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LIQUID FEEDING OF HOGS WITH FEED-LEVEL-SENSORS IN THE TROUGHS

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ABSTRACT

Liquid feeding of hogs can be controlled by using feed-level-sensors in the troughs. In this way restricted feeding with computer control of the eating time is possible. For this purpose the feed supplied is adjusted according to the eating time of the previously fed portion. With ad libitum feeding the same sensors can provide for a clean trough once a day and thus help to overcome sanitary problems. The effect of the feeding systems on daily intake and performance of hogs are dealt with.

Key Word: Liquid Feeding of Hogs, Feed-Level-Sensor, Control of Eating Time

INTRODUCTION

Liquid feeding - contrary to dry feeding - can be used for all feeds. It thus allows free selection and unrestricted adaptation to changing market conditions for feeds.

Restricted liquid feeding usually is done by mass control or volume control along a ration-curve, which adjusts for the age of the pigs. This rigid method does not take into consideration that the appetite or feed intake of the hogs may vary with the climatic conditions and the health. Feeding in accordance with the influence of these factors is possible by controlling the eating time.

Many farmers try to do this manually; they view the troughs some minutes after filling and adjust the ration curve for the next feeding somewhat in case they assume the meal is consumed too fast or too slowly. This paper deals with computer controlling of the eating time using feed-level-sensors in the troughs.

Ad libitum liquid feeding in the past often led to spoiled feed and thus to sanitary problems. These problems too can be overcome by placing feed-level-sensors in the trough, which signalize to the computer whether the trough is filled or empty.

In this way computer controlled ad libitum feeding can provide for a preset supply time per day and thus for a clean trough at least once a day.

CONCEPT FOR THE COMPUTER CONTROL

A conventional liquid feeding system with a mixing tank resting on a strain-gage weighing system is used. The strain-gage weighing system functions as the sensor for controlling the feed intake for batch-mixing. However, the control of the feed mix supply to the pens is quite different from the conventional method. In addition to the conventional mass-control or volume-control the feed supply to the pens is controlled by feed-level-sensors in the trough (Fig. 1). These sensors signalize to a personal-computer whether the trough contains feed or is empty. They consist of two metal probes with an electric potential of 8 to 24 volts between them; their function relies on the change of the electric resistance when dipping into the feed-soup. The personal-computer converts the signals to orders for the conventional computer of the liquid feeding system.

FEED LEVEL SENSORS

It is necessary to distinguish between full state sensors and empty state sensors. Both are hardly suitable for precise metering along a ration-curve with restricted feeding.

With full state sensors the flowing of the feed in the trough can result in inaccurate information about the level of filling. The feed coming from the delivery tube is reflected at the ends of the trough (Fig. 2). In this way the signal for a full trough is given too early. Furthermore, stirring of the feed-soup by the hogs leads to inaccurate signals.

Empty state sensors in principle are not suited for metering along a ration-curve. But they can be used as sensors for controlling the eating-time with restricted feeding or for controlling the supply-time with ad libitum feeding (Fig. 3). Thus the sanitary problems with liquid ad libitum feeding can be solved. For restricted feeding empty state sensors can be combined with feed metering by mass using the weighing system of the mixing tank or by volume using an inductive flow meter. With this combination the feeding system can be programmed such that at each mealtime a minimum portion as a fixed percentage of the conventional ration-curve plus a supplemental portion are given. The supplemental portion depends on the eating speed or eating time for the minimum portion.

PROGRAM FOR CONTROL OF EATING TIME

The minimum portion at each meal-time was either 65%, 75%, or 85% of the ration-curve for restricted feeding.
The supplemental portion was served 20 minutes later than the minimum portion. The amount of feed given with the supplemental portion depended on the eating time for the minimum portion (Table 1). The faster the minimum portion was eaten, the more feed was delivered in the supplemental portion, and vice-versa. However, there was an upper limit in the supplemental portion depending on the amount given with the minimum portion (Table 1). No supplemental portion was granted if with the minimum portion amounting to 65% of the conventional ration-curve the eating time was more than 8 minutes. The same was programmed if with the minimum portion amounting to 75% or 85% of the conventional ration curve the eating time was more than 9 or 10 minutes respectively.
In short, the amount of feed given in the supplemental portion depended on the eating speed with the minimum portion. Thus the total amount of feed served was defined by man's computer program as well as by hog's behaviour.

PROCEDURE OF INVESTIGATIONS

A feed mix consisting of barley, wheat, extracted soybean meal and a mineral supplement containing vitamins and lysine was used. The relation water : dry matter was 3:1. The dry feed had 13,1 MJ metabolizable energy per kg.
The feeding strategies used were:

1. restricted feeding along the conventional ration-curve, i.e. BHZP ration-curve (Neupert, 1989),
2. feeding with a computer controlled eating time by supplying a minimum portion as a fixed percentage of the conventional ration-curve plus a variable supplemental portion at each mealtime,
3. ad libitum feeding with a daily supply time of 12 hours during the whole fattening period,
4. ad libitum feeding as stated above until the 10th fattening week, thereafter daily supply time limited to 2 hours.

In all cases the feed was distributed to the pens by computer-controlled inductive flow metering. Empty state feed level sensors were used with controlled eating time feeding and with ad libitum feeding. With restricted feeding along the ration curve and with controlled eating time feeding the hogs were fed twice a day, i.e. in the morning and 7,5 hours later in the afternoon.

RESULTS IN FEED INTAKE

With the restricted feeding along the conventional BHZP ration-curve the feed intake increased evenly within the fattening period - as programmed. When the computer controlled eating time programs were used, the same held true merely on the average of several weeks. In these cases the feed intake varied considerably from mealtime to mealtime. The programmed scope in supply between the lower feeding curve consisting merely of the minimum-portion and the upper feeding curve consisting of the minimum portion plus the maximum supplemental portion was fully utilized. When the minimum portion amounted to 75% of the conventional ration-curve, the maximum supply with the highest supplementary portion was 50% more of the conventional ration (Table 1). Despite this considerable difference meals with maximum intake and minimum intake followed each other directly several times (Figure 4). The results indicate that feeding along an evenly increasing ration-curve can be far away from hog's appetite, which can change considerably within short time spans. The time which elapsed between the afternoon meals and the morning meals was approximately twice that vice-versa. But despite this the feed intake in the morning in most cases was lower than in the afternoon. In this way the results confirm the contention of ethologists that pigs are dull in the morning.

Figure 5 shows the feed intake when the main portion amounted to 85% of the conventional feeding curve. Again meals with maximum intake and minimum intake several times follow each other immediately, and again the intake in the morning in most cases is lower than in the afternoon.

The daily feed intake with ad libitum feeding increased on the average with the age of the pigs - as can be expected. Yet there also were substantial differences in intake from day to day; the difference between the 33th and 34th day was 61% (Figure 6).

RESULTS IN PERFORMANCE

In the first series of trials restricted feeding along the conventional ration-curve, restricted feeding with eating time control for 9 minutes per total mealtime, and ad libitum feeding were compared. Ad libitum feeding resulted in the highest daily feed intake, the highest daily weight gain, but the lowest percentage of lean meat, as can be expected (Figure 7). Restricted feeding along the conventional ration-curve or with eating time control had the same average daily feed intake and percentage of lean meat. But control of the eating time instead of conventional restricted feeding resulted in a higher daily gain and had the best feed efficiency.

In the second series of trials only restricted feeding methods either along the conventional ration-curve or with eating time control were compared (Figure 8). With

eating time control the programs for 9 minutes as well as for 10 minutes per total mealtime (Table 1) were used. Again there were no significant differences in the mean daily feed intake and in the percentage of lean meat. But both methods of eating time control again were better than the conventional ration-curve in the daily gain and therefore also in the feed efficiency.
In a third series of trials only the three programs for the eating time control (Table 1) were compared (Figure 9). No significant differences in any criteria showed up.

CONCLUSIONS

It is known, that increasing the daily feed intake lowers the maintenance energy per unit of weight gain, but in final feeding stage results in more fat production. The energy needed per mass unit of weight gain for fat is several times higher than that for meat. A high daily feed intake in the final stage therefore - despite savings in maintenance energy - impairs the feed efficiency. Even more important is that the market strives for lean meat. With ad libitum feeding the energy intake in the liquid state is even higher than in the dry state. The performance results can be explained by this context. However, since in the first feeding stage fat production hardly takes place, ad libitum feeding in this stage still may be efficient.

With restricted feeding the performance differences between the conventional ration-curve and eating time control cannot be explained by differences in the average feed intake. The differences in the mean intake were very small and not significant. The better feed efficiency with eating time control probably results from the fact, that the within short time distances considerably changing appetite of the hogs was taken care of. Eating time control by feed-level-sensors in the trough thus in effect makes it possible to compromise between the conception of man and the varying craving of the hog from mealtime to mealtime.

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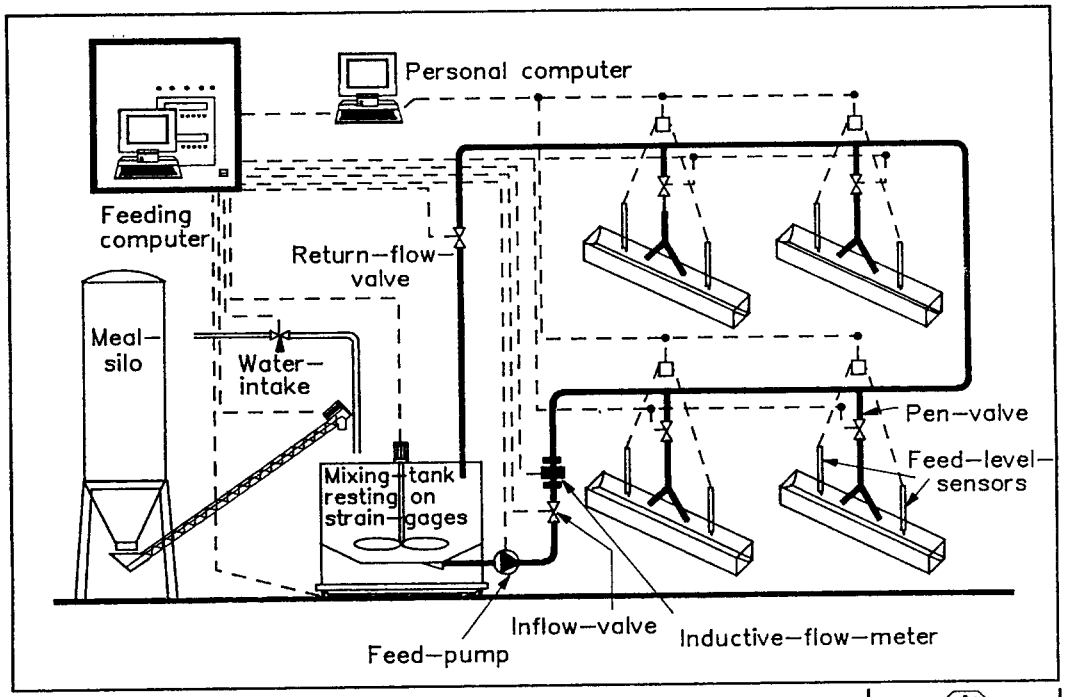
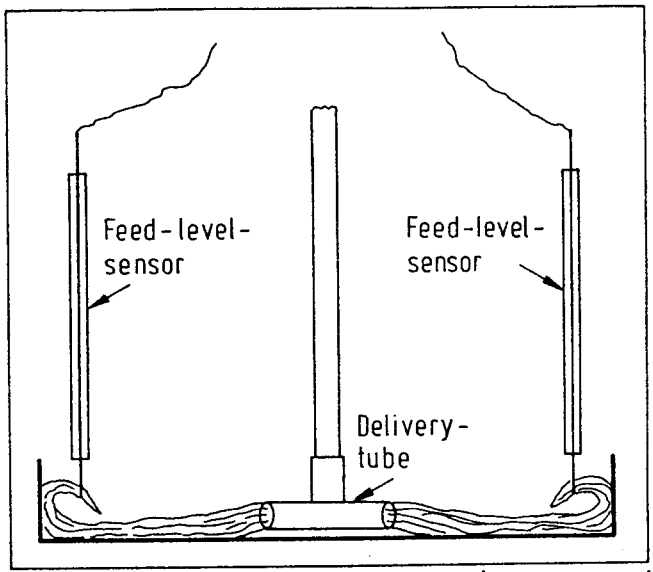


Fig. 1: Liquid feeding with eating time control using feed–level–sensors in the troughs



Inflow of liquid feed into the trough

Fig. 2

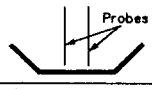
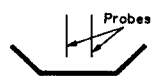
	Empty–state–sensor 		Full–state–sensor 
	Metering of the feed–quantity per trough		
	Mass–metering by strain–gages of the mixing–tank	Volume–metering by inductive flow–meter	volume–metering by feed–level–sensor
Adjusting of the feed–portion	centrally by using the key–board or the program of the computer		decentrally at each trough
Precision in metering	satisfactory		not satisfactory for restricted feeding
Trough–hygiene with ad libitum feeding	statisfactory, since always an empty trough is refilled		not always satisfactory
Recording of the feed quantity per trough	possible via monitor–screen or via printer		not possible
Recording of the supply–time per trough			not possible

Fig.3: Liquid feeding by empty–state– or full–state–sensor in the trough

Minimum - portion = 65 % of conventional ration - curve		Minimum - portion = 75 % of conventional ration - curve		Minimum - portion = 85 % of conventional ration - curve	
Eating - time in s for minimum - portion	Supplemental - portion in % of the ration - curve	Eating - time in s for minimum - portion	Supplemental - portion in % of the ration - curve	Eating - time in s for minimum - portion	Supplemental - portion in % of the ration - curve
> 500	0	> 540	0	> 590	0
500 - 410	10	540 - 450	10	590 - 540	10
410 - 360	15	450 - 400	15	540 - 450	15
360 - 310	20	400 - 350	25	450 - 400	20
310 - 260	30	350 - 300	35	400 - 350	25
260 - 210	40	300 - 250	40	350 - 300	30
210 - 160	50	250 - 205	45	300 - 250	35
< 160	60	< 205	50	< 250	40
Mean total eating - time per meal for minimum - and suppl. - portion ≈ 8 min		Mean total eating - time per meal for minimum - and suppl. - portion ≈ 9 min		Mean total eating - time per meal for minimum - and suppl. - portion ≈ 10 min	

Table 1: Supplemental - portion depending on the eating - time for the minimum - portion

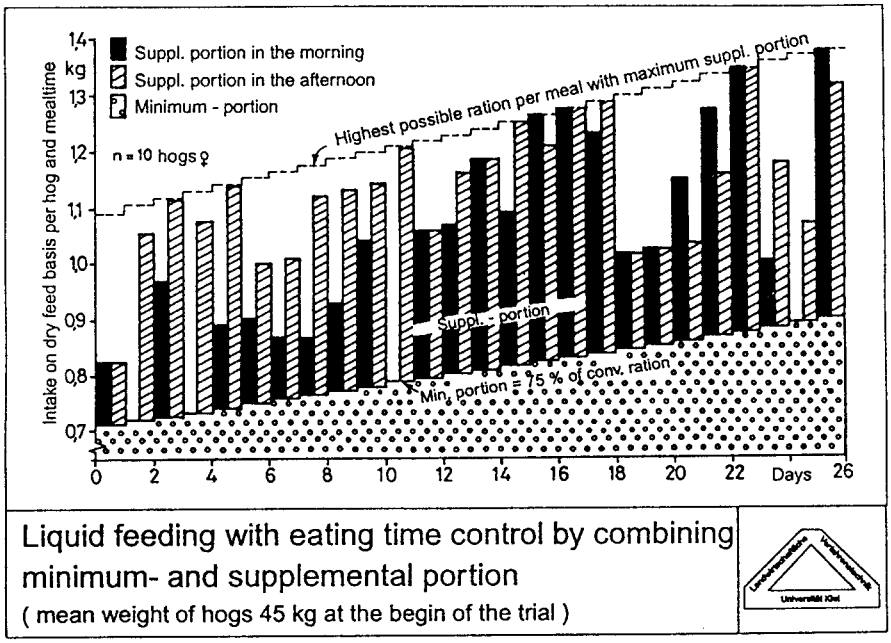


Fig. 4

Liquid feeding with eating time control by combining minimum- and supplemental portion
(mean weight of hogs 45 kg at the begin of the trial)

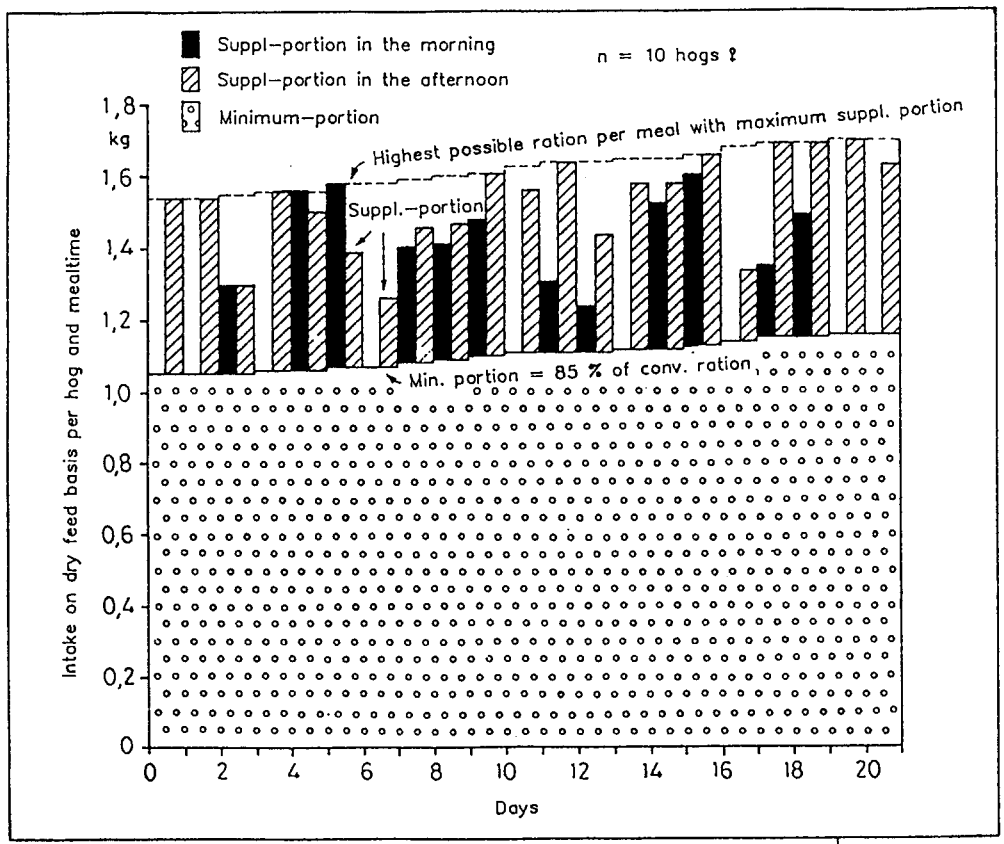


Fig. 5: Liquid feeding with eating time control by combining minimum– and supplemental portion
(mean weight of hogs 70 kg at the begin of the trial)

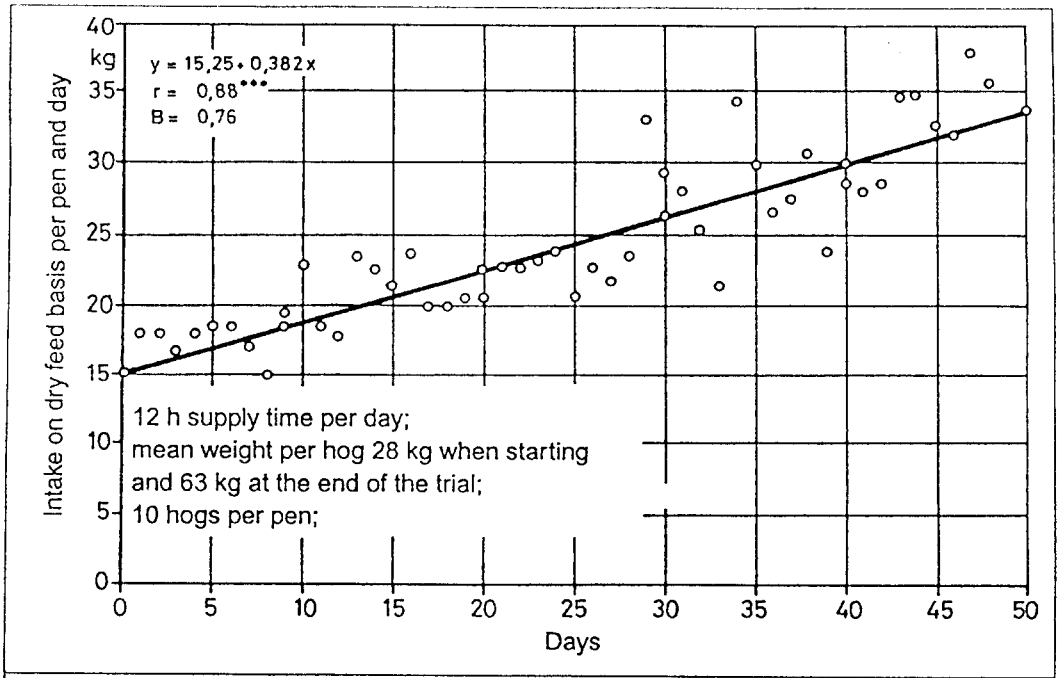


Fig. 6: Liquid ad libitum feeding with feed - level - sensors in the trough

Feeding-system	Number of hogs (n)	Final-weight (kg)	Mean intake on dry feed basis per day (kg)	Lean-meat (%)	Daily gain (g)	Feed-efficiency
Restricted feeding along conv. ration-curve	115 (57♂,58♀)	97.5	1.99	52.5	644	3.09:1
Restricted feeding with eating time control (9min.per total mealtime)	124 (71♂,53♀)	100.4	2.06	52.0	723	2.85:1
Ad libitum feeding 12h supply time	106 (50♂,56♀)	100.9	2.55	50.0	817	3.19:1
Ad libitum feeding 2h supply time (final stage)	119 (59♂,60♀)	97.3	2.61	50.9	826	3.08:1
LSD 5%		1.9	0.15	0.96	25.9	0.14

Fig. 7 Performance results of liquid feeding systems (starting weight of hogs 25kg)

Feeding - system in the final stage	Number of hogs (n)	Final - weight (kg)	Mean intake on dry feed basis per day (kg)	Lean - meat (%)	Daily gain (g)	Feed - efficiency
Restricted feeding along conventional ration - curve	38 (20♂, 18♀)	106,3	2,231	54,33	684	1:3,300
Restricted feeding with eating time control (9 min. p. total meal)	39 (19♂, 20♀)	111,4	2,339	53,34	749	1:3,142
Restricted feeding with eating time control (10 min. p. total meal)	39 (20♂, 19♀)	109,7	2,290	53,23	734	1:3,148
LSD 5 %		2,89	0,15	1,22	29	0,15

Fig. 8: Performance results with restricted liquid feeding (starting weight of hogs 50 kg)

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Program in eating time control	Number of hogs (n)	Final - weight (kg)	Mean intake on dry feed basis per day (kg)	Lean - meat (%)	Daily gain (g)	Feed - efficiency
Min. portion = 65 % (8 min. p. total meal)	40 (20♂, 20♀)	107,3	1,987	54,57	639	1:3,149
Min. portion = 75 % (9 min. p. total meal)	42 (22♂, 20♀)	106,9	2,042	54,75	653	1:3,135
Min. portion = 85 % (10 min. p. total meal)	40 (21♂, 19♀)	109,2	2,112	54,37	679	1:3,181
LSD 5 %		2,55	0,14	1,15	27	0,22

Fig. 9: Performance results with eating time control in restricted liquid feeding (starting weight of hogs 50 kg)

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