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D. J. Horvath

Kendall C. Elliott

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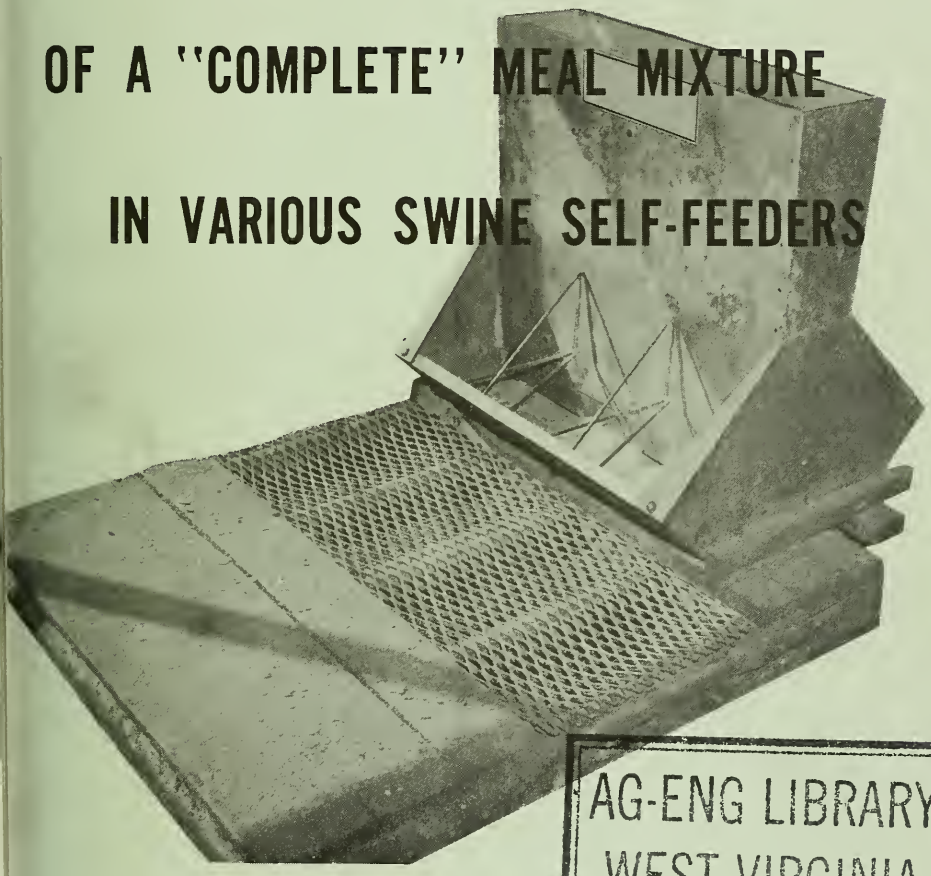

EST VIRGINIA UNIVERSITY AGRICULTURAL EXPERIMENT STATION

THE AUTHORS

D. J. Horvath is Associate Animal Husbandman in the Agricultural Experiment Station and Associate Professor of Animal Science in the College of Agriculture, Forestry, and Home Economics; K. C. Elliott is Assistant Agricultural Engineer in the Station and Assistant Professor of Agricultural Engineering in the College.

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West Virginia University
Agricultural Experiment Station
College of Agriculture, Forestry, and Home Economics
A. H. VanLandingham, Director
Morgantown

COMPARISON OF WASTAGE OF A "COMPLETE" MEAL MIXTURE IN VARIOUS SWINE SELF-FEEDERS

D. J. HORVATH AND K. C. ELLIOTT

Feed wastage with many types of self-feeders varies considerably among experimental pigs and jeopardizes the reliability of feed "consumption" data in nutrition or feeding trial experiments. Sweeping up wasted feed and putting it back into the feeder is not a satisfactory solution since pigs sort feed particles and generally reject the "fines." Feed wastage is also of concern to the commercial pork producer. With the premise that analysis of construction features associated with wastage control and observation of animal behavior might reveal information necessary for designing efficient feeders, a series of trials was begun in 1958. Seven trials have been conducted involving a total of 19 feeders.

Materials and Methods

A feeding shed with a concrete floor was used for the feed wastage trials.

The feeders were placed on a 4-in.-high wood platform (trials A through F, and two in G) or on a 2-in.-high metal platform (two feeders in trial G). The tops of the platforms were covered with horizontal expanded metal screens (¾-in., No. 9-11), with at least 18 in. of screen in front of each of 18 of the feeders. (Feeder No. 19 had at least 9 in. of screen in front of the feeding space.) Wasted feed dropped through the screens into pans underneath. The feed was collected at the end of each period in the early trials but weekly thereafter; then it was sieved to remove straw and fragments of manure, and weighed. Pigs were weighed at the start of each period. Feed offered was weighed, and uneaten feed was weighed back at the end of each period. Barrows were used in Trials A and B. It was occasionally necessary to dry the samples in an oven before weighing them since some barrows urinated while eating. Only gilts were used in subsequent trials. Pigs were assigned as litters in Trial B, but in all other trials they were assigned at random with pigs from each litter appearing in each group.

Feeders which feed from two sides were pushed against the fence so that only the section above the screen could be used by the pigs.

Except in Trial A, the pigs were rotated in a Latin square design at regular intervals so that each group of pigs ate from each feeder for at least one period. Each group of pigs in Trial A remained on the same feeder throughout the trial. For all trials the initial weight of the pigs was approximately 40 to 80 lb. and the final range was usually from 170 to 240 lb.

Feed was a corn-soy ration with 3 per cent alfalfa meal. The corn was ground through a hammer mill with a 7/16-in. screen. A few particles of the corn would not pass through the No. 8 U. S. Series sieve (square openings 0.094 in.) used when removing coarse foreign material from the wasted feed collected in the pans.

If the feeders had not been mounted on the platforms, some of the feed wasted from the feeders might have been eaten since the feeders were located on a concrete floor. This would have been less likely had the feeders been in a dirt lot. On the other hand, some feed washed off the jaws in the water trough. These are moderate errors and it is felt that the method provides a satisfactory index of wastage.

Three per cent of all feed offered was arbitrarily judged to be the maximum acceptable wastage. In economic terms 4 per cent would increase the cost of production one-half cent per pound, if feed costs total 12 cents per pound of market hog. Feeders were adjusted as necessary in order to minimize wastage. As an initial guide, the baffles were set at a level that permitted the pigs to keep the trough or "cups" about 1/3 full.

The statistical analysis used was the standard analysis of variance for multiple factor experiments and differences for significance were calculated from May's (1952) "Q" values as described by Snedecor (1956).

Results and Discussion

General. Measurable wastage varied between extremes of 1 per cent and 20 per cent of all feed offered. The data and observations on other characteristics of the feeders are presented in Table 1. In Tables 2 through 4, "lb. wasted/day" is total feed wasted rather than "lb. wasted per pig per day." Durocs, Yorkshires, and crosses of these were used in various trials. Berkshires have different skull and jaw proportions and might perform differently on some feeders than the animals studied.

Construction Features. A major problem with some metal feeders was lack of durability. The worst features, in our judgment, were the use of self-tapping metal screws and the absence of lock washers or similar devices to prevent screws or bolts from working loose.

Another problem was the inability of some fastening devices to hold the adjustable feed gate (baffle) at the desired position. On one model, which had only a stamped sheet metal thumb-nut without a lock washer, the pigs sometimes rooted up one side of the baffle which therefore had to be reset several times. The baffle on some feeders had to be shut down to the minimum opening for all groups of pigs, but effective baffles do exist. In the case of one model (Smidley), the baffle was very effective in regulating feed flow and could even be set so low that some pigs could not get enough to eat. The need to adjust the baffle for each group of pigs would not be a problem in ordinary experiments in which groups are not shifted from one feeder to another.

Certain construction features are apparently related to wastage. Excessively large trough openings, particularly in combination with absence of trough compartments, permit pigs to root out more feed. A few pigs were even observed using their front feet to do so. The width of the lip of the trough opening seems to be positively related to wastage control. Admittedly, mud from the pigs' jowls could fill in the lip in time under dirt lot or pasture conditions. Also, positive adjustment of the baffle to reduce the slot through which feed flows to as little as 3/8 in. seems necessary. Experience with one European design suggests that division struts between compartments are important also.

Behavior of Pigs. Behavior was a factor in rooting, but another form of wastage was observed in Trial F. One group of pigs, when on the Jamesway No. CB 1764, apparently wasted feed from their jaws as they pulled their heads out while chewing the feed.

Had the ration been as finely ground as most commercial feeds, there might have been less tendency for the pigs to sort the feed and therefore less wastage. However, as the more finely ground feed would flow less freely than coarse feed, it would have been necessary to raise the baffle in some models, which may increase wastage.

The effect of varying the number of pigs per feed cup has not yet been tested, but it merits consideration.

Trial A. A regression analysis was conducted to estimate whether there were any effects of time or age of pigs on wastage. The regressions of wastage on time were significant and also significantly different ($P < .01$) among feeders. Change in lb. wasted per week were ± 0.44, ± 5.1, ± 1.5 and ± 1.1, respectively, for feeders 1 to 4. Subsequent trials therefore were conducted as Latin squares with periods and pig groups as rows and columns, respectively.

Trial B. This trial (Table 2) was conducted as a Latin square having four periods of 21 days each. A fifth period was conducted, but the data were deleted for purposes of analysis. However, the wastage in period V, in which pigs were returned to the feeders on which they had

started, was far greater for two of the feeders, No. 6 and 3, (82 and 38 lb., respectively) than it had been in period I. Feeder means and litter means are shown in Table 2. Since these groups represent individual litters, extrapolation to trials using randomization is not justified; however, significant differences between groups occurred in two trials.

Trial C. Trial C was begun as 28-day periods, but due to rapid gains the first 28-day period was followed by three 21-day periods so that the pigs would not be too heavy at the end of the trial. Therefore, comparisons between periods would be biased. Data for feeder means and pig group means are included in Table 2. The rotary feeder will not be discussed and is not listed in Table 1. New platforms for more accurate study of round feeders were prepared for Trial G.

Trial D. Trial D (Table 3) was conducted as 21-day periods for periods I, II, and IV; however, period III was inadvertently only of 14 days' duration.

Trial E. Trial E (Table 3) included one manufacturer's experimental model (No. 10) with a circular opening. All periods were 21 days long. In this trial pounds wasted per period approached significance ($P \cong .05$).

Trial F. The inclusion of only three feeders in Trial F (Table 4) reduced degrees of freedom to the point where differences necessary for significance were very large. Period I was 28 days, but because of the rapid gains, periods II and III were held to 21 days each so that the pigs would not be too heavy at the end of the trial. The addition of a "feeder-saver lip" to the Jamesway (No. CB 1764) resulted in slight reduction in wastage per pound offered (0.015 vs. 0.013) in Trial F compared to Trial E. However, even if the differences were greater, comparisons between trials are less reliable than comparisons based on replications within a trial.

Trial G. A missing plot was calculated for period III because the baffle on the Oakes rotary was accidentally left up for 1 week. Largely as a result of this, wastage per day was not significant ($P > .05$), but wastage per lb. offered was significantly different ($P < .05$) among feeders. All periods were of 21 days duration.

Rotation of pig groups is desirable for statistical reasons, but the need to adjust the feeders increases wastage in some cases. This was judged a factor with feeder No. 14 in Trial F, in which adjustments were relatively critical. Performance probably would be better under field conditions. Also, this particular feeder was judged more effective for young pigs than for those that weighed 200 lb. or more.

In practical terms, the authors would not suggest using a feeder which wastes more than 3 per cent feed nor one which lacks features necessary for long life.

For the conduct of feeding trials or nutrition research, the need to consider feeder characteristics and to adjust feeders carefully is of great importance. Failure to attend to either aspect can introduce errors which exceed the differences among treatments expected in present-day research.

The implications of this variation should be extended to the current emphasis on restricted feeding as a means of reducing feed input per pound of gain.

TABLE 1. CHARAC

Feeder Name	Manufacturer	Principal Structural Material	Adjustments	Agitator	No. of Sides In Model Tested
1 Smidley No. 6	Marting Mfg. Co. Washington Court House, Ohio	Wood	Yes (Very Effective)	Yes	2 (6 lids)
2 Thumabilt	Thuma Mfg. Co. Washington Court House, Ohio	Wood	Yes	Yes	2 (8 lids)
3 Premier	National Ideal Co. Toledo 6, Ohio	Metal	Yes	No	1 (2 lids)
4 Oakes (Old Model)	Oakes Mfg. Co. Tipton, Ind.	Metal	Yes (Slips)	No	1 (6 lids)
5 Oakes (New Model) "D-hole" No. 411-10	Oakes Mfg. Co. Tipton, Ind.	Metal	Yes	Yes	2 (4 lids)
6 Unico 10 bushel	Southern States Cooperative	Metal	Yes	No	2 (4 lids)
7 Clearwater Tank No. 420	Clearwater Tank Co. Dannsville, Ill.	Metal	Yes	No	2 (4 lids)
8 Brower No. 4G	Brower Mfg. Co. Quincy, Ill.	Metal	Yes	Yes	2 (8 lids)
9 Brower No. 2G	Brower Mfg. Co. Quincy, Ill.	Metal	Yes	No	1 (4 cups) (No. lids)
10 Shenandoah No. HF 10	Shenandoah Equipment Co. Harrisonburg, Va.	Metal	Yes	No	1 (2 lids)
11 Shenandoah No. HF 11	Shenandoah Equipment Co. Harrisonburg, Va.	Metal	Yes	No	1 (2 lids)
12 Jamesway No. CB1764	James Mfg. Co. Fort Atkinson, Wis.	Metal	Yes	Yes	2 (4 lids)
13 Warner No. 702	Warner Brooder Corp. New Manchester, Ind.	Metal	Yes	No	2 (4 lids)
14 Big Dutchman No. 20-28-0000	Automatic Poultry Equipment Co. Zeeland, Mich.	Metal	Yes	Yes	Round (6 positions)
15 Jamesway with Feed Saver Lip No. CB1764	James Mfg. Co. Fort Atkinson, Wis.	Metal	Yes	Yes	2 (4 cup)
16 Jamesway 2 cup No. FB1770	James Mfg. Co. Fort Atkinson, Wis.	Metal	Yes	No	1 (2 cup)
17 Dawson	Lifetime Gate Corp. Crawfordsville, Ind.	Wood	No	Yes	2 (8 lids)
18 Big Dutchman	Automatic Poultry Equipment Co. Zeeland, Mich.	Metal	Yes	No	2 (equivalent 6 lids)
19 Oakes No. 444	Oakes Mfg. Co. Tipton, Ind.	Metal	Yes (external crank)	No	Round

*Trial A–Winter 1958-59 (65 days duration) 4 pigs/lot - Pigs not shifted from one feeder to another.
Trial B–Summer 1959 (105 days duration) 6 pigs/lot - Pigs rotated.
Trial C–Winter 1959-60 (91 days duration) 5 pigs/lot - Pigs rotated.
Trial D–Spring 1961 (77 days duration) 5 pigs/lot - Pigs rotated.

TICS OF FEEDERS

	Weather Tight Features	Compartments In Trough	Bolts With Lock Washers	Ground Feed Wasted *Trial	*Per Cent	Comments and Evaluations
	Good (Double end-wall)	Yes	–	A B C G	†6.0 ‡2.0 ‡1.0 ‡1.0	Recommend the 3½" baffle plate. Excellent control of feed flow. High cost but expect longest life.
	Fair	No	–	A	20.	Could not set adjustable baffle lower because of agitators.
	Poor in time	No	No Self-tapping screw	A B	6.0 4.0	Self-tapping metal screws judged not satisfactory.
	Fair	No	No	A B	2.0 2.0	Previous experience less satisfactory than that during trials.
way eed	Satisfactory	No	Yes	C D	2.0 2.0	"D-hole" features seem valuable in control of waste. Considered one of the best metal feeders studied
	Fair	No	No	B C	5.0 6.0	
ut)	Fair	Yes	No Self-tapping screw	D	3.0	Corrugations prevent slippage of baffle. Not fully satisfactory; wastage 8 per cent with one group of pigs.
	Satisfactory	No	Yes	D	4.0	Wastage 7 per cent in one period.
	No (Interior use)	No	No	D	2.0	For inside use only. Positive (drilled hole) adjustment control, but only 4 positions.
l :)	Satisfactory	No	Yes	E	1.0	Experimental Model
	Satisfactory	No	Yes	E	2.0	
)	Good	No	Yes	E	1.5	Very good construction.
	Satisfactory	No	Yes	E	2.5	Wastage reached 4 per cent in one period.
	No (Interior use)	Yes	(Cast iron base)	F	2.0	Small capacity (intended for use in auger fed automated system). Adjustment critical. Mounted on "Feed Saver Tray."
ed p	Good	No	Yes	F	1.3	Very good construction.
t)	Satisfactory	No	Yes	F	1.4	Very good construction.
	Fair	Only partial	–	G	4.0	Judged less durable than other wooden feeders studied.
	No (Interior use)	No (But double struts)	Yes	G	0.5	Very satisfactory performance. Intended for use with automatic refilling equipment. Struts seem important in controlling waste.
	Good	No	Yes (Serrated nuts)	G	1.0	Very satisfactory performance.

Trial E–Spring 1962 (84 days duration) 4 pigs/lot - Pigs rotated.
Trial F–Autumn 1962 (70 days duration) 5 pigs/lot - Pigs rotated.
Trial G–Spring 1963 (84 days duration) 4 pigs/lot - Pigs rotated.
†Narrow Baffle
‡Wide Baffle

TABLE 2. FEED WASTAGE DATA, TRIALS A AND B

Feeder and Group	Lb. wasted/ day	Lb. wasted/ lb. offered	Lb. wasted/ lb. gain
Trial B, Feeder Means			
Feeder			
4 Oakes (old model)[a]	0.58	0.025	0.076
6 Unico[a]	0.64	0.030	0.089
1 Smidley No. 6 (3½" baffle)	0.45	0.021	0.062
3 Premier	0.68	0.033	0.093
Trial B, Group Means			
Pig Group			
1	0.49	0.017	0.055
2	0.71	0.035	0.104
3	0.66	0.035	0.090
4	0.49	0.022	0.071
Difference for P< .05 significance	1.63	0.022	0.072
Trial C, Feeder Means			
Feeder			
5 Oakes No. D-10	0.48	0.025	0.080
1 Smidley No. 6 (3½" baffle)	0.23	0.011	0.036
6 Unico	1.33	0.063	0.212
X "X" Rotary	–	–	–
Trial C, Group Means			
Pig Group			
1	0.76	0.037	0.119
2	0.44	0.021	0.066
3	1.22	0.060	0.212
4	0.61	0.026	0.092
Difference for P< .05 significance	0.85	0.044	0.16

[a] This model superseded by a later one.

TABLE 3. FEED WASTAGE DATA, TRIALS D AND E

Feeder and Group	Lb. wasted/ day	Lb. wasted/ lb. offered	Lb. wasted/ lb. gain
Trial D, Feeder Means			
Feeder			
5 Oakes No. D-10	0.36	0.017	0.066
7 Clearwater Tank No. 420	0.63	0.028	0.103
8 Brower No. 4-G	0.93	0.040	0.154
9 Brower No. 2-G	0.36	0.015	0.056
Trial D, Group Means			
Pig Group			
1	1.16	0.052	0.196
2	0.39	0.017	0.066
3	0.50	0.021	0.080
4	0.23	0.010	0.038
Difference for P< .05 significance	0.65	0.035	0.12
Trial E, Feeder Means			
Feeder			
10 Shenandoah No. HF 10	0.26	0.013	0.042
13 Warner No. 702	0.61	0.028	0.110
11 Shenandoah No. HF 11	0.41	0.019	0.065
12 Jamesway No. CB 1764	0.33	0.015	0.060
Trial E, Group Means			
Pig Group			
1	0.24	0.011	0.041
2	0.48	0.022	0.086
3	0.46	0.021	0.075
4	0.44	0.020	0.071
Difference for P<.05 significance	0.34	0.018	0.062

TABLE 4. FEED WASTAGE DATA, TABLES F AND G

Feeder and Group	Lb. wasted/ day	Lb. wasted/ lb. offered	Lb. wasted/ lb. gain
Trial F, Feeder Means			
Feeder			
14 Big Dutchman No. 20-28-0000	0.54	0.020	0.060
12 Jamesway No. CB 1764	0.33	0.013	0.035
16 Jamesway No. CB 1770	0.38	0.014	0.042
Trial F, Group Means			
Pig Group			
1	0.47	0.017	0.052
2	0.36	0.014	0.042
3	0.41	0.015	0.043
Difference for P<.05 significance	0.93	0.094	0.091
Trial G, Feeder Means			
Feeder			
17 Dawson (8 openings)	0.92	0.041	0.240
18 Big Dutchman (European Design)	0.085	0.005	0.018
19 Oakes (Round) No. 444	0.22	0.010	0.058
1 Smidley No. 6	0.18	0.009	0.032
Trial G, Group Means			
Pig Group			
1	0.24	0.014	0.075
2	0.25	0.013	0.048
3	0.51	0.021	0.140
4	0.39	0.018	0.078
Difference for P< .05 significance	0.87	0.029	0.28

Summary

Feed wastage has been measured in seven trials involving 19 feeders. Significant linear regressions of change in wastage per week occurred in the first trial in which pigs remained on the same feeder from weaning to market. These regressions for individual feeders were significantly different from each other and were not all of the same sign. Six subsequent trials were designed as Latin squares. There were significant differences among feeders in four trials.

From the standpoint of conduct of nutrition experiments, the significant variation between pig groups in some of these trials is important. Such variation could increase errors in feed "consumption" as recorded for different rations if feeders permitting appreciable waste were to be used. Several structural design features have been found to be associated with wastage.

Literature Cited

May, Joyce M. 1952. Extended and corrected tables of the upper percentage points of the "Studentized" range. *Biometrika* 39: 192.

Snedecor, G. W. 1956. *Statistical Methods.* (5th ed.) Iowa State College Press, Ames, Iowa.