between series (kinds of corn), however, are slight and not significant.

There was more variation in gains made by the pigs within a series than between series. An analysis of variance showed no significant difference between types of corn in either rate of gain or feed requirements per unit of gain.
TABLE 10. WEIGHTS, GAINS, FEED CONSUMPTION AND FEED REQUIREMENTS OF PIGS IN SECOND EXPERIMENT.*

<table>
<thead>
<tr>
<th>Final weight per pig (lbs.)</th>
<th>Average daily gain (lbs.)</th>
<th>Feeds used</th>
<th>Average daily feed consumed (lbs.)</th>
<th>Total</th>
<th>Feed required for 100 lbs. gain (lbs.)</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Series I, Reid Yellow Dent (medium) (Average of 12 pigs)</td>
<td>269.03</td>
<td>1.79</td>
<td>Shelled corn “Big 10”</td>
<td>7.23</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Series II, Krug (hard) (Average of 12 pigs)</td>
<td>262.02</td>
<td>1.68</td>
<td>Shelled corn “Big 10”</td>
<td>6.58</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Series III, Special Reid Yellow Dent (soft) (Average of 12 pigs)</td>
<td>266.79</td>
<td>1.73</td>
<td>Shelled corn “Big 10”</td>
<td>7.07</td>
</tr>
</tbody>
</table>

*Feb. 24, 1932, to April 20, 1932—56 days. Experiment 355, dry lot feeding, all lots on concrete. Three series of 12 pigs, averaging approximately 160 pounds at start.

THIRD EXPERIMENT

Corn grown in 1932 was used in the third experiment. A larger supply of corn of each of the three kinds made it possible to feed pigs during a longer period than in the previous year.

A different supplemental mixture was used in this third experiment. This mixture was made up of 97 pounds of the regular Trinity mixture and 3 pounds of a mineral mixture (see “rations fed” for the ingredients of these mixtures).

ANIMALS USED AND DURATION OF EXPERIMENT

The experimental design was changed somewhat from the previous experiments. The pigs were divided into 12 lots of three pigs each. Lots were paired and both lots in each pair were given the same kind of corn, but the supplemental mixture was self-fed in one and hand-fed in the other. Two paired lots of pigs were fed each kind of corn. Pigs in the lots fed the same kinds of corn were allotted to pens by means of a random sample table so that pen location should not be a determining factor.

Mean initial weight per pig at the start of the experiment (Jan. 27, 1933) was 105 pounds, and these pigs were fed until they reached an average weight of 250 pounds.
HOU SIN G AND R ANGE

All lots were fed in dry yards, the same ones as used in the previous experiment.

R ATIONS F ED AN D M ETH O D OF F EED IN G

The 12 lots of fall pigs were divided into three series as in the preceding experiment. The rations fed were:

Series I, Special Reid Yellow Dent, (Soft) Corn
Lots IA and IB—Shelled corn (soft) self-fed plus supplemental mixture A [regular Trinity mixture (tankage, 50; linseed oilmeal, 25; and alfalfa meal, 25; total 100 pounds), 97 pounds; mineral mixture (salt, 20; limestone, 40; bone meal, 37.95; iron oxide, 2; copper sulphate, 0.03; potassium iodide, 0.02; total 100 pounds), 3 pounds; total 100 pounds] self-fed.
Lots IIA and IIB—Shelled corn (soft) self-fed plus supplemental mixture A hand-fed A.M. feed at the rate of 1 pound per pig daily.

Series II, Reid Yellow Dent (Medium) Corn
Lots IIIA and IIIB—Shelled corn (medium) self-fed plus supplemental mixture A self-fed.
Lots IVA and IVB—Shelled corn (medium) self-fed plus supplemental mixture A hand-fed A.M. feed at the rate of 1 pound per pig daily.

Series III, Krug (Hard) Corn
Lots VA and VB—Shelled corn (hard) self-fed plus supplemental mixture A self-fed.
Lots VIA and VIB—Shelled corn (hard) self-fed plus supplemental mixture A hand-fed A.M. feed at the rate of 1 pound per pig daily.

FEEDS USED

Corn
Crushing Resistance

The same apparatus used to test crushing resistance in the second experiment also was employed in this trial. Three tests were made on samples of 100 kernels of each kind of corn. The moisture in the corn when the tests were made and the pounds required to crush the kernels are given in table 11.
TABLE 11. MEAN CRUSHING RESISTANCE TEST OF CORN USED IN 1932-33 TRIAL.

<table>
<thead>
<tr>
<th>Type of dent corn</th>
<th>Moisture (percent)</th>
<th>Crushing resistance with probable error (pounds)</th>
<th>Moisture (percent)</th>
<th>Crushing resistance with probable error (pounds)</th>
<th>Moisture (percent)</th>
<th>Crushing resistance with probable error (pounds)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Special Reid Yellow Dent (soft)</td>
<td>20.2</td>
<td>20.13 ± .48</td>
<td>18.2</td>
<td>20.47 ± .44</td>
<td>18.6</td>
<td>28.88 ± .41</td>
</tr>
<tr>
<td>Reid Yellow Dent (medium)</td>
<td>18.4</td>
<td>24.28 ± .57</td>
<td>17.3</td>
<td>22.38 ± .49</td>
<td>18.1</td>
<td>29.24 ± .57</td>
</tr>
<tr>
<td>Krug (hard)</td>
<td>16.9</td>
<td>30.95 ± .61</td>
<td>16.7</td>
<td>28.45 ± .50</td>
<td>16.3</td>
<td>38.73 ± .61</td>
</tr>
</tbody>
</table>

As compared with the hard, the pounds pressure required to crush was 71 percent as much for the soft corn and 77 percent as much for the medium corn. Soft corn required 92 percent as many pounds to crush as medium corn.

The crushing resistance differences with the probable errors of the differences are reported in table 12.

TABLE 12. CRUSHING RESISTANCE DIFFERENCE IN POUNDS.

<table>
<thead>
<tr>
<th>Difference between means</th>
<th>Feb. 24</th>
<th>March 24</th>
<th>May 25</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medium—soft corn</td>
<td>4.15 ± .75</td>
<td>1.91 ± .66</td>
<td>.36 ± .70</td>
</tr>
<tr>
<td>Medium—hard corn</td>
<td>6.67 ± .84</td>
<td>6.07 ± .70</td>
<td>9.49 ± .84</td>
</tr>
<tr>
<td>Hard—soft corn</td>
<td>10.82 ± .78</td>
<td>7.98 ± .67</td>
<td>9.85 ± .74</td>
</tr>
</tbody>
</table>

With the corn samples dried to a constant weight less difference existed between the crushing resistance. Softer corns lost more moisture in the partial drying process which may account for the smaller spread.

Water Gained on Soaking

Soaking tests were run to determine the absorptive rate of the corns. Two tests were made at about 30-day intervals during the progress of the feeding trial, and in both instances the corn was tested as fed and after drying to a rather constant moisture content. These data are included in table 13.

The softer corn either taken as fed or dried had a greater absorptive rate than the medium or hard corn although the differences are not significant.
TABLE 13. PERCENTAGE GAIN IN WEIGHT OF CORN SAMPLES AFTER SOAKING.

<table>
<thead>
<tr>
<th>Kind of corn</th>
<th>Soft</th>
<th>Medium</th>
<th>Hard</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>3 hours</td>
<td>20 hours</td>
<td>3 hours</td>
</tr>
<tr>
<td>Date</td>
<td>Treatment</td>
<td>Moisture gain</td>
<td>Moisture gain</td>
</tr>
<tr>
<td>Feb. 24</td>
<td>As fed</td>
<td>11.38</td>
<td>24.70</td>
</tr>
<tr>
<td>March 24</td>
<td>As fed</td>
<td>12.96</td>
<td>27.84</td>
</tr>
<tr>
<td>Feb. 24</td>
<td>After drying</td>
<td>18.06</td>
<td>37.87</td>
</tr>
<tr>
<td>March 31</td>
<td>After drying</td>
<td>17.27</td>
<td>34.74</td>
</tr>
</tbody>
</table>

Chemical Composition and Moisture Content

Samples of the corn were tested at intervals during the trial. Average moisture contents by months are given in table 14.

TABLE 14. MOISTURE CONTENT IN CORN AS FED TO THE PIGS. (MONTHLY MEANS.)

<table>
<thead>
<tr>
<th>Kind of corn</th>
<th>Month</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>February</td>
</tr>
<tr>
<td>Special Reid Yellow Dent (soft)</td>
<td>19.2</td>
</tr>
<tr>
<td>Reid Yellow Dent (medium)</td>
<td>19.0</td>
</tr>
<tr>
<td>Krug (hard)</td>
<td>18.8</td>
</tr>
</tbody>
</table>

Chemical composition of composite samples of each kind of corn used in the third experiment is given in table 15.

TABLE 15. CHEMICAL COMPOSITION OF CORN FED (THIRD EXPERIMENT). (All figures are percentages.)

<table>
<thead>
<tr>
<th>Type of dent corn</th>
<th>Water</th>
<th>Dry matter</th>
<th>Crude protein</th>
<th>Carbohydrates</th>
<th>Nitrogen free extract</th>
<th>Fiber</th>
<th>Ether extract</th>
<th>Ash</th>
<th>Calcium</th>
<th>Phosphorus</th>
</tr>
</thead>
<tbody>
<tr>
<td>Special Reid Yellow Dent (soft)</td>
<td>14.00</td>
<td>86.00</td>
<td>9.12</td>
<td>68.42</td>
<td>3.12</td>
<td>4.02</td>
<td>1.31</td>
<td>.015</td>
<td>.28</td>
<td></td>
</tr>
<tr>
<td>Reid Yellow Dent (medium)</td>
<td>14.00</td>
<td>86.00</td>
<td>9.06</td>
<td>68.51</td>
<td>3.08</td>
<td>4.03</td>
<td>1.32</td>
<td>.015</td>
<td>.29</td>
<td></td>
</tr>
<tr>
<td>Krug (hard)</td>
<td>14.00</td>
<td>86.00</td>
<td>9.15</td>
<td>68.51</td>
<td>2.74</td>
<td>4.12</td>
<td>1.23</td>
<td>.015</td>
<td>.28</td>
<td></td>
</tr>
</tbody>
</table>

Although the corns were significantly different in their crushing resistance, little difference in composition existed in the types of dent corn fed.
Other Feeds Used

Feeds from sources other than those listed under the first and second experiments are listed below:

Tankage, Swift and Company, Chicago, Ill., guaranteed 60 percent protein.

Flake salt, Myles Salt Company, New Orleans, La.

THIRD EXPERIMENT RESULTS

Average initial and final weights of the pigs, the average daily gain, the average daily feed consumption and feed requirements per unit of gain are presented in table 16.

<table>
<thead>
<tr>
<th>Lot no.</th>
<th>No. of days required to reach 250 lbs.</th>
<th>Average daily gain (lbs.)</th>
<th>Feeds used</th>
<th>Average daily feed consumed (lbs.)</th>
<th>Feed required for 100 lbs. gain (lbs.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>IA and IB</td>
<td>92.50</td>
<td>1.57</td>
<td>Shelled corn</td>
<td>6.91</td>
<td>59</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Supplemental mixture</td>
<td>.93</td>
<td>441</td>
</tr>
<tr>
<td>II A and II B</td>
<td>89.25</td>
<td>1.63</td>
<td>Shelled corn</td>
<td>6.77</td>
<td>62</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Supplemental mixture</td>
<td>1.00</td>
<td>416</td>
</tr>
<tr>
<td>III A and III B</td>
<td>86.50</td>
<td>1.67</td>
<td>Shelled corn</td>
<td>6.84</td>
<td>6.91</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Supplemental mixture</td>
<td>.93</td>
<td>441</td>
</tr>
<tr>
<td>IV A and IV B</td>
<td>85.75</td>
<td>1.69</td>
<td>Shelled corn</td>
<td>7.19</td>
<td>7.19</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Supplemental mixture</td>
<td>1.00</td>
<td>426</td>
</tr>
<tr>
<td>VA and VB</td>
<td>88.75</td>
<td>1.64</td>
<td>Shelled corn</td>
<td>7.05</td>
<td>7.05</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Supplemental mixture</td>
<td>.76</td>
<td>431</td>
</tr>
<tr>
<td>VIA and VIB</td>
<td>87.75</td>
<td>1.65</td>
<td>Shelled corn</td>
<td>6.85</td>
<td>6.85</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Supplemental mixture</td>
<td>1.00</td>
<td>416</td>
</tr>
</tbody>
</table>

*Jan. 27, 1933, until each lot averaged 250 pounds; Experiment 364, dry lot feeding. Three pigs in a lot, averaging approximately 105 pounds at start.
There were some differences in the amount of shelled corn taken from the self-feeders daily by the pigs. These differences are greater, however, within than between series, hence it appears that one kind of corn was as palatable to the pigs as another.

Specific observations on the time spent by the pigs in eating the different kinds of corn were not made. It did appear that the pigs in the lots fed the hard type of corn spent more time at the corn feeders. This may or may not be true, but it apparently made little difference as the gains and feed requirements between the pigs in the series showed little difference.

Pigs in each series which were allowed to take their protein and mineral supplemental feed mixture from self-feeders ate less than those which received a specific amount of the supplementary blend hand-fed in the troughs. Apparently more protein was fed in the troughs than was necessary.

An analysis of variance of the rate of gain and feed requirements per unit of gain did not show a significant difference due to kind of corn or treatment.

It is evident from the results obtained in the three trials that pigs weighing 75 pounds or more when started on feed make as efficient use of the hard type of shelled corn as they do from shelled corn with the softer or “flour” starch.