Piglet Rearing with an Automatic Tube Mash Dispenser or Interval Feeding

Hinrich Snell, Jürgen Hofsommer and **Herman Van den Weghe**
Research Centre for Animal Production and Technology, Vechta

During two rearing periods, a newly developed automatic interval feeding mash dispenser was compared with a conventional automatic tube mash dispenser with regard to its suitability for piglet rearing.
The use of the automatic interval mash dispenser did not lead to improved rearing performance. Feed consumption, however, increased. The design of the feed trough as well as the kind of feed metering must be discussed as possible reasons.
Animal behaviour was also significantly influenced by the feeding system. At the automatic tube feed dispenser, more eating processes were observed, and fewer animals showed interest in eating without actually doing it. The results of the first rearing period indicate that increased aggression must be expected if the setting of automatic interval feeding mash dispensers is relatively restrictive.

Keywords
Piglet production, piglet rearing, feeding technology, interval feeding

Introduction

As a consequence of structural change in livestock farming, piglet rearing is increasingly being shifted to larger, highly specialized farms and operational units. In these areas, the process technology used must meet great demands. In addition to the optimization of stall climate and pen design, attention is particularly focusing on feeding technology, which is the prerequisite for the exploitation of the biological performance potential of the rearing piglets. It also exerts significant influence on the feed expenditure for body mass increase, the amount of piglet losses, and different fields of piglet behaviour.
The spectrum of feeding systems available on the market is large. After liquid sensor feeding at the short trough was described in an earlier contribution [1], the present study was intended to compare a conventional automatic tube mash dispenser with a newly developed automatic interval feeding mash dispenser. As criteria, characteristics of the behaviour and the biological performance of the rearing piglets were employed.

Animals, Material, and Methods

Mode of Procedure

The studies were carried out during two successive rearing periods (14/2/2001 until 6/4/2001; 11/4/2001 until 30/5/2001) in two compartments of a piglet rearing stall, which were stocked with animals of the same sex. Since it was possible to realize a favourable, uniform stall climate as will be explained below, repetitions of the trials in other seasons could be dispensed with.
In both compartments, observation pens were used one of which was equipped with an automatic tube mash dispenser and the other one featured an automatic interval feeding mash dispenser. On the stalling-up days, each of these four experimental pens was stocked with 40 individually marked and weighed animals. Subsequently, characteristics of stall climate, animal behaviour, and rearing performance were registered.

The Examined Stall System

The examinations were carried out in Bühren (Cloppenburg county). The farm chosen for the study had ca. 1,400 piglet rearing places, 2,300 fattening places, and co-owned a sow stall with 1,500 productive sows. In the sow stall, Hülsenberg hybrid sows were kept which were mated with stress-resistant Pietrain boars. The piglets were weaned after 21 days and then raised on the partners´ farms. On the farm selected for the study, they were kept in the piglet rearing stalls until they reached a live mass of ca. 25 kg. Afterwards, the largest part of them was fattened on the owner´s farm. Excess piglets were sold to fattening farms in the region.

Housing System

The trials were carried out in a rack-shaped stall with six compartments and a lateral service aisle. For the studies, two large pens with an area of 14.66 m^2 each were created in each of the two compartments. Per piglet, 0.366 m^2 were available. The exact measurements are shown in the ground plan (**figure 1**).

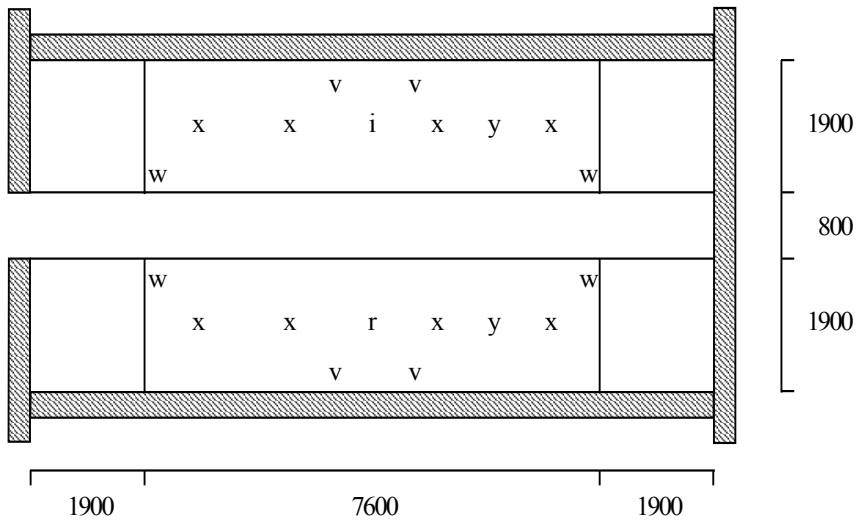

Figure 1: Ground plan of a trial compartment; measurements in mm.
i, automatic interval feeding mash dispenser; r, automatic tube feed dispenser (ad libitum feeding); v, video camera; w, biting nipple drinkers; x, measuring points for discontinuous climate measurements; y, measuring points for humidity and temperature

The pens were separated by galvanized iron bars, whereas plastic boards and galvanized pipes served to separate the pens from the aisle. The pen floor consisted of fully perforated plastic grids. Computer-controlled door hole ventilation with underfloor suctioning and central exhaust air discharge was used for climate control. For the heating of the compartments, one gas convector was installed at the end of each feeding aisle. The stall did not have any windows. During the trial period, the observation compartments were permanently lighted artificially.
Stocking was done stall-wise using the all in – all out method.

Feed Supply
In each trial compartment, one observation pen each was equipped with a conventional automatic tube mash dispenser (Lean Machine, company Big Dutchman, Calveslage) or a newly developed automatic interval feeding mash dispenser (prototype, Atka company, Lohne) respectively. Both were filled by hand. Before, the feed was weighed on an electronic scale.
At the automatic tube mash dispenser, the piglets permanently had feed at their disposal. In the trough bowl (d = 400 mm), they were able to mix it with water from spray nipple drinkers.
At the automatic interval feeding mash dispenser (**figure 2**), the piglets received feed in 30-minute intervals between 6:00 a.m. and 11:30 p.m. The feed was dispensed by an auger conveyor installed below the storage container. For feed metering, a system-programmable controller was employed which determined the number of auger revolutions.
The auger was driven pneumatically. During each stroke of the pneumatic cylinder, a valve was opened through which water was metered into the trough bowl (d = 600 mm). This valve was set such that the piglets were able to mix feed and water into mash. In addition to water supply at the automatic feed dispensers, two biting nipple drinkers were available in each pen at different heights.

Registration of Feed Intake- and Social Behaviour
The studies focused on the registration of animal behaviour. For this purpose, time lapse video films were shot weekly for one day. The arrangement of the cameras is shown in the ground plan (figure 1).

Observation of Anonymous Piglets
With the aid of the *scan sampling* method, anonymous data about the eating behaviour of the piglets were gained. For this purpose, the complete recordings of one day (12:00 a.m. until 11:56 p.m.) of each rearing week were evaluated. The following data were recorded:

- How many animals ate at the trough?
- How many animals showed interest in eating, but did not get the opportunity to eat?
- How many animals sucked on other animals?
- How many animals bit other animals?
- How many animals were sucked on?
- How many animals were bitten?

The evaluation of the first day was carried out in 2-minute intervals. After a comparison of the results gained in 2-minute intervals and 4-minute intervals obtained by cancelling every second value had not shown any remarkable differences, the recordings were evaluated in 4-minute intervals.

Observation of the Focus Animals
For the observation of individual animals, ten animals per pen were marked with additional earmarks immediately after stalling up in order to allow them to be found quickly. Once per week, the backs of these focus animals were marked with animal marking spray.
The evaluation of the behaviour of these piglets was limited to four days per rearing period. The videotapes of one day of each of the rearing weeks 1, 2, 3, and 5 (rearing period I) as well as 1 (automatic tube mash dispenser only), 2 (automatic interval feeding mash dispenser only), 3, 4, and 6 (rearing period II) were assessed. The chosen observation interval was again 4 minutes. The following data were collected:

- Which focus animals ate during observation?
- Which focus animals actively participated in aggressive acts (as “perpetrators”)?
- Which focus animals passively participated in aggressive acts (as “victims”)?
- Which focus animals sucked on other piglets?
- Which focus animals were sucked on?
- Which focus animals were interested in eating, but did not do it even though they were not driven away?
- Which focus animals were interested in eating, but were driven away from eating?

Registration of the Housing Environment
In 15-minute intervals, air temperature and relative humidity were measured by one sensor (Tiny Tag, company Gemini Data Loggers, UK) per pen installed at a height of ca. 900 mm. Once per week, ammonia concentration was measured discontinuously at four points per pen at animal height (ca. 300 mm) using the measuring instrument Pac III E (Dräger company, Lübeck). Air speed was measured with the aid of a hot-wire anemometer (GGA-26, Alnor company, Finland). The measurements were carried out at the same places and at the same time as the measurement of ammonia concentration.
For the description of stall hygiene, pen cleanliness in the observation pens was evaluated on those days on which discontinuous stall climate measurements were carried out. For this purpose, a sketch of each pen was made which showed zones of different soiling degrees (1, clean to 5, very dirty). The sketches were digitalized.

Figure 2: Automatic interval feeding mash dispenser, arrangement in the pen

Then, the areas of different soiling degrees were quantified with the aid of the image processing program Adobe Photoshop 6.0 using the pixel number as a criterion.

Data Evaluation

The data were entered and organized using the the spreadsheet program Microsoft Excel 2000. Subsequent data analysis was carried out with the statistics program SAS 8.01. The statistical methods employed are described in reference [2].

Results and Discussion

Biological Performance

Table 1 shows the body mass development of the rearing piglets. The trial period exerted a significant ($p < 0.05$) to highly significant ($p < 0.01$) influence on all listed characteristics. The feeding system had a tendential ($p < 0.10$) influence. Interaction between these two factors was significant in all cases.

Secured differences between the trial compartments could not be established. The known strong influence of the stalling-up mass on body mass development after stalling-up was confirmed by the present study ($p < 0.01$).

A comparison of the two feeding systems showed that the newly developed automatic interval feeding mash dispenser did not enable any larger weight gains to be achieved than conventional ad libitum feeding with an automatic tube mash dispenser. In the first rearing period, body mass development at the automatic interval feeding mash dispensers was even worse.

Independent of the mentioned influencing factors, biological performance during the two trial periods was at a relatively low level. In previous studies in an outdoor climate stall [3], daily weight gain (LSM, Least Squares Means) during two rearing periods amounted to 468 and 408 g/d at stalling-up masses of 9.4 and 8.0 kg/animal respectively. In a rearing stall with liquid sensor feeding [1], a daily weight gain of 428 to 444 g/d was established depending on sex and stocking intensity. In this case, stalling-up masses amounted to 5.9 to 6.5 kg/animal. Given these considerations, it must be emphasized that during the trial presented here the farm manager mentioned current health problems in the stall.

Table 2 characterizes feed consumption during rearing. It is shown clearly that during both rearing periods considerably more feed was used at the automatic interval feeding mash dispenser. This observation was independent of the trial compartment. During ad libitum feeding, increase-related feed expenditure was significantly better than in the comparative system.

With regard to possible reasons, the sub-optimal design of the feed trough (large diameter, edge design, no feeding place dividers) and the waste of food caused by these features must be mentioned first (cf. **figure 3**). Second, the metering technique (no sensor in the feed trough, no daily periodicity) must be analyzed critically. Due to this system, feed was metered out even

Table 1: Body mass development as a function of the rearing period and the feeding system

		Period I		Period II	
		Interval	ad libitum	Interval	ad libitum
stalling-up mass [kg/animal]	LSM	$6,3^{b}$	$6,8^{a}$	$6,1^{b}$	$6,0^{b}$
	SE	0,12	0,12	0,12	0,12
stalling-out mass [kg/animal]	LSM	$23,1^{b}$	$25,0^{a}$	$25,3^{a}$	$25,2^{a}$
	SE	0,47	0,48	0,46	0,46
weight increase [kg/animal]	LSM	$16,8^{b}$	$18,7^{a}$	$19,0^{a}$	$18,9^{a}$
	SE	0,47	0,48	0,46	0,46
daily weight gain [g/d]	LSM	$330,4^{b}$	$366,8^{a}$	$388,0^{a}$	$386,6^{a}$
	SE	9,3	9,6	9,23	9,22

LSM, least squares means; SE, standard error
Values in one line which do not feature identical exponent letters differ significantly ($p<0.05$). If the numbers are not marked with exponent letters, there are no significant differences.

Table 2: Feed consumption and number of reared piglets as a function of the rearing period and the feeding system

	Period I		Period II	
	Interval	ad libitum	Interval	ad libitum
feed consumption, total [kg] [1)]	1291	1148	1485	1171
weight increase-related feed expenditure [kg/kg] [2)]	1,96	1,53	2,05	1,59
number of piglets stalled out as planned [n]	73	74	77	76
number of piglets prematurely moved to another stall [n]	5	5	0	3
dead piglets [n]	2	1	3	1

1) Mean values of two pens each. The data include the consumption of those piglets which died or which were moved to another stall during the rearing process.

2) Feed expenditure. Data adjusted to delete the feed consumption of piglets which died or which were moved to another stall during the rearing process. The adjustment was carried out based on the assumed mean daily feed expenditure per animal, which was calculated for one period and one feeding system.

Figure 3: Sub-optimal trough design at the automatic interval feeding mash dispenser

when there was no demand, which caused even more feed to be wasted. This situation was aggravated because, according to his own statements, the farm manager increased the quantity metered out per feeding interval during the second rearing period in order to prevent the animals from growing apart too much. This statement is in accordance with the improved daily weight gain in the 2nd period on the one hand and the increased feed expenditure on the other hand.
The two feeding systems exhibited no difference with regard to the number of piglets reared.

Animal Behaviour
In **Table 3**, piglet behaviour is characterized as a result of the observation of anonymous animals. The separated statistical evaluation of both rearing periods showed a significant ($p < 0.05$) or highly significant ($p < 0.01$) influence of the feeding system on all characteristics shown in Table 3. The only exceptions were the characteristics "sucking" in period I and "biting" in period II.
When comparing the feeding systems, one notices that during interval feeding significantly fewer animals were observed eating while the number of those animals which showed interest in eating was larger. During interval feeding in period I, an elevated number of aggressive acts in the form of biting other piglets was established. This must be attributed to the feeding management, which was handled in a more restrictive manner in the first rearing period. The number of sucking processes on other piglets was slightly lower during interval feeding.
Figure 4 visualizes eating activity. The increase in eating activity until the third week is clearly noticeable. With growing body mass, the number of eating processes observed diminished again. During interval feeding, the number of eating processes observed grew again in the last two rearing weeks. For this feeding system, the first rearing period cannot be characterized so clearly. During ad libitum feeding, which does not limit access to the feed, more feeding processes were observed in virtually every rearing week than during interval feeding.
The absence of values for rearing weeks 1, 2, and 8 must be attributed to a failure of the recording instruments.
Table 4 provides information about the focus animals, which shows that the selected animals represent the entirety of the examined piglets well with regard to their stalling-up mass. Eating behaviour also exhibited a high degree of consistency with the evaluation of anonymous piglets. For this reason, the complete listing of the anonymous behavioural data is dispensed with in Table 4. Instead, the reader is referred to Table 3.

Table 3: Behaviour of the piglets as a function of the rearing period and the feeding system, results of anonymous behaviour observation

		Period I		Period II	
		Interval	ad libitum	Interval	ad libitum
eating	Avg	40,3	49,8	37,9	42,7
	±	21,52	19,75	19,33	14,37
interest in eating	Avg	14,4	11,2	10,6	7,4
	±	12,33	9,37	7,75	7,45
sucking, active	Avg	0,2	0,3	0,1	0,3
	±	0,69	0,64	0,28	0,59
biting, active	Avg	2,8	1,0	0,9	0,9
	±	3,37	1,26	1,21	1,08
active behaviour [1)]	Avg	3,1	1,3	0,9	1,2
	±	3,56	1,42	1,25	1,30
passive behaviour [2)]	Avg	2,6	1,2	0,9	1,2
	±	2,99	1,31	1,16	1,26

Avg, arithmetic mean; ±, standard deviation
Evaluation after data aggregation. 15 counting processes each carried out in 4-minute intervals were summed up. It is shown how often the individual acts were observed per pen during one hour on the average of the trial.
1) Number of piglets which either sucked on or bit other piglets.
2) Number of piglets which were either sucked on or bitten by other piglets.

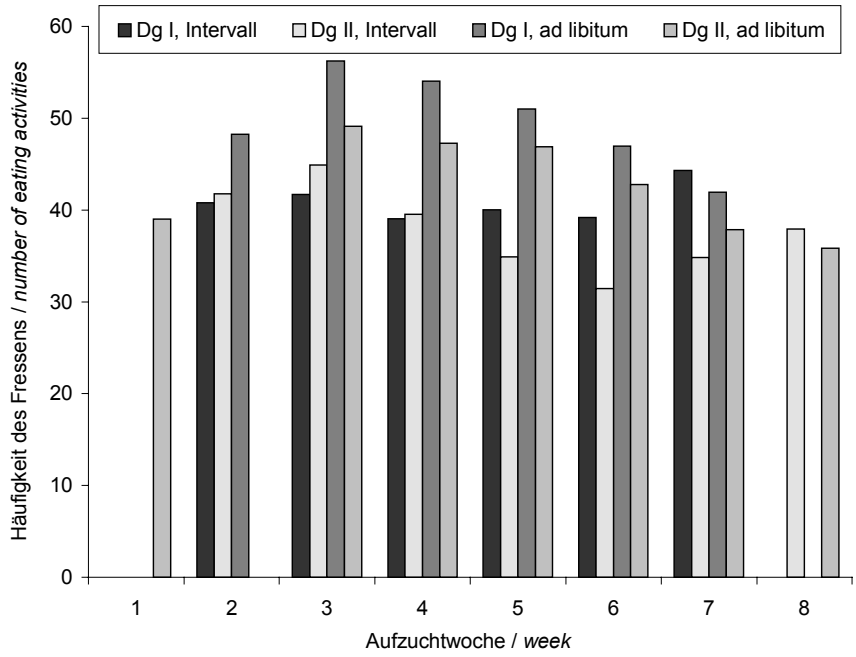

Figure 4: Number of eating activities as a function of the rearing period (Dg), the rearing week, and the feeding system. It is shown how many eating processes were observed per pen within one hour on the average of the trial.

Table 4: Body mass development and eating behaviour of the focus animals as a function of the rearing period and the feeding system.

		Period I		Period II	
		Interval	ad libitum	Interval	ad libitum
stalling-up mass	Avg	6,6	6,8	6,2	6,2
	±	0,8	0,9	0,9	1,3
eating[1)]	Avg	3,8	5,9	3,8	6,5
	±	2,9	3,7	2,8	4,0

Avg, arithmetic mean; ±, standard deviation
1) 90 counting processes each carried out in 4-minute intervals were summed up. It is shown how often eating processes were observed per piglet during a 6-h time block on the average of the trial.

Figure 5 uses the fact that the information about the focus animals can be attributed to individual animals. This table shows the eating- and aggression behaviour of animals which achieved particularly high or low growth performance. The representation illustrates the fact that those piglets which were more frequently observed eating grew faster than their groupmates. However, there are many exceptions from this observation. With regard to aggression behaviour, such a connection could not be established.

After it has already been mentioned that more eating activities were observed at the automatic tube mash dispensers, Figure 5 proves that this applied to both fast and slowly growing piglets.

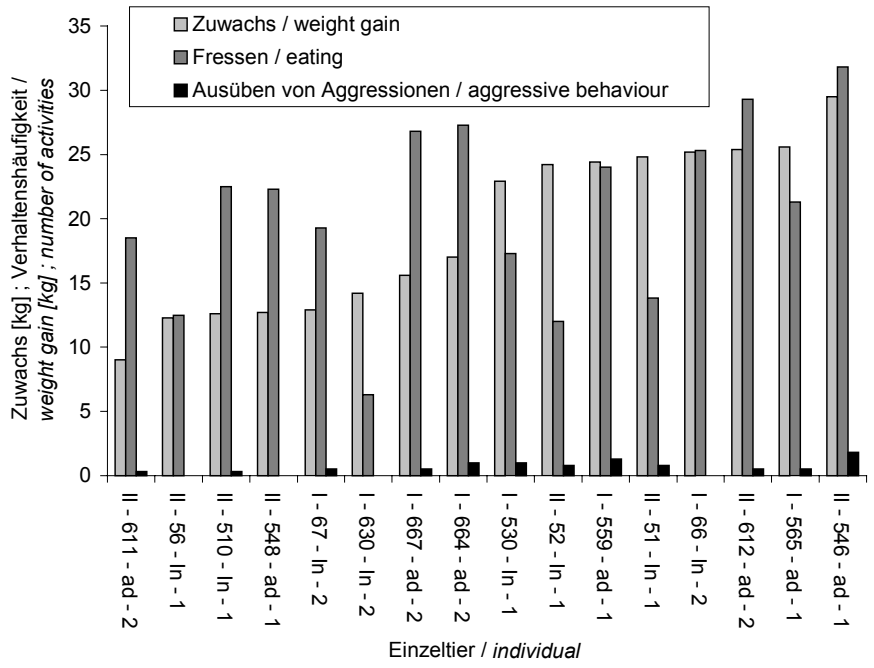

Figure 5: Eating- and aggression behaviour as well as body mass increase of 16 focus animals. It is shown how often each individual animal exhibited the different kinds of behaviour within 24 hours (one mean value from 4 observation days per animal). Within one rearing period and one feeding system, the two piglets with the largest and the two piglets with the lowest weight increase were selected. Naming of the animals: rearing period (I, II) – animal number – feeding system (ad, ad libitum; In, interval feeding) – sex (1, male; 2, female).

Housing Environment

Table 5 lists the mean values and standard deviations of stall air temperature and relative humidity. These parameters show uniform courses with extraordinarily small amplitudes. Graphic representation can therefore be dispensed with here.

Table 5 also shows the results of the discontinuous measurement of ammonia concentration in the stall air. The statistical model used provided a highly significant explanation for this characteristic. The influence of the factors rearing period and rearing week was highly significant. Other significant influences could not be established.

During the entire study, air speed was below the measuring- and display range of the described instrument. Therefore, air speed was continuously below 1 m/s^{-1}.

Due to the data structure, statistical assessment of the evaluation of pen soiling was dispensed with. The arithmetic mean values, however, did not exhibit any differences caused by the feeding system. During the rearing process, an increase in soiling was only observed until approximately the fourth rearing week.

Table 5: Stall climate data as a function of the rearing period and the feeding system

		Period I		Period II	
		Interval	ad libitum	Interval	ad libitum
temperature [°C]	Avg	27,1	27,2	27,7	27,5
	±	1,07	1,07	0,71	0,75
rel. humidity [%]	Avg	57,5	55,0	49,9	47,8
	±	6,33	6,77	5,56	7,33
NH_3 [ppm] 1)	LSM	5,3[a]	5,1[a]	4,5[b]	4,4[b]
	SE	0,15	0,15	0,15	0,15

Avg, arithmetic mean; ±, standard deviation; LSM, least squares means; SE, standard error
1) Values in this line which do not feature identical exponent letters differ significantly ($p<0.05$).

Conclusions

Under strictly comparable trial conditions, the use of a newly developed automatic interval feeding mash dispenser did not lead to higher rearing performance as compared with conventional ad libitum feeding at the automatic tube mash dispenser. In the first rearing period, daily weight gain was even lower. At the automatic interval feeding mash dispenser, feed consumption was higher.

At the automatic tube feed dispenser, more eating processes were observed. Fewer animals showed interest in eating without actually doing it. The results of the first period indicate that increased aggression must be expected as a result of a relatively restrictive setting of the automatic interval feeding mash dispenser.

In conclusion, the present report proves that the concept of interval feeding for piglets does not necessarily constitute a process-technological improvement over the proven automatic tube mash dispensers. If interval feeding is intended to provide actual progress as compared with ad libitum feeding, the development of a feed metering system which allows feeding to be adapted to the demand while keeping losses low is of prime importance. As regards the prototype examined here, feed trough design also needs improvement.

References

[1] *Snell, H., R. Schlichte und H. Van den Weghe* (2001): Ferkelaufzucht in Großgruppen - Sensorfütterung, Tierverhalten und biologische Leistungen. Agrartechnische Forschung 7 (2001) Heft 6, S. 99-104.

[2] *Hofsommer, J.* (2002): Zwei Fütterungssysteme für die Ferkelaufzucht. Ein Vergleich hinsichtlich Tiergerechtheit und Aufzuchtleistung. Masterarbeit, Fakultät für Agrarwissenschaften, Universität Göttingen.

[3] *Snell, H., S. Dellwisch und H. Van den Weghe* (2002): Ferkelaufzucht im Außenklimastall - Tiergerechtheit und biologische Leistungen. Agrartechnische Forschung 8 (2002) Heft 3, S. 32-37

Acknowledgements

Thanks are due to the company Big Dutchman for the financial promotion of the trials and to the operator of the piglet rearing stall for the continuously helpful support during the studies.

Authors

Dr. Hinrich Snell
Forschungs- und Studienzentrum für
Veredlungswirtschaft Weser-Ems, Vechta
Universitätsstr. 7
49377 Vechta
Tel.: +49/(0)4441/15-439
Fax: +49/(0)4441/15-448
E-mail: hsnell@gwdg.de

Cand. agr. Jürgen Hofsommer
Kirchweg 10
34399 Oberweser-Arenborn

Prof. Dr. Ir. Herman Van den Weghe
Forschungs- und Studienzentrum für
Veredlungswirtschaft Weser-Ems, Vechta
Universitätsstr. 7
49377 Vechta
Tel.: +49/(0)4441/15-435
Fax: +49/(0)4441/15-448
E-mail: herman.vandenweghe@agr.uni-goettingen.de