ASPECTS OF SLURRY MANAGEMENT ON PIG FARMS

END OF PROJECT REPORT

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SUMMARY

The objectives of manure or slurry management on intensive pig farms are the provision of adequate slurry storage capacity and the efficient recycling of the slurry nutrients for crop production. However, recent surveys of pig slurry dry matter suggest there is excessive dilution of raw pig slurry with water. This has two important implications for management. The first is greater storage capacity will be required due to the increased volume of slurry generated. Slurry storage is expensive. For example, a 350 sow unit adding 10 weeks storage needs to invest £50,000. Secondly, evidence from the literature indicates an improved slurry nitrogen efficiency with the more dilute manure.

Increasingly, pig farmers are required to secure off farm spread lands for their slurry as part of their nutrient management plan. Securing recipient farmers is facilitated by the knowledge that properly managed pig slurry is a reliable substitute for inorganic fertilisers particularly nitrogen. Therefore, if pig farmers are to take steps to reduce the dilution of their slurry it may increase the difficulties in securing recipient farmers due to potentially reduced crop responses. The work reported was to examine potential strategies which pig farmers might use to reduce slurry dilution and to examine the impact of pig slurry dry matter on its nitrogen efficiency for grass silage production.

In liquid feed systems lowering the water: feed ratio from 4:1 to 2:1 reduced the daily volumes of slurry produced by over 50%. This was a direct result of the 63% reduction in daily urine output by pigs on the lower water: feed ratio. The study also indicated that the influence of house temperatures on the volume of slurry produce may be more important than previously realised. There was a 22% reduction in slurry production and a 17% increase in slurry dry matter content from pigs exposed to high temperatures (28 to 30° C) compared with those kept at lower temperatures (20 to 22° C). This can be explained through greater water loss via respiration as a means of controlling body heat at higher temperatures.

The results of field trials showed that higher dry matter pig slurries reduced the relative efficiency of pig slurry nitrogen for second cut silage production. This is probably linked to reduced ammonia volatilisation losses, consequent to the less viscous nature of dilute slurry which permits a more rapid infiltration of the ammonium nitrogen into the soil. The use of a band spreader or shallow injection rather than the conventional splash plate were shown to increase the efficiency of pig slurry nitrogen for grass silage production. Therefore, the potential for the higher pig slurry dry matter, required for cost effective storage/handling costs, to reduce the efficiency of its nitrogen for grass silage production can be partially offset by using band spreaders or shallow injection spreading systems. These have the added advantage of reducing odour emissions from the land spreading operation.

EXPERIMENT 1 :

EFFECT OF WATER: FEED RATIO AND HOUSE TEMPERATURE ON PIG SLURRY PRODUCTION AND DRY MATTER CONTENT

INTRODUCTION

The low dry matter (DM) content of pig slurry has an important influence on storage requirements and handling costs. Water consumption can have a significant impact on the volume of slurry produced and will also affect its DM content. The environment of the pig house exerts an indirect effect on slurry volume and DM content in that temperature may influence water and feed intake and evaporative loss from the pig.

The objective of this study was to examine the effect of both water: feed ratios and house temperature on pig slurry production and DM content.

MATERIALS AND METHODS

Eighteen boar pigs (25-30 kg) were weighed individually and assigned at random to one of 3 dietary treatments:- 2 l water:1 kg feed; 3 l water:1 kg feed and 4 l water:1 kg feed, at two temperature regimes: 20-22°C and 28-30°C. Pigs were penned individually in metabolism cages in one room. Each pig was exposed to a 7-day adaptation period to the temperature regime followed by a 5-day collection period. The room temperature was then abruptly altered, and a second 7-day adaptation period and 5-day collection period carried out. All pigs were fed 1.3 kg and 1.6 kg per day of a finisher diet, in two equal feeds, in the first and second adaptation/collection periods, respectively. Half the pigs were exposed to 20-22°C first, and half to 28-30°C first. Feed, faeces and urine samples were taken twice daily, frozen and analysed for DM contents.

RESULTS AND DISCUSSION

The effect of water: feed ratio and house temperature on pig slurry production and DM contents are shown in Tables 1 and 2. Daily water consumption was significantly increased (P<0.01) with increasing water: feed ratio. Daily urine output was in turn significantly increased (P<0.01) with increasing water: feed ratio. Urine and slurry DM contents were higher from pigs fed the 2:1 treatment. The differences between treatments in urine as a percentage of water intake and slurry as a percentage of feed and water intake were also significant (P<0.01). There was a reluctance by some pigs to consume the full allocation of the most dilute feed mix.

Urine DM content was marginally higher from pigs fed at 28-30°C, but the difference was not significant (P>0.10). There was a significant effect of temperature on slurry DM content, urine as a percentage of water-intake, and slurry-output as a percentage of feed and water consumed. There was no significant treatment by temperature interaction for any variable.

Table 1: Effect of water: feed ratio on slurry production and DM content

Water: feed ratio **Number of pigs**	**2:1** **11**	**3:1** **12**	**4:1** **12**	**s.e.**	**F-test**
Feed, kg/day	1.4	1.4	1.34	0.05	NS
Water, kg/day	2.81	4.19	5.38	0.15	**
Faeces, kg/day	0.58	0.55	0.49	0.04	NS
Urine, kg/day	1.16	2.27	3.13	0.15	**
Slurry, kg/day	1.74	2.82	3.62	0.16	NS
Faeces DM, %	33.8	33.8	36.0	1.28	NS
Urine DM, %	0.59	0.41	0.49	0.04	*
Slurry DM, %	11.9	6.9	5.3	0.28	**
Urine, % water consumed	40.5	54.0	58.0	2.5	**
Slurry, % feed/water consumed	40.7	50.3	53.6	1.89	**

Table 2: Effect of temperature on slurry production and DM content				
Temperature ˚C	**20-22**	**28-30**	**s.e.**	**F-test**
Number of pigs	**17**	**18**		
Feed, kg/day	1.41	1.35	0.04	NS
Water, kg/day	4.20	4.05	0.12	NS
Faeces, kg/day	0.56	0.52	0.03	NS
Urine kg/day	2.51	1.86	0.15	**
Slurry kg/day	3.07	2.38	0.13	**
Faeces, DM, %	34.9	34.3	1.04	NS
Urine DM %	0.47	0.54	0.03	NS
Slurry DM, %	7.3	8.8	0.24	**
Urine, % water consumed	58.4	43.2	2.04	**
Slurry, % feed/water consumed	53.9	42.6	1.54	**

The results of this experiment show that minimising the water: feed ratio is an important step in reducing the volume of slurry produced and increasing the DM of the slurry. There was a significant reduction in the volumes of water consumed by the pigs and in the volume of urine produced. Slurry DM was increased due to increases in the DM of the urine. These are consistent with previously published data. The results also show that water: feed ratio is a good predictor of slurry production and DM content.

The effect of house temperature, on slurry volumes and DM content, may be more important than previously realised. There was a 22% reduction in slurry production and a 17% increase in slurry DM content from pigs exposed to high temperatures (28 to 30° C) compared with those kept at lower temperatures (20 to 22° C). This can, in part, be explained through greater water loss via respiration as a means of controlling body heat at higher temperatures. However, research is required to quantify more precisely the volumes lost and the mechanisms by which it occurs.

EXPERIMENT 2.

EFFECT OF PIG SLURRY DILUTION WITH WATER AND SLURRY APPLICATION METHODS ON THE AMMONIUM NITROGEN EFFICIENCY FOR A SECOND-CUT SILAGE CROP

INTRODUCTION

It is generally accepted that the availability of the slurry nitrogen for grass production, in particular the ammonium nitrogen (NH_4-N) component, is regarded as higher for pig than for cattle slurry (Teagasc, 1994). This is, in part, attributed to the generally higher DM content of cattle slurry. Stevens *et al.* (1992) reported an increase in the efficiency of cattle slurry NH_4-N for grass production from more dilute slurry. Consequently, the strategies that might be employed by pig producers to increase pig slurry DM content required to reduce storage/handling costs will possibly have an adverse effect on its NH_4N efficiency. Recent results indicated that the NH_4-N efficiency for high DM slurry can be increased by using band-spreading (BS) and shallow injection (SI) techniques instead of the conventional splash-plate (SP) (Carton *et al.*, 1994).

The objective of the experiment reported here was to assess the implications of pig slurry DM content and application method on the NH_4-N efficiency for second-cut silage.

MATERIALS AND METHODS

Undiluted (P0), or slurry diluted with water in the ratios 1:1 (P1) or 1:2 (P2), were applied to plots (10 x 5 m) on June17th, 1996. The DM and NH_4-N concentrations of P0, P1 and P2 slurries were 78, 45 and 23 g/kg and 3790, 1890 and 1020 mg/kg, respectively. The measured NH_4-N application for the three treatments were 61, 61 and 64 kg/ha, respectively. The slurries were applied using the SP, BS and SI methods. Plates 1 and 2. Nitrogen (N) fertiliser was applied to control plots, which received no slurry, at either 0, 25, 50, 75, 100 and 125 kg/ha. The sward was Lolium perenne which had a silage crop removed in early June. There were six replicate plots per treatment in a randomised block design. Grass from the central strip (1.5 x 10 m) was harvested in early August, using a Haldrup plot harvester. Plate 3 Grass yields were recorded and samples taken for DM determination.

Analysis of variance was conducted to determine the treatment effects on DM yield. The DM yield results for the N fertilizer treatments were used to construct an N response-curve of the form - y = A + Brx, where y = DM yield (t/ha), x = 1,2,3,4,5 or 6 for the N treatments 0, 25, 50, 75, 100 and 125 kg/ha, respectively, and A, B and r are constants. Inorganic N equivalent for DM yield of the slurry treatments were calculated from the curve. Slurry NH_4-N efficiency for grass DM production (DMeff) was calculated by dividing the inorganic N equivalent by the actual quantity of NH_4-N applied in the slurry.

RESULTS AND DISCUSSION

There was a significant (P<0.01) grass DM yield response to the N fertilizer and slurry treatments. Yields ranged from 1.4 t/ha for zero N treatment to 4.4 t/ha for the 125 kg N treatment. DM yields for the slurry treatments ranged from 2.4 t/ha to 4.1 t/ha. Dilution (P<0.01) and spreading method (P<0.05) had significant effects on DM yield (Table 3). Dilution at 1:1 and 1:2 slurry: water ratios increased DM yields by 0.6 and 1.3 t/ha compared with the undiluted control slurry. The SI applied slurry gave the highest yield, 3.5 t/ha compared with 3.3 and 3.2 t/ha for the BS and SP, respectively. There was no interaction between dilution and method of spreading.

Table 3: The mean effect of dilution and spreading method on second-cut dry matter yield (t/ha) in 1996

Dilution	**P0**	**P1**	**P2**	**s.e.d.**	**F-Test**
DM yield	2.70	3.31	4.0	0.13	0.01
Method	Splashplate	Bandspreader	Shallow Injector		
DM yield	3.2	3.3	3.5	0.13	0.05

The DM_{eff} was increased from 30% for the P0 to 100% for the P2 treatment (Table 4). The SI system gave the highest efficiency and the differences between the BS and SP were variable. This variability is not untypical in field trials of this type. The 100% + DMeff for the P2 treatments is not realistic and may indicate that part of the organic N in the slurry became mineralised and was utilised by the grass.

Table 4: The effect of dilution and spreading method on the efficiency (%) of pig slurry NH4-N relative to inorganic nitrogen fertiliser for second-cut grass silage yields in 1996

Method	P0	P1	P2
Splashplate	30	70	100+
Bandspread	43	65	100+
Shallow Injector	55	81	100+

Dilution of pig slurry from 78 to 45 and to 23 g/kg in this experiment increased its DMeff for second cut silage significantly. This is similar to the previously reported results. The DMeff from slurry applied with SI and possibly with the BS techniques is greater with the higher DM slurry. These results suggest that the efficiency of pig slurry NH4-N for grass production will decline as pig farmers increase its DM content. The high slurry storage and land spreading costs will require pig farmers to reduce the volumes of slurry produced. The results showed a potential agronomic disadvantage, in terms of reduced crop recovery of the NH4-N, associated with the increases in pig slurry DM especially where the SP method was used. This can be partially offset by using the low emission spreading systems such as BS and SI. In this way the consequences for recipient farmers of higher DM slurries can, in part, be addressed. The use of these systems have the added advantage over the SP of reducing odour emissions from the land spreading operation.

CONCLUSIONS

Reducing the volume of slurry produced on pig farms will become increasingly important because of the high costs associated with storage and land spreading. The work conducted has indicated that reducing the water: feed ratio from 4:1 to 2:1 results in a 50% reduction in the volume of manure produced by fattening pigs. The effect of temperature on slurry production and dry matter may be more important than previously realised. Other practical strategies to reduce the volumes of pig produced are outlined below.

A field trial with second silage found that the higher dry matter pig slurries have a lower relative nitrogen efficiency for grass production compared with more dilute pig slurry. The results indicated that this effect can be partially offset by using band spreading or shallow injection spreading techniques rather than the splashplate.

STRATEGIES FOR REDUCING SLURRY VOLUMES

The dilution of pig slurry resulting in increased volumes to be managed can arise from other sources aside from high water: feed ratio of the diet. Some of these include

1. Ingress of extraneous water from leakages - gutters, plumbing, inward leakage from soil into tanks, surface run-off, undiverted yard water.
2. Washing water - house washing, yard washing.
3. Wastage/spillage during drinking.
4. Voluntary consumption of excessive amounts of water.

Some other strategies for reducing pig slurry volumes are briefly outlined below.

1. ***Ingress of water***
   - Keep plumbing and guttering in good repair.
   - Divert clean water away from slurry tanks.

2. ***Washing***
   - Fixed washing lines where the power washer fed from a header tank will reduce spillage. Soaking pens, use of detergents, use of efficient jets will reduce washing time and water usage.

3. ***Spillage from drinker***
   - Bite action nipples and low wastage bowls will all reduce spillage. Water pressure should be sufficient but not excessive.

4. ***Voluntary water consumption***
   - Pigs consume more water if the diet contains a high level of salt or a high level of crude protein.

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Plate 1. Injection of slurry for field trials.

Plate 2. Band spreading of slurry for field trials. Note band spreading was achieved by running the shallow injector with the tines raised off the ground.

Plate 3. Harvesting of grass plots using the Haldrup plot cutter.