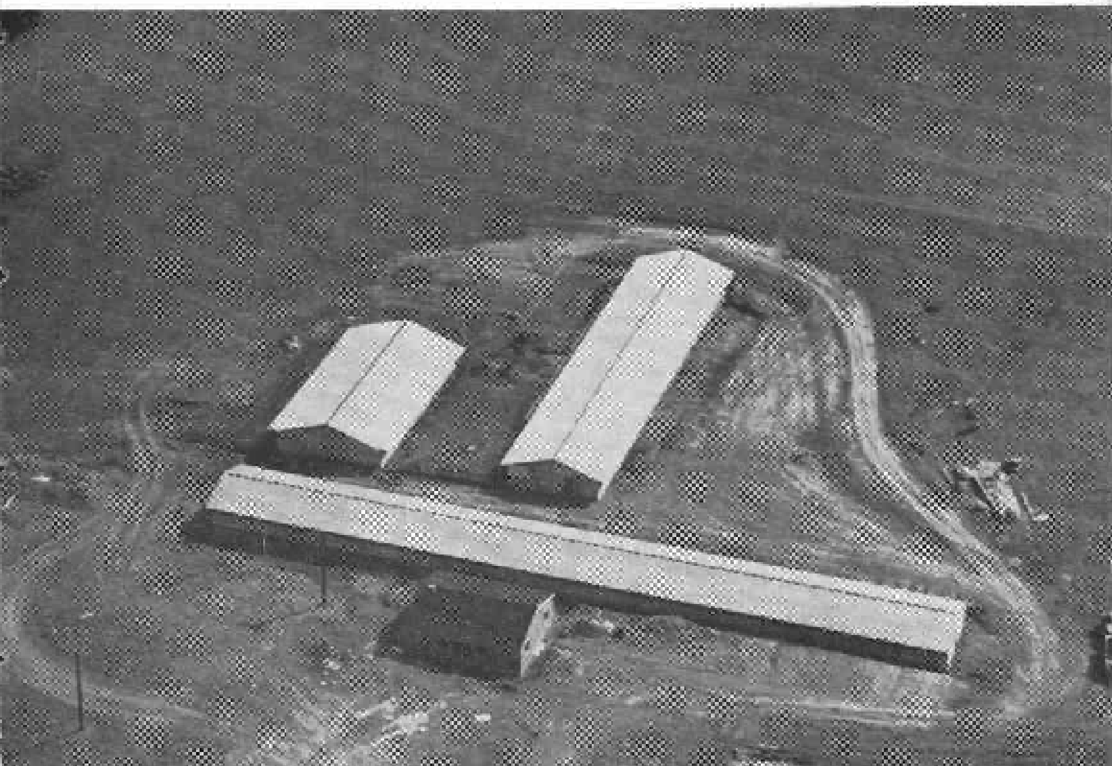
Summary of Reports . . .

Seventh Annual Swine Day



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Summary of Reports . . .

Seventh Annual Swine Day

Contents

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The Feeding Value of High Protein Barley, Low Protein Barley, and a Variety of Hull-less Barley in Grower Rations

J. E. Oldfield

In the continuing search for improvement in animal nutrition or, more specifically in the context of this program, in swine feeding, attention is often leveled at various additives that may be included in rations in fairly small amounts, with the hope that they will stimulate growth in some way. This has been a fruitful path to follow, for along it we have reached the application of antibiotics, vitamin B_{12}, and a number of other substances that have been of real value in improving pork production efficiency. It is not the only approach, however, and perhaps there are times when its dramatic results have diverted interest away from the more common ingredients in swine rations. One should not ignore the very great importance of the cereal grains, which are usually the major components of these rations.

The swine-feeding business of the Pacific Northwest is essentially barley-oriented, and this grain, more than any other, serves as the basis on which swine rations are formulated. Barley is usually thought of as an "energy feed," in common with the other cereal grains, and it is true that it makes a major contribution in this respect. As an energy source, barley is frequently fed at levels of 70-80% of the total feed. The importance of protein for growing swine has been emphasized repeatedly; it is generally agreed that barley is not a good source of protein, and hence needs some supplementing.

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Barley, averaging about 10% crude protein, is by no means a protein-rich feed when compared to such materials as soybean oil meal (testing 45% crude protein), meat meal (testing 50% crude protein), or herring meal (testing 70% crude protein). Nevertheless, barley can contribute significantly to the total ration protein content, simply because it makes up such a large part of the ration. For example, a 100-pound feeder pig will consume about 5.3 pounds of feed a day, according to National Research Council data. If 80% of this feed is barley, testing 10% crude protein, it will supply the animal with .42 pounds of protein. The protein requirement for this size of pig is .69 pounds daily, meaning that the barley actually supplies 60% of this important requirement.

It is interesting to compare the effects of adding protein supplements to barley with different inherent protein contents. Some years ago tests were run at the University of Alberta, in Canada, on the relative values of low, medium, and high protein barleys for growing pigs. The results are summarized in Table 1.

None of the weight gains are particularly good by present-day standards (this work was completed in 1949); however, they do illustrate the general fact that increasing the protein levels in grains is useful in improving gains. Of more direct practical application is the comparison of various grains supplemented to the same total protein level, in terms of amount of supple-

Table 1. Comparative Values of Low, Medium, and High Protein Barley (Canadian)

Grain	Crude protein	Avg. daily gain
	%	*pounds*
Low protein barley	9.1	0.81
Medium protein barley	11.8	0.94
High protein barley	15.1	1.16

ment saved. Experiments have been run at the Umatilla Experiment Station at Hermiston, Oregon, to test this point; the data are listed in Table 2.

Here, due to sampling and mixing problems, the total ration protein levels were not exactly equal; however, they varied less than one-half percent. Obviously, when the grains were supplemented to an equivalent protein level (and, of course, supplemented equally with necessary minerals and vitamins), the growth performance was essentially equal. There is no statistically significant difference between the gains of 1.52 and of 1.46 pounds per day. These rations contained 81% barley; therefore, 7.3% and 10.1% of protein in the total rations was supplied by the low and high protein barleys, respectively. The balance of the protein fed in each case had to come from supplementation, namely 14.4% − 7.3% = 7.1% and 14.1% − 10.1% = 4.0%, respectively. The data from Table 2 may now be translated into practical terms of the amount of protein supplements that must be added to the grains of the two different protein levels (Table 3).

Table 2. Comparative Values of Low and High Protein Barleys Supplemented to Same Total Ration Protein Level (Oregon)

Grain	Crude protein	Total ration protein	Average daily gain	Feed/lb. gain
	%	*%*	*pounds*	*pounds*
Low protein barley	9.0	14.4	1.52	3.4
High protein barley	12.5	14.1	1.46	3.9

Table 3. Amount of Protein Supplement Needed for Low and High Protein Barley

Grain	Total feed from 50-200 pounds weight	Protein supplementation required: Total crude protein	As soybean meal*	As meat meal*
	pounds	*pounds*	*pounds*	*pounds*
Low protein barley	510	36.2	80.4	72.4
High protein barley	585	23.4	52.0	46.8

* Calculated from data in Table 2.
Soybean meal tests 45% crude protein; meat meal tests 50% crude protein.

The high protein barley thus permits a considerable saving per pig in the amount of supplementary protein needed over the growth period from 50 to 200 pounds, which roughly approximates growth from weaning to slaughter. The amounts of supplement listed can be translated into dollars and cents at appropriate local prices.

Turning from direct consideration of barley protein to the matter of overall ration protein levels, another place where economy can be introduced is in the reduction of the amount of protein fed as the animals grow larger. In the Hermiston trials, four groups of pigs were kept on rations containing approximately 16% crude protein throughout their entire growing period to 200 pounds, while a similar number of groups were fed the 16% protein rations to 150 pounds and approximately 12% protein rations thereafter. The results are shown in Table 4.

In interpreting these data, both the average daily gains and the feed conversion efficiency figures are insignificantly different between the two series of groups. This means that it is unnecessary, and uneconomical, to maintain pigs on a high protein ration (in terms of the levels illustrated here) beyond 150 pounds body weight. The National Research Council recognizes this diminishing protein requirement by recommending the following ration protein levels for growing swine: at 50 pounds, 16%; at 100 pounds, 13%; and at 150 pounds or above, 12%.

Barley is primarily an energy source, but it is not the best energy source for swine because its fibrous hull is largely indigestible. A considerable amount of research effort has been expended at the Oregon Agricultural Experiment Station in attempts to overcome this utilization problem. Logically, one answer would seem to be the use of naturally hull-less barley, and tests with a new variety, Utah hull-less, have been promising, as evidenced by the data in Table 5.

Table 4. Comparison of Low and High Protein Rations Fed from 150 to 200 Pounds Body Weight

Ration	Avg. protein	Avg. daily gain	Avg. feed per lb. gain
	%	*pounds*	*pounds*
Low protein	11.6	1.67	4.34
High protein	16.0	1.71	4.27

Table 5. Hull-less Barley Versus Other Cereal Grains

Grain	Avg. daily gain	Feed/lb. gain	Backfat thickness*
	pounds	*pounds*	*inches*
Utah hull-less barley	1.87	3.29	1.15
Hannchen barley	1.69	3.97	1.15
Oregon H-355 corn	2.02	3.24	1.30
Gaines wheat	1.84	3.49	1.22

* Average of three probes, corrected to 200 pounds body weight.

The results show that this hull-less barley will support gains by grower pigs as great as those of pigs fed wheat, but not the equivalent of those fed corn. Gains on hull-less barley were significantly better than those on regular Hannchen barley. Feed conversion efficiency was generally directly related to the rates of gain and, interestingly, the carcass leanness was as good on hull-less barley as it was on the regular barley.

These various data may be added to the growing store of knowledge on Pacific Northwest barley. They emphasize the importance of understanding the nutritional qualities of the major ration components in any program aimed at increasing efficiency of pork production.

Age of Pig and Site of Injection for Iron Administration to Suckling Pigs

D. C. ENGLAND, F. G. GOMEZ, AND ROY FANCHER

Increased weaning weights for pigs injected with 100 mg. of elemental iron at two days of age and at 14 days of age, as compared to those injected with 100 mg. at two days of age only have been reported in a previous publication (Oregon Agricultural Experiment Station Special Report No. 179). Three additional experiments have been conducted to compare: (1) the dorsal area of the neck as an alternative to the ham as a site for injection of iron in the young pig; (2) adequacy of a single injection of 200 mg. at two days and of an injection of 100 mg. at two days and again at 14 days; and (3) the product Rubrafer versus the product Jexin.

Management practices were as equal as possible under normal production conditions. For comparison 1, pigs within litters were assigned in such a manner that birth weights of pigs on the two treatments were equal. The injections were given with a 22-gauge needle at the selected site.

Approximately 100 young pigs were used in each treatment. The results are summarized in Table 1.

The differences between the two treatments were not significant statistically. In the experiment to compare a single injection of 200 mg. iron at two days of age with an injection of 100 mg. at two days and repeated at 14 days, pigs were allotted in similar manner as in the first comparison to equalize birth weight and sex effects. All injections were made in the dorsal area of the neck. Management procedures were alike for the two groups inasmuch as each litter contained, as nearly as possible, an equal number of pigs on each treatment. Approximately 135 pigs were used for each treatment. The treatments resulted in similar weaning weights, Hematocrit values were obtained for only 44 pigs.

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Table 1. Comparison of sites of injection of iron for baby pigs

Site of injection	No. of pigs	Avg. hematocrit values*	Avg. weight at 56 days
			pounds
Dorsal area of neck	96	34.75	36.3
Ham	97	34.61	36.6

* Hematocrit values are directly related to hemoglobin values and erythrocyte counts.

As shown in Table 2, the results were similar for both treatments. Hematocrit values (hemoglobin measure) were 39.9 and 38.5 for one injection and two injections, respectively. Average weights were almost identical at 56 days. Walker and Taylor also found that 200 mgs. of iron given at two days of age gave satisfactory hemoglobin values and 56-day weights (Ani. Prod., *3*:225).

In the third experiment, the products Rubrafer and Jexin were compared. A total of 44 pigs were used for both treatments. The differences in hemoglobin values (hematocrit) at 28 days and in weight at 56 days were not significant statistically (Table 3).

In total, the above results indicate: (1) the dorsal area of the neck seems to be a better site for the injection of iron because hemoglobin values and weight gains are as adequate as from administration in the ham and undesirable effects that iron products could have on the ham are prevented; (2) one injection of 200 mg. of elemental iron two days after birth is as good as two injections, each 100 mg., at two days and at 14 days of age; and (3) the two commercial products, Rubrafer and Jexin, gave equally good results.

Table 2. A comparison of pigs injected with 200 mg. iron at two days of age, or with 100 mg. at two days and again at 14 days of age

Treatment	No. of pigs	Hematocrit values*	No. of pigs	Avg. weight at 56 days*
				pounds
200 mg. at 2 days of age	22	39.9	135	37.4
100 mg. at 2 days and at 14 days	22	38.5	135	37.7

* Differences were not statistically significant.

Table 3. Comparison of Rubrafer* versus Jexin† as iron supplements

Treatment	No. of pigs	Hematocrit values at 28 days	Avg. weight at 56 days
			pounds
Jexin	22	39.7	37.0
Rubrafer	22	40.0	36.1

* Product name—manufactured by E. R. Squibb and Sons.
† Product name—manufactured by Wm. Cooper and Nephews.

Comparison of Wheat, Oats, and Barley in Lactation Rations and Wheat and Corn in Creep Rations

D. C. England, R. E. Fancher, and F. G. Gomez

Profit from swine production often depends upon or is enhanced by choice of grains that are most favorably priced in relation to their nutritive value. Each phase of production, such as preweaning, weaned pigs, gestation, and lactation, has its own special ration requirements for optimum performance. One of the requirements during lactation is high energy content; this is necessary because of the high expenditure of energy in milk by the lactating sow. Grains vary in their energy content, and this is generally in reverse proportion to the amount of fiber in the grain. Because of the relatively high fiber content of oats (about 11% average), recommendations generally are that oats be used as no more than 25 to 33% of the ration. When oats are included in this amount, they are generally regarded, pound for pound, as equal to grains of higher energy content.

The opinion appears to be prevalent among many Oregon hog producers that using oats in amounts of about 25% of the grain portion of the lactation ration results in more adequate weaning weights of pigs than the use of barley as the only grain in the ration. Because oats are usually slightly higher than barley, it is important to know whether inclusion of oats in the lactation rations enhances the weaning weight of pigs.

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Twenty-four litters farrowed in the fall of 1964 were used to compare weaning weights of pigs from sows fed lactation rations that were alike in all respects except that oats replaced 25% of grain in one of the rations. The litters were assigned in such manner that sows of approximately equal age, number of pigs per litter, and background of breeding were fed each of the rations. Both rations were pelleted. All sows were full-fed. Formulas for the rations were as follows:

Barley ration	*pounds*
Barley	1,570
Alfalfa	100
Fish meal	100
SBOM	100
Tankage or meat and bone scraps	100
Salt	10
Ground limestone or oyster shell flour	20
Total	2,000
Zinc sulphate	12 oz./ton

Oats ration	*pounds*
Barley	1,177
Oats	393
Alfalfa	100
Fish meal	100
SBOM	100
Tankage or meat and bone scraps	100
Salt	10
Ground limestone or oyster shell flour	20
Total	2,000
Zinc sulphate	12 oz./ton

Average weight at 56 days was 37 pounds for pigs nursing sows that were fed the barley ration and 36 pounds for pigs nursing sows fed the barley-oats ration. These results indicate that when oats are used as no more than 25% of the grain portion of the ration, the choice of all barley or a barley-oats mixture for the grain portion of the ration can be made on price alone. In making the choice on this basis, it should be remembered that the quality of any grain has an effect on its feeding value.

Because wheat and barley have been selling at similar prices during much of 1964 and 1965, information was obtained on the relative value of wheat and barley in lactation rations. Sows farrowing litters in the spring of 1965 were fed rations in which either barley or wheat was the only grain. Formulas of the ration were as shown above, except that in ration 2 (oats ration) wheat was used as the grain instead of a barley-oats mixture. Both rations were pelleted and all sows were full-fed. Average weight of pigs at 56 days from 16 sows that were fed the barley ration was 37 pounds; average weight of pigs from 18 litters nursing sows fed the wheat ration was also 37 pounds.

Creep rations for suckling pigs are usually formulated to be high in energy and low in fiber. Corn is commonly used as the grain in these rations because fiber content is low and energy content is high. Wheat is also low in fiber and high in energy. Experiments were thus conducted to compare 56-day weights of pigs fed creep rations in which wheat or corn was the grain portion. Formulas for the two rations are shown below. Both rations were pelleted.

Corn ration	*pounds*
Coarsely ground yellow corn	1,460
Soybean oil meal	200
Alfalfa meal	100
Dried buttermilk	120
Fishmeal (Herring, good quality)	100
Ground limestone	10
Iodized salt	10
Total	2,000
Zinc sulphate	12 oz./ton
Irradiated yeast	0.1 lb./ton

Antibiotic—according to manufacturer's directions.

Wheat ration	*pounds*
Wheat	1,460
Soybean oil meal	200
Alfalfa meal	100
Dried buttermilk	120
Fishmeal (Herring, good quality)	100
Ground limestone	10
Iodized salt	10
Total	2,000
Zinc sulphate	12 oz./ton
Irradiated yeast	0.1 lb./ton

Antibiotic—according to manufacturer's directions.

Pigs from 20 litters that were fed the corn ration had average 56-day weights of 35.5 pounds. Those from 16 litters fed on wheat rations had average 56-day weights of 39.5 pounds. The difference was statistically significant ($P < .05$). Thus, the results indicate that wheat is somewhat superior to corn as the grain portion of creep rations for pigs. With relative prices of wheat and corn as they have been during the past year, wheat would be preferred over corn to use in pelleted creep rations for suckling pigs.

Development of the Oregon State University Swine Center

J. C. Miller, D. C. England, J. E. Oldfield, and R. E. Fancher

Oregon State University gave the United States government a long-term lease on a 10-acre tract of land where our old swine barn is located. The 2½ million dollar Northwest Regional Water Research Laboratory now under construction on that tract is nearing completion. A provision of the lease required that the swine and the old barn be moved prior to completion of the water laboratory. Funds provided by the state emergency board made it possible to develop plans and award a contract for $56,500 for construction of the basic units of the Swine Center, which are almost completed.

Two years of planning were spent in development of the Swine Center, incorporating the latest ideas in swine production. But it is more than a place to raise pigs. It is a research center where every animal is involved in one or more experiments in breeding, feeding, housing construction, space requirements, behavioral studies, nutritional requirements, waste disposal, and management. Obviously it represents a sizable investment, but its use for research and teaching should contribute toward a stronger and larger swine industry in Oregon.

The facilities consist of four separate but interrelated buildings (see cover). These are: (1) an office-laboratory unit; (2) a farrowing-nursing-growing unit; (3) a brood stock unit; and (4) a nutrition research unit.

The office-laboratory unit consists of the herdsman's office; a laboratory area which will permit on-the-spot types of laboratory work; an area of similar size which is adaptable for controlled studies with newborn pigs or other appropriate experimental animals; and living quarters for two students. Adequate provision has been made for lavatories and dressing rooms.

The farrowing-nursing-growing unit has 48 pens for nursing and growing pigs and a farrowing room that houses 12 farrowing crates. The farrowing unit is separated by a partition but is otherwise structurally continuous with the nursing-growing unit and occupies 36 linear feet on one end of the unit. Each nursing-growing pen is approximately 8 feet by 10 feet. These pens are arranged in two rows, with an alley 4 feet wide between them.

The brood stock unit is designed to handle about 65 mature animals. This unit also contains a large multiple-purpose room at one end that will be used for teaching various aspects of swine production and for appropriate meetings of producers, 4-H and FFA groups, and so forth.

The nutrition research unit has 48 pens 4 feet by 6 feet, a laboratory-workroom, scales, and a feed handling room.

All units housing animals embody the following principles:

✓ Partially slotted floors made from low-cost standard dimension lumber laid flat over self-emptying manure collection pits.

✓ Multiple-use capacity of pens.

✓ A pen for each animal or unit of animals and each purpose to be served.

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✓ Low-cost experimental design superstructure with sides and roof made of exterior plywood.

✓ Recessed slats about one-half inch below the solid floor that are not nailed or otherwise individually fastened down. Instead, one-inch spacers are nailed to one side of each slat at each end. The slats are laid together with just enough horizontal pressure to prevent sidewise movement. Any individual slat can be snapped sharply vertically to remove for quick and easy replacement without damage to underlying supports.

✓ Storage of manure and urine under water in collection pits for gravity disposal to an outside lagoon when the drain plug in the floor of each pit is removed.

✓ Use of water spigots to direct a stream of water into the drain openings during discharge of manure.

✓ Drain openings in each pit are ringed with ⅝-inch rods embedded 3 inches apart in the cement and extended vertically about 12 inches. This helps prevent entrance by objects that might clog the drains. A drain plug within this circle can be lifted with a hook to secure the outflow of manure.

All of the structures contain both proven and experimental features. The latter include both materials and design of facilities for increased adequacy of management as well as decreased cost.

Ultrasonic Measurement of Lean-Fat Ratio and Loin Eye Area in Swine

S. E. Zobrisky

Most of us who have worked with swine will agree that it is difficult to predict the degree of muscular development of any given hog. And, most of us could, after some deliberation, come to a general agreement concerning many of the characteristics associated with muscularity in swine. Most of us also know that many swine show characteristics of muscle development outwardly, but when they are slaughtered are found to contain a high percentage of fat and little lean meat.

Here we have the "culprit." In order to solve the problem of fat and muscle development, it has been necessary in the past to slaughter the animal. Once the animal is on the rail, it cannot reproduce. Many good potential breeding animals have been castrated or slaughtered without realizing how good they really were. On the other hand, others should have been slaughtered instead of being kept for breeding purposes.

Furthermore, there is general agreement among researchers as to the low predictive value or impracticality of the majority of the live hog and carcass assessments, such as live hog or carcass visual scores, length, width or depth measurements, as well as biopsy and chemical analysis of body constituents. Critical reviews of live hog and carcass studies strongly indicate that

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backfat thickness and *loin eye muscle area measurements* are among the best dimensional objective measurements available as predictors of the quantity of muscle and fat in a live hog or its carcass. Perhaps we should add that many procedures employed by investigators yield results which are 'statistically significant' but are of little immediate practical value to the average hog man.

These results indicate that it would be profitable for all progressive swine men to include backfat thickness and loin eye area with their production data to better select their superior swine. A nondestructive, humane technique is available, by which backfat thickness, loin eye area, and other valuable information can be obtained from live hogs, cattle, and sheep. This technique is known by many names, i.e., high frequency sound, supersound, ultrasonics, acoustics, sonics, and sonoray.

The application of sound waves for measuring distances is not new. Certain animals use sound waves to detect obstacles. The bat in flight sends out short high-pitched sounds which reflect echoes from obstructions. Similarly, the porpoise relies on sound waves to detect the presence of obstacles.

Perhaps the first man-made application of this principle was for underwater detection of obstacles such as submarines and mines and for determining the depth of the sea. Next industry adapted this principle for the nondestructive test and measurement of flaws in metal and machinery. It is said that pin-point flaws in 20 feet of metal can be accurately detected with ultrasonic equipment. The medical profession also has made use of this application for the visualization of tissue structures and for therapeutics. Most recently, this equipment and principle have been used to visualize the thickness and area development of fat and muscle tissue in meat animals.

High frequency sound (HFS) waves can be described as mechanical vibrations in solid, liquid, or gaseous mediums lying above the range of human hearing. They travel in the frequency range of 0.5 megacycle (500,000 cycles per second) to 12 megacycles (12,000,000 cycles per second), which is beyond the audible range of humans. The human ear is most sensitive to sound of 2,000 to 5,000 cycles per second. Unlike radio waves, which travel mainly in air, HFS waves travel best in liquids and solids.

Several instruments have been manufactured for taking nondestructive measurements by the HFS principle. The Sonoray 12 is one such instrument. Within this instrument electrical current is converted over to HFS pulses. These sound pulses are transmitted into and received from the object being measured by way of a crystal transducer or "sound head" in a very narrow beam. At the surface and at every point within the object where the sound pulse goes into a structure of different acoustical properties, a portion of the sound energy is reflected back as a short discrete echo. The echo is picked up by the transducer "head" which converts the echo into an electrical impulse which, in turn, is displayed on the cathode ray oscilloscope, where time intervals are translated into linear distance. This unit incorporates both sending and receiving mechanisms in the same transducer. There is a quiescent period between transmittance and echo. Thousands of pulses are formed and echoes are received in this manner every second. Because of the rapidity of this operation, a visually continuous picture exists on the oscilloscope. The intensity of the oscilloscope peaks is proportional to the strength of the echo returned to the transducer.

At this point, let me attempt to simplify this principle with a recognizable experience. Suppose you were in a canyon and shouted for help. You could conceivably hear two, three, four, or more echoes. The time interval between each successive echo heard would be proportional to the distance from your mouth to the canyon wall that reflected the noise back to your ear. The last echo received would be from the most distant canyon wall. The last echo would also be the weakest. This experience in one sense approximates sending HFS through several layers of material. In our case this material is the backfat and loin of a porker. With this general understanding of how the HFS instrument functions, perhaps we can better capitalize on the benefits of its use in animal research.

To measure the backfat thickness and loin eye area of a hog accurately, the animal must be restrained to eliminate excessive movement and at the same time maintain a near-normal posture without distorting fat and muscle tissue. Conditions that cause the animal to move or tense the muscles while making the actual measurements should be avoided. A restraining crate, as shown in Figure 1, appears to be the most practical way to restrain the hogs. Next, a band of hair is closely clipped from the middle of the back down over the 10-11th rib, a distance of about five inches. The clipped area is marked with an indelible pencil at one-inch intervals from the midline laterally 4 inches. The actual curvature of the animal's back is obtained with a heavy piece of solder wire (Figure 1). This curvature is recorded on a graph paper.

Figure 1. A hog in a restraining crate used to eliminate excessive movement. The curvature of the animal's back is being measured with a piece of heavy solder wire.

A weighted needle and protractor are affixed to the transducer to give the angle of sound penetration, as illustrated in Figure 2. Number 30 motor oil is placed directly under the transducer to establish good conductivity. A series of readings are taken at one-inch intervals, beginning at the 10th rib in the middle of the back and extending

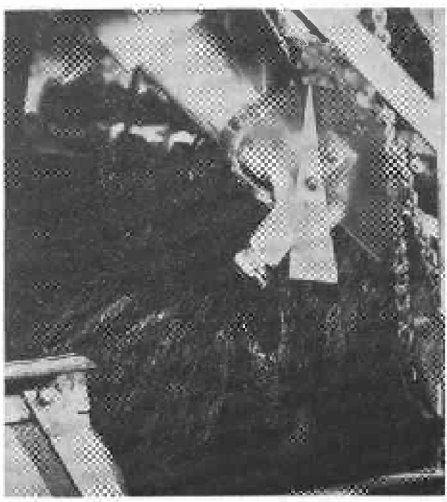

Figure 2. A weighted needle and protractor affixed to a transducer to obtain the angle of sound penetration. A series of readings are taken at one-inch intervals.

down 4 to 5 inches. Each individual reading and angle of sound penetration is recorded and later plotted on graph paper with the curvature outline of the hog's back. The thickness of fat and the area of the loin eye are then traced with the aid of the points plotted (Figure 3). It should be recognized in Figure 3 that both sides of the loin were measured and plotted. Note the three fat layers that comprise the total backfat thickness (Figure 3). A planimeter is used to determine the area of the estimated loin eye area. This same technique can be used to evaluate carcass composition in cattle and sheep.

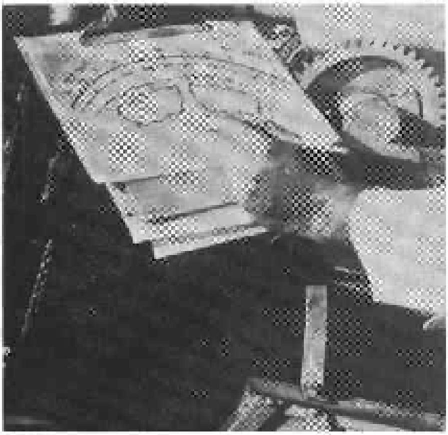

Figure 3. A graph plotting each reading and angle of sound penetration with the curvature outline of the hog's back. The thickness of fat and the area of the loin eye are traced by use of the points plotted.

The next logical question probably is, "How accurately can backfat thickness and loin eye area be estimated?" Let us first consider backfat thickness. It can be estimated as precisely or more so with HFS than by the standard metal probe technique. There are several reasons for this accuracy. First, the top of the loin muscle provides a very distinct interface or boundary which reflects the sound echoes to the instrument. Secondly, sound penetrates all three backfat layers, whereas the metal probe quite often does not penetrate the innermost (or third) fat layer. This is especially true for thin hogs. Statistically, we find no difference between carcass, live hog probe, and HFS fat thickness measurements. However, data indicate that when backfat thickness is measured at the same site, carcass measurements will tend to be slightly greater than metal probe measurements.

Estimating the loin eye area is more difficult than estimating backfat thickness. This would be expected, since it requires several measurements to plot the shape and size of the loin eye. Large loin eyes can generally be estimated more accurately than small loin eyes. Statistically, the results thus obtained could be obtained by chance less than one time in a thousand. Over 75% of the variation in the loin eye area can be accounted for. It takes 5 to 10 minutes for a skilled operator to measure one hog, then 10 to 20 minutes to plot and trace the estimated area. Table 1 shows some of the results.

It should be noted that the estimated loin areas are slightly smaller than the actual areas. In our experiments, we have found that we underestimate more frequently than overestimate. However, underestimation is not considered objectionable as long as it is not too far off actual measurements. Note also that standard deviations are very similar for the actual areas and the HFS estimates. There is some variation between the areas of the loin eye obtained from the right as versus the left side of swine. This difference is not statistically significant, however. Also, note that the "r's" (correlation coeffi-

Table 1. Actual versus Ultrasonic Measurement of *Longissimus dorsi* Muscle

Measurement	*Longissimus dorsi* muscle area				
	Avg.	S.D.[1]	Avg.	S.D.	"r"[2]
	sq. in.		*sq. in.*		
Actual	4.86	0.86	4.83	0.86	0.95
HFS[3]	4.78	0.84	4.58	0.85	0.91

[1] Standard deviation.
[2] Correlation coefficient.
[3] High frequency sound.

cients) approach unity, as should be the case.

Perhaps Table 2 will better illustrate the accuracy that can be expected in estimating loin eye areas. This table shows the percent of the estimated loin eye area within .2 inch increments of the actual areas for three separate surveys. It is realized that this method of presenting results does not constitute a critical test, but it does focus attention on the relative accuracy of the technique. The swine in these groups ranged in weight from 199 to 250 pounds. They consisted of Polands, Hampshires, Durocs, and their crosses. Note that 60 to 70% of the areas were predicted within .2 of a square inch of the actual areas, better than 95% within .6, and about 99% within .8 of a square inch of the actual areas.

At the present time, after six or seven years of use, reasonable confidence in accuracy has been achieved. Repeatability studies are made continually in order to be doubly sure. We are now endeavoring to simplify the procedure by reducing the number of measurements and time required. At the same time, it is hoped that accuracy can be increased or maintained as the anatomy of the hog and the operation of the equipment become more familiar.

In our investigations at the University of Missouri, over 1,500 hogs have been measured. The Animal Husbandry Extension people have measured more than 2,000 hogs. The Extension Service makes the following charges for this service: $5 a head for 20 head or more, $7 for 15 to 19 head, $8 for 10 to 14 head, and $10 for less than 10 head.

This technique is not considered the only criterion for selecting replacement

Table 2. Comparison of Estimated to Actual Loin Eye Area

No. of samples		Percent of estimated LEA* within stated increments of the actual areas					
		.09 in.	.2 in.	.4 in.	.6 in.	.8 in.	.10 in.
		%	%	%	%	%	%
Pork	200	27	70	90	95	98	99
Pork	127	20	57	84	95	99	....
Pork	100	33	78	95	96	99	....

* Loin eye area.

animals. However, the Sonoray is considered an important tool to be used in conjunction with other production and evaluation data to better enable swinemen to select superior livestock.

What are some of the advantages and disadvantages of the HFS technique? Disadvantages include: (1) The instrument must be understood and considerable experience in using it must be acquired before reliable results are obtainable; (2) the animals must be properly restrained; (3) as used today, the instrument requires too much time to be useful on a large scale; and (4) the instrument actually measures thickness or shape of the tissue under study. Therefore, it aids in predicting the lean-fat ratio only to the extent that these measurements are associated with lean and fat of the live hog.

Advantages include: (1) when used by experienced people, the instrument yields reasonably accurate results; (2) animals need not be sacrificed to determine backfat thickness and loin eye area; (3) there is no danger or harm to the animal being measured or to the technician; and (4) it could be a very fast way of evaluating hogs when the time required to restrain the hog and to obtain and plot the readings are appropriately shortened.

It is believed that the time necessary to predict the loin eye area and obtain the backfat thickness can be reduced to less than five minutes per hog. The procedure is presently being refined at the University of Missouri station.