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Limited Feeding of Finishing Swine

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Limited Feeding of Finishing Swine

L. F. TRIBBLE AND K. L. MCFATE[1,2]

In recent years, increased emphasis has been placed on the production of market hogs with more meat and less fat. One method of increasing the percentage of lean in a pork carcass is to limit feed during the finishing period. Past general opinion was that more feed was required per unit of gain when the feed intake was restricted. However, Tribble, *et al.* (1956), and more recently, Becker, *et al.* (1962), obtained more efficient gains under limited feeding regimes. This recent work has stimulated interest in limited feeding and has resulted in the design of buildings and equipment for limited feeding of finishing swine.

This research was initiated to study the performance of a newly developed automatic limited feeding system, to obtain additional information on the value of limited feeding of finishing swine, and to compare fine ground corn with coarse rolled corn for limited feeding.

Procedure

The arrangement of the physical facility and the location of the treatment groups are shown in Figure 1.

On June 24, 1963, eighty-four pigs (64 gilts and 20 barrows) averaging 63 pounds were divided as equally as possible and placed in groups of 14 into pens 1, 2, 3, 4, 5, and 6. Pigs in pens 1 and 2 comprised lot A. They averaged 63.4 pounds per pig. These pigs were limit-fed a fine ground 16 percent protein ration (Table 1). Pigs in pens 3 and 4 comprised lot B, averaged 61.4 pounds per pig, and were limit-fed a coarse rolled 16 percent protein ration. Pigs in pens 5 and 6 comprised lot C, averaged 64.0 pounds per pig, and were self-fed the same 16 percent fine ground ration as used in lot A.

Those pigs in lots A and B were fed their daily ration in four equal portions, at 6:00 a.m., 12 noon, 6:00 p.m., and at 12 midnight. Lot C pigs were placed at the extreme end of the open-front, straw loft shelter to eliminate or reduce the effect of equipment noise that might otherwise affect the eating habits of the self-fed pigs. To duplicate some current limit feeding practices, and to keep initial cost of equipment low, all feed used in lots A and B was dropped directly upon the floor near the north end of each pen. During this first period

[1]Departments of Animal Husbandry and Agricultural Engineering respectively.
[2]Appreciation is expressed to Peerless Equipment Co., Joplin, Mo. for furnishing equipment.

Fig. 1
ARRANGEMENT OF PHYSICAL FACILITIES
FOR
LIMITED FEEDING OF FATTENING SWINE
Swine Farm, University of Missouri

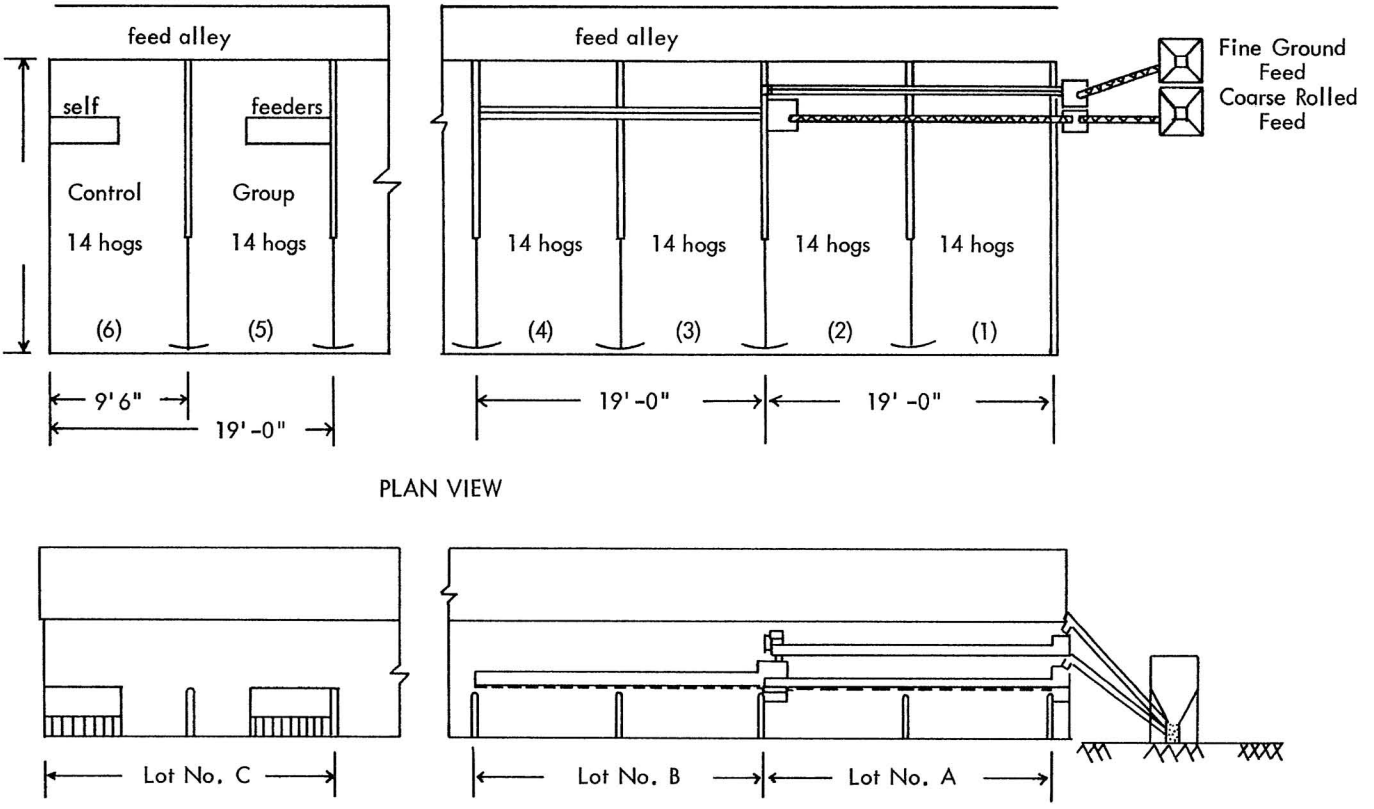


TABLE 1 - RATIONS USED DURING STUDY

	16% Protein (Fed June 24-July 25)	12% Protein (Fed July 25-Oct. 24)
Corn	79.0	88.5
Soybean oil meal	15.0	7.6
Meat and bone scraps	5.0	2.5
Salt	0.4	0.4
Bone meal	0.2	0.4
Limestone	0.3	0.5
Vitamin premix[a]	0.1	0.1
Antibiotic	500 mg. chlortetra cycline per 100 lb. feed	None

[a] supplied the following vitamins per 100 lb. of ration vitamin A - 50,000 IU, Vitamin D - 9,000 IU, riboflavin 50 mg., pantothenic acid 100 mg, nicotinic acid 225 mg., choline 250 mg and vitamin B_{12} 0.25 mg.

(June 24-July 25), automatic feeding was adjusted so as to drop that amount of feed which pigs would clean up properly. Periodic checks on equipment were made to determine its accuracy and assure the pigs' proper amounts of feed. Amounts of feed consumed were determined by actual weights of feed processed and used.

The fine ground feed was processed with a large portable hammer-mill, while the coarse rolled feed was processed with an automatic electric roller-mill, furnished by the cooperating equipment manufacturer.

Feeding Equipment Description

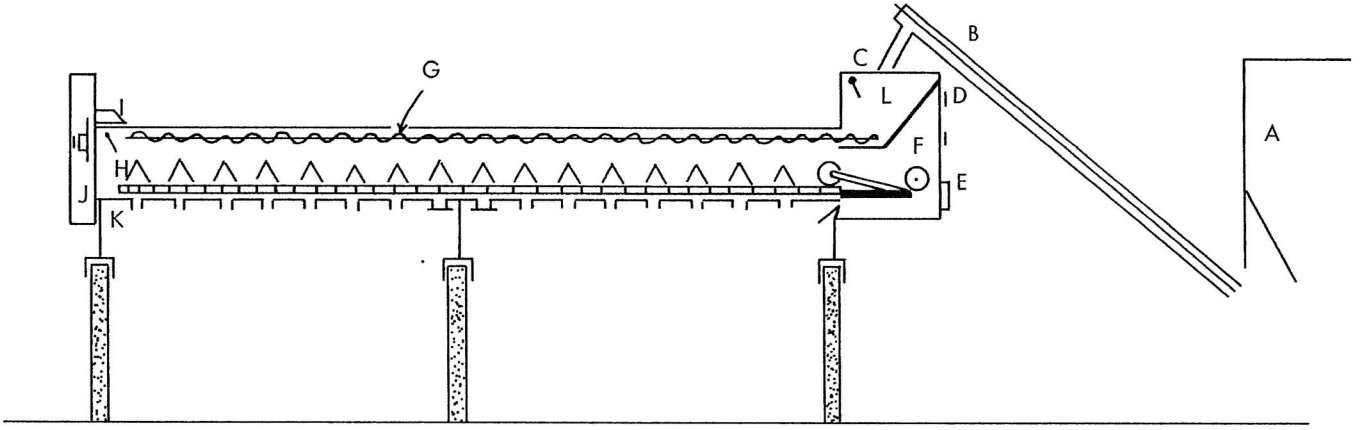
The sketch in Figure 2 shows a cross-section view of the equipment. The sequence of operations is as follows. When the time clock E approaches the hour of feeding (6, 12, 6 or 12) it energizes a circuit that allows reset timer D to start feeder drag motor F. As feed falls through openings (and especially at K) and away from paddle switch H, this small snap-action switch allows the refill auger to recharge the feeder. Bin switch C starts and stops supply auger B to keep proper level of feed in small bin.

After equipment calibration, the amount of feed dropped at any one time depends on the length of time the reciprocating feeder drag is allowed to operate.

Fineness of Grind

To determine the relative fineness of the feeds, samples were collected at each feeder discharge point. These samples were air dried and shaken in a Ro-Tap machine for a 5-minute period. The fine ground feed, as processed for lots A and C, had a fineness modulus of 3.4 and a modulus of uniformity of 1:6:3.

Fig. 2
LIMITED FEEDER CONVEYER AND CONTROL COMPONENTS
(Cross section view)



KEY

A	FEED SUPPLY BIN	G	FEEDER REFILL AUGER, 2½" DIA.
B	SUPPLY AUGER, 4" DIA.	H	FEEDER TROUGH CONTROL SWITCH
C	FEEDER BIN SWITCH	I	MERCURY SAFETY SWITCH, BACK-UP FOR "H"
D	RESET TIMER	J	AUGER DRIVE AND MOTOR
E	TIME CLOCK	K	FEEDER DISCHARGE OPENINGS
F	GEAR REDUCER AND DRIVE	L	SMALL FEEDER BIN

(The modulus of uniformity is the ratio of coarse particles to medium particles to fine particles, respectively.)

The roller-mill was adjusted to obtain a fineness modulus of 4.5 with a modulus of uniformity of 5:4:1. During subsequent processing of runs or batches of feed used in lot B, the fineness modulus varied from 4.3 to 4.8, but the modulus of uniformity of feed, as processed, remained relatively constant.

Conditioning Period, June 24 to July 25

The primary purpose of this portion of the study was to get the pigs accustomed to the feeding practices and environment with the intent to full feed until they reached about 100 pounds average weight. Upon starting the study, the two automatic feeders (supplying feed to lots A and B) were set to discharge three pounds per pig per day and increased to four pounds per pig per day after 17 days.

The average daily amounts fed during this conditioning period were 3.58 pounds per pig per day for lot A and 3.41 pounds per pig per day for lot B, compared to the 4.1 pounds per pig per day for the self-fed pigs in lot C. The average daily amount of feed actually consumed by both limit-fed lots was 85 percent of that amount consumed by self-fed pigs. Table 2 shows that self-fed pigs were about 13 pounds per pig heavier than limit-fed hogs on July 25.

There was little difference in the gain of pigs between pen 1 and pen 2 and again between pen 3 and pen 4. It is important to note, however, that the feed used per pen, within a given lot, has *no significance*, since only the total feed used per *lot* could be weighed. Feed placed in the self-feeders located in pens 5 and 6 was, however, separately weighed, and these data are quite meaningful. The possibility of greater feed waste by pigs in lot A on the fine ground feed may be an explanation for the difference in performance between the pigs in lot A, compared to those in lot B.

TABLE 2 - RESULTS OF GAIN FOR CONDITIONING PERIOD

June 24 - July 25, 1963, By Pens

Feeding Method	Automatic - limited-fed 4 times/day				Self-fed	
Lot Designation	A		B		C	
Type Feed	Fine Ground Corn		Coarse Rolled Corn		Fine Ground Corn	
Pen Number	1	2	3	4	5	6
Pigs per Pen	14	14	14	14	14	14
Initial weight/pig	62.9	64.1	61.2	61.6	66.2	62.0
Final weight/pig	96.7	97.8	98.8	98.9	114.4	106.8
Av. daily gain/pig	1.09	1.09	1.21	1.20	1.55	1.44
Total gain/pen	473	473	527	522	675	627
Total feed/pen	1553	1553	1480	1480	1900	1659
Daily feed/ pig	3.58	3.58	3.41	3.41	4.38	3.82
Feed/lb/gain	3.28	3.28	2.81	2.84	2.81	2.64

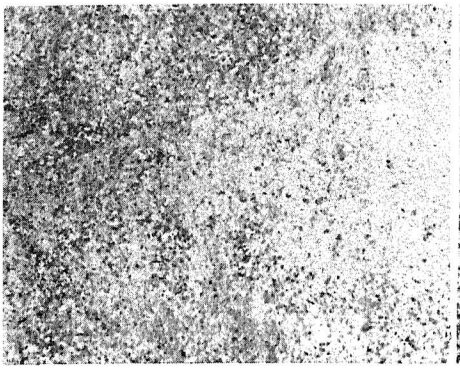


Fig. 3—Fine ground corn in complete mixed ration.

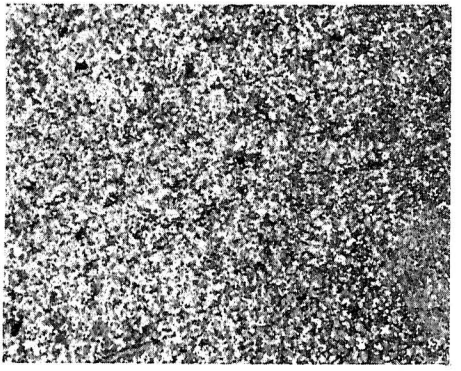


Fig. 4—Coarse rolled corn in complete mixed ration.

Feed Homogeneity

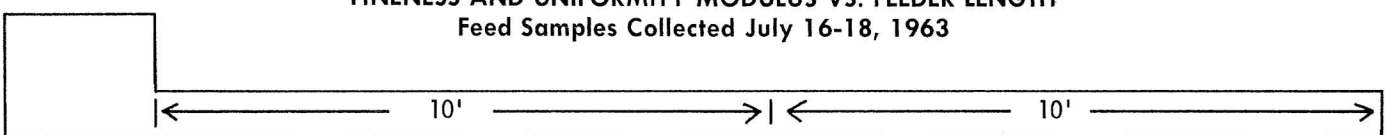
The fineness of the rations is illustrated in Figures 3 and 4. Midway in the conditioning period it was suspected that some separation of the protein supplement and ground or rolled corn was taking place when the refill auger moved the ration from feeder hopper to the extreme end of the feeder. If such were the case, those pigs in pen 2 would not receive the same ration as those in pen 1, even though fine ground feed was being distributed by the same feeder. It was also thought that this condition might have been prevalent in pens 4 and 3.

To evaluate the suppositions above, samples of feed were taken from discharge openings over the length of each feeder during the conditioning period and again during the experimental period. Each of these samples was checked for fineness modulus, modulus of uniformity, and protein content. The results of the first series of tests made on feeder No. 1, serving pens 1 and 2, lot A, are shown in Figure 5. Similar results of tests on feeder No. 2, serving pens 3 and 4, lot B, are shown in Figure 6.

From these data, it can be seen that there was little difference in the fineness modulus and no difference in the uniformity modulus at the six points of investigation over the length of feeder No. 1. There was slightly over one percent difference in protein content over the 20-foot length of feeder. This would indicate only a slight degree of separation with the fine ground feed, with consideration given to any possible errors in sampling.

Data in Figure 6 show no greater variation in the fineness but some difference in the uniformity modulus of the different samples of rolled feed dropped by feeder No. 2 over the length of the unit. Protein analysis, however, indicates a severe and progressive separation of the supplement and corn particles. As indicated earlier, this was surmised by visual inspection.

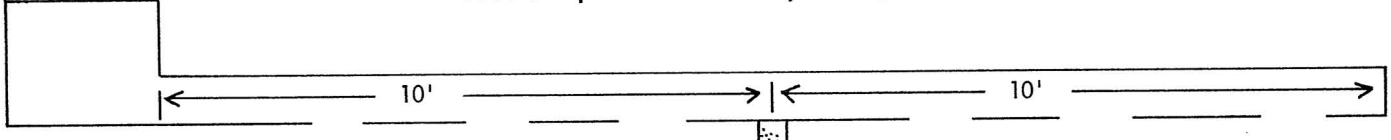
Fig. 5
PERFORMANCE OF LIMITED FEEDER NO. 1
(Fine Ground Feed)
FINENESS AND UNIFORMITY MODULUS VS. FEEDER LENGTH
Feed Samples Collected July 16-18, 1963



DROP NO.	1	4	7	8	11	14
FINENESS MODULUS	3.25	3.24	3.30	3.30	3.41	3.45
UNIVORMITY MODULUS	1:6:3	1:6:3	1:6:3	1:6:3	1:6:3	1:6:3
PROTEIN CONTENT, %	13.88	13.81	13.37	13.50	13.06	12.75

PEN NO. 1 PEN NO. 2

Fig. 6
PERFORMANCE OF LIMITED FEEDER NO. 2
(Coarse Rolled Feed)
FINENESS AND UNIFORMITY MODULUS VS. FEEDER LENGTH
Feed Samples Collected July 16-18, 1963



DROP NO.	1	4	7	8	11	14
FINENESS MODULUS	3.91	4.04	4.10	3.92	4.06	4.03
UNIFORMITY MODULUS	4:4:1	5:4:1	5:4:1	5:4:1	5:4:1	5:4:1
PROTEIN CONTENT, %	15.75	14.94	14.25	14.31	12.38	10.56
	PEN NO. 3				PEN NO. 4	

Experimental Period, July 25 - October 24 (Up to 200 lb.)

The primary portion of the study was begun on July 25 when pigs in lots A and B averaged almost 100 pounds. The intention was to feed lot A and lot B hogs about 75 percent as much feed as self-fed hogs, assuming that they would eat an average of six pounds of feed daily for the weight period from 100 to 200 pounds. In practice, however, the amount fed was somewhat tempered by the degree to which hogs "cleaned up" the feed within a short time after the regular feeding time. This amount, in turn, was affected by the air temperature and humidity conditions within the lots. While all pens were equally affected, during the hot weather, limit-fed pigs would not always eat the amounts of feed placed before them. During the first two weeks of this period, average feed consumption in lot A and lot B was 4.08 pounds per per pig per day; for the next 4 weeks, it was 4.32 pounds per pig per day; and for the remainder of the feeding period, about 5.25 pounds per pig per day. The average consumption for the entire period was 4.74 pounds per pig per day for those receiving fine ground feed and 4.61 pounds per pig per day for those receiving coarse rolled feed (Table 3). On the average, then, this was 84.5 percent of the amount actually consumed by the self-fed hogs, since they ate a lower daily amount than was anticipated.

The lower feed consumption of the pigs on the self-feeder may have been due in part to the fact that most of the pigs on the test were gilts. It has been shown that gilts consume less feed than do barrows (Amick 1957).

The combined data for the limited feeding period are shown in Table 3. The pigs on the self-feeder gained 20 to 25 percent faster than the pigs limited-fed fine ground corn and coarse rolled corn rations, respectively. This difference was statistically significant ($P<.01$). There was much more variation in the weights of the hogs on the limited rations than in those of hogs on the self-feeder. Some of the limited-fed pigs did not reach market until four weeks after those on the self-feeder. This indicates that some of the pigs being limit feed were eating a larger portion of the feed, while others were getting a smaller portion.

Feed Homogeneity

To check for feed separation during this period, ration samples were again collected August 5 at the same six discharge points along the length of feeder No. 2. Figure 7 shows a greater difference in fineness modulus than before, but again little difference in the uniformity modulus. Consequently, protein analyses of these specific samples were not made. Therefore, amounts of protein in Figure 7 are transposed from Figure 5.

Data in Figure 8 relate to the check on feeder No. 2. These show a much wider variation in fineness modulus and uniformity modulus at the six check points when compared with the previous tests on this unit. The protein content of this rolled ration varies nearly as much as in those samples shown in Figure 6. Thus, it appears that there is considerable separation of supplement from the

TABLE 3 - PERFORMANCE OF PIGS AND BACKFAT PROBE AS AFFECTED BY METHOD OF FEEDING

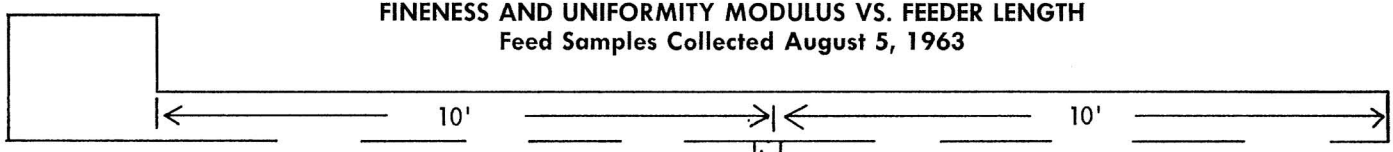
Feeding Method	Automatic - limit fed 4 times/day		Self-fed
Lot Designation	A	B	C
Type Feed	Fine Ground Corn 12% Ration	Coarse Rolled Corn 12% Ration	Fine Ground Corn 12% Ration
Pigs/lot	28*	28	28
Initial weight/pig	97.3	98.9	110.6
Final weight/pig	197.8	199.1	196.2
Average daily gain/pig	1.25	1.20	1.51***
Total gain/lot	2,649	2,806	2,395
Total feed/lot	10,100	10,778	8,803
Daily feed/pig	4.74	4.61	5.54
Feed/lb/gain	3.82	3.84	3.68
Average B. F. Probe	1.06 (22)**	1.01 (23)	1.14 (22)

* Two removed from Lot A on 9/7/63. Records of these pigs included in final weights

** Number of pigs probed in parenthesis

*** Statistically significant ($P<.01$) faster gains than A and B

Fig. 7
PERFORMANCE OF LIMITED FEEDER NO. 1
(Fine Ground Feed)
FINENESS AND UNIFORMITY MODULUS VS. FEEDER LENGTH
Feed Samples Collected August 5, 1963

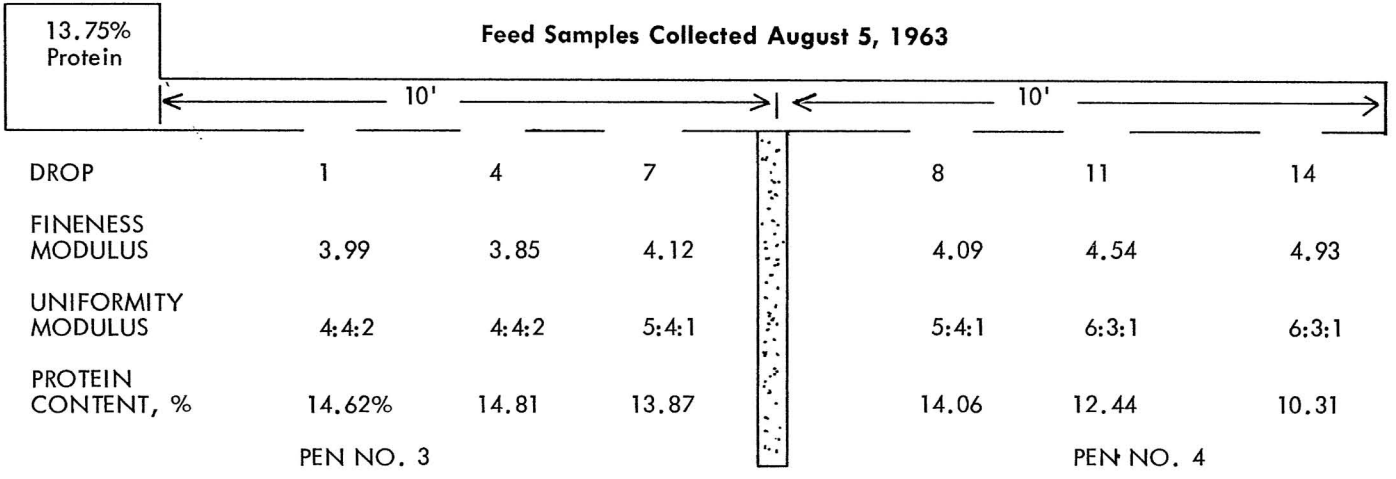


DROP NO.	1	4	7	8	11	14
FINENESS MODULUS	3.06	3.12	3.33	3.35	3.72	3.62
UNIFORMITY MODULUS	1:6:3	1:6:3	2:6:2	2:6:2	2:6:2	2:6:2
PROTEIN* CONTENT, %	13.88	13.81	13.37	13.50	13.06	12.75

PEN NO. 1 PEN NO. 2

Assumed to be same as July 16-18, as changes in Uniformity Modulus were insignificant.

Fig. 8
PERFORMANCE OF LIMITED FEEDER NO. 2
Coarse Rolled Feed
FINENESS AND UNIFORMITY MODULUS VS. FEEDER LENGTH



DROP	1	4	7	8	11	14
FINENESS MODULUS	3.99	3.85	4.12	4.09	4.54	4.93
UNIFORMITY MODULUS	4:4:2	4:4:2	5:4:1	5:4:1	6:3:1	6:3:1
PROTEIN CONTENT, %	14.62%	14.81	13.87	14.06	12.44	10.31
	PEN NO. 3			PEN NO. 4		

coarse rolled feed particles when the mixture is moved along the length of the feeder by the small refill auger.

Further evidence that the pigs in pens 1 and 2 and those in pens 3 and 4 may not have been receiving the same ration is found in the difference in gains of the pigs in the two pens on the same ration. The data are shown in Table 4.

Pigs in pen 2 gained less than those in pen 1, both fed the same fine ground ration except for changes due to separation. Likewise, pigs in pen 4 gained less than pigs in pen 3, which were fed the same coarse rolled ration except for changes due to separation. While feed could not be weighed for each pen separately, the volume of feed used was approximately equal.

Based on these data, it might be speculated that pigs in pens located farthest from the supply bins were adversely affected by the lesser amounts of protein dropped by the feeder.

The majority of the pigs in each lot were probed for backfat thickness when they weighed 200 pounds. The limit-fed pigs had approximately 0.1 inch less backfat than the full-fed pigs. However, the full-fed pigs averaged only 1.14 inches. Therefore, the full-fed pigs were very lean and were not the type of hog that would benefit from limited feeding in terms of improvement in the carcass.

One pig in pen 1 became a "tail-biter" on September 6 and was removed the following day. A pig of equal size was also removed from pen 2 in order to keep the number of pigs in each pen equal and thus make equipment adjustments on each unit more feasible.

Performance of Equipment

Because of the apparent densities of the material as it is distributed over the length of the feeder by the refill auger, the volumetric measuring unit or feeder drag did not drop the same weight of material through each discharge opening. This introduced some error in that there was no simplified way of determining exactly how much was dropped into each individual pen of either lot A or lot B. As a result, feeding efficiencies could not be determined independently for each pen.

In a test on the accuracy with which feed was discharged, individual samples were collected from each of 14 openings on feeder No. 1 filled with fine ground feed. With the automatic reset timer adjusted to drop 24 oz. per hole per run, the actual net weights ranged from 22.0 oz. to 25 oz. for a maximum variation of 8 percent of the desired weight. This factor was not static, however, as it was affected by the position of the drag relative to the openings at the time of starting. Consequently, considerable adjusting and checking was necessary throughout the test period in order to be assured that pigs were receiving the desired amount of feed.

Once the limit-feeding equipment was installed, a considerable amount of attention had to be given to control switches C and H (see Figure 2). Relocation of switch C in small bin L made the supply auger operate automatically but because the bin was small, the motor oscillated "OFF" and "ON" more

TABLE 4 - PERFORMANCE OF PIGS, BY PENS
AUTOMATIC LIMIT-FEEDING VS. SELF-FEEDING (100 TO 200 LBS.)

Feeding Method	Automatic-limit-fed 4 times/day				Self-fed	
Lot Designation	A		B		C	
Type Feed	Fine Ground Corn		Coarse Rolled Corn		Fine Ground Corn	
Pen Number	1	2	3	4	5	6
Pigs/ pen	14*	14*	14	14	14	14
Initial weight/pig	96.7	97.8	98.8	98.9	114.4	106.8
Final weight/pig	201.4	194.2	204.8	193.4	196.9	195.4
Average daily gain/pig	1.28	1.21	1.27	1.13	1.45	1.56

* One pig removed from lots 1 and 2 on 9/7/63. Records of these pigs included, except in final weight.

frequently than would normally be desired. Switch H would occasionally become inoperative because of grain particles becoming lodged between the switches' actuating "paddle" and the inside wall of the feeder.

On two different occasions, grain collected moisture, failed to flow out of discharge opening provided, and lodged behind the feeder drag near the gear drive assembly. Because of the positive displacement gear-reducr, the drive-assembly had the ability to develop high pressure without creating an overload on the motor. On one occasion, a half inch bolt was sheared and the driving arms twisted. While no such serious damage was encountered with feeder No. 1, a considerable amount of time was required to repair feeder No. 2. As a result, hogs in pens 3 and 4 were hand-fed four times per day for a period of two days.

Some bridging of feed in the small feeder hoppers was encountered.

Other Observations and Factors to Consider

Figure 9 illustrates a problem common to all pens. When feed was dropped directly onto the floor, the starting of the machine would awaken pigs for "dinner." Since the feed "dribbled" onto the floor slowly and intermittently over a relatively long period of time, much of the feed dropped onto the backs of the hogs. This, in turn, scattered the feed over a large area of the floor.

The housekeeping manners of the hogs were good at times and very poor at others. This would vary from pen to pen.

Summary

1. During the conditioning period (62 to 100 lb.), there was a small difference in rate of gain in favor of pigs that were fed a ration with coarse rolled corn, compared to those fed a fine ground corn ration.
2. Automatic floor feeding was less satisfactory than self-feeding for both rate and efficiency of gains.
3. During the limited feeding test period there was:
   (a) No significant difference in either daily gain or feed conversion for hogs receiving fine ground feed versus hogs receiving coarse rolled grain, all on a limit-fed basis.
   (b) Self-fed hogs made faster daily gains ($P<.01$) and had somewhat better feed conversion than did either of the lots that were fed limited amounts of feed.
   (c) Self-fed hogs gained faster than limit-fed hogs, as expected, and were ready for market about 3 weeks sooner than limit-fed hogs.
   (d) Limit-fed hogs had less back-fat than self-fed hogs but not to such extent that they would have increased in carcass grade to command a premium price.
4. The cost of the limited-feed unit would need to be relatively high because of its heavy construction. If it is commercially made, the design will need to

Fig. 9—Illustration of feed dropping on the backs of the pigs at feeding time.

be modified if it is to obtain a generally favorable acceptance by the farmer—if he accepts the general practices of limited feeding of hogs at all.

(a) The "built-in" supply hopper needs to be enlarged and reshaped to avoid bridging.

(b) Controls need to be improved to avoid "hanging up" of feed in the feeder.

(c) Attention needs to be given the matter of feed particle separation during filling of the feeder.

(d) Change in design is needed to eliminate possibility of grain becoming moist and packing behind feeder drag.

(e) A slip clutch or other safety device to prevent equipment damage should be considered in case the situation in (d) above occurs.

5. The development of a simplified "quick-dump" unit would be a more practical solution if the limit feeder is to be made commercially.

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