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THE EFFECT OF APPLYING SLURRY DURING THE GRAZING SEASON ON DAIRY COW PERFORMANCE

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OVERALL SUMMARY OF PROJECT

- The slurry produced by a 100 cow dairy herd over the winter has a fertiliser value of approximately £3000.
- As large quantities of nutrients are removed from fields when silage is harvested, it makes good management sense to return these nutrients back to silage fields via slurry.
- Historically, most slurry within Northern Ireland has been applied using the splash plate method, however, this method can lead to high losses of nitrogen from slurry. It also offers little opportunity for slurry to be applied to grazing swards due to contamination of the sward with slurry.
- Trailing-shoe systems on the other hand can increase the efficiency of slurry nitrogen utilisation (compared to the splash plate), and reduce grass contamination.
- Two studies were conducted to examine the effect of applying slurry during the grazing season using a trailing-shoe on dairy cow performance.
- In Study 1, 80 kg/ha of inorganic (bag) nitrogen was replaced by two applications of slurry (31 and 19 m^3/ha (2,800 and 1,700 gallons/acre)) using a trailing-shoe applicator. Herbage growth and utilisation were not affected by slurry application. In addition, slurry application had no effect on dairy cow grazing behaviour, milk yield or milk composition.
- Study 2 was conducted under both ‘normal’ and ‘tight’ grazing management (residual sward heights of 6 and 5 cm, respectively). Four applications of slurry (40, 27, 18 and 19 m^3/ha (3,600, 2,400, 1,600 and 1,700 gallons/acre)) replaced a total of 150 kg/ha of inorganic fertiliser N.
- With the ‘normal’ grazing management, slurry application had no effect on cow performance or residual sward height. However, with the ‘tight’ grazing management, slurry application reduced milk yield by 1.0 kg/cow/day, compared to the fertiliser only treatment.
- The results clearly demonstrate that with normal grazing management, slurry can be applied during the grazing season using a trailing-shoe applicator without adverse effects on cow performance.
- Replacing 80 and 150 kg/ha of inorganic fertiliser N with slurry in Studies 1 and 2, resulted in a saving of £32 and £44/ha (CAN costed at £240/t).
- When using slurry on a grazing area, care needs to be taken to ensure that soil does not become over supplied with phosphate.

BACKGROUND

The Value of Cattle Slurry

On the majority of Northern Ireland farms slurry is no longer considered to be a waste product, but rather a valuable source of plant nutrients. The nutrient content of slurry is influenced by a number of factors, including livestock species, diet offered, duration of storage, and perhaps most importantly, the dry matter content of the slurry (amount of added water). Table 1 summarises typical values for the total nutrient content of cattle slurry with a dry matter content of 2% (very dilute), 6% ('normal') and 10% (very thick).

Table 1 Typical values for the total nutrient content of cattle slurry at a range of dry matter contents

Slurry dry matter content	Total nitrogen	Total phosphate	Total potash
		kg/m^3	
2%	1.5	0.6	2.0
6%	3.0	1.2	3.5
10%	4.0	2.0	5.0

(Source: RB209)

Of the nutrients contained in slurry, up to 50% of the total nitrogen, approximately 50% of the phosphate and 90% of the potash are readily available for rapid crop uptake. To put this into context, a 2,000 gallon tanker ($9.1 m^3$) of dairy cow slurry (6% dry matter) applied in early spring will contain approximately 9.6 kg of available nitrogen (N), 5.5 kg of available phosphate (P_2O_5) and 29.0 kg of available potash (K_2O). Assuming a fertiliser price of £240/t for CAN, £360/t for triple super phosphate and £360/t for muriate of potash, this tanker of slurry has a financial value of approximately £30. Thus the value of slurry produced by a 100 cow dairy herd during a five month winter period is approximately £3,050.

Making more efficient use of slurry

The introduction of a ‘closed period’ means that slurry can no longer be applied during the winter when there is no crop requirement. As a consequence, livestock farmers now enter the spring with significant quantities of slurry stored in tanks. Having invested heavily in storage capacity to meet the requirements of the Nitrates Directive Action Programme, it makes sense to recoup some of this outlay by maximising the efficiency with which nutrients within slurry are utilised.

Although slurry contains considerable quantities of available N, up to 80% of this can be lost during and immediately after spreading by ‘volatilisation’. Volatilisation is the process by which N in the slurry changes to ammonia gas and is lost to the atmosphere. However, AFBI research has demonstrated that N losses can be reduced when slurry is spread using either band spreading or trailing-shoe type systems. As a result of improved N use efficiency, grass yields were increased by 19% (band spreading) and 21% (trailing-shoe) compared to yields when slurry was applied using a splash plate. The trailing-shoe has particular benefits in that slurry is placed at the base of the sward thus minimising contamination of the grass leaf by slurry.

Can slurry be utilised within a grazing system?

As large quantities of nutrients are removed from fields when silage is harvested, it makes good management sense to return these nutrients back to silage fields via slurry. However, with increased slurry storage capacity in place on many farms, large quantities of slurry are now available on farms in the spring. This may create an opportunity to make effective use of some slurry on grazing areas.

For farms with later turnout dates, slurry can be applied early in the spring using a splash plate. However, during the grazing season a splash plate can not be used effectively as grazing animals will reject contaminated herbage. In addition, there is an increased risk of exposure to harmful pathogens at the next grazing. The use of a trailing-shoe system may allow some of these problems to be overcome.

To address this issue, two studies were conducted to examine the effect of applying slurry during the grazing season using a trailing-shoe tanker on dairy cow performance.

STUDY 1

Cows: This study involved 48 spring calving dairy cows managed within a paddock grazing system (mean stocking rate = 5.4 cows/ha). Cows were offered an average of 2.6 kg concentrate daily throughout the study.

Treatments: Two treatments were examined as follows:

1) Normal grazing + fertiliser (fertiliser only treatment)

- Inorganic (bagged) fertiliser N applied after each grazing.
- Total N input during the study = 280 kg/ha (8.4 bags/acre CAN).

2) Normal grazing with approximately 30% of fertiliser N replaced by slurry N (fertiliser + slurry treatment)

- Total input of bagged fertiliser was reduced to 200 kg N/ha (6.0 bags/acre CAN).
- On two occasions (after the second and fifth grazing cycles) fertiliser N was replaced by slurry.
- Slurry was applied using a trailing-shoe tanker at 31 and 19 m^3/ha (2,800 and 1,700 gallons/acre). These rates were chosen so that the quantities of available N in the slurry would equal N inputs within the fertiliser only treatment.
- Thus the minimum interval between slurry application and the following grazing was normally 10 days.

Table 2 Details of fertiliser N and slurry N applied during Study 1

	Fertiliser Only Treatment	**Fertiliser & Slurry Treatment**	
	Fertiliser N applied (kg/ha)	Fertiliser N applied (kg/ha)	Available N applied in slurry (kg N/ha)
Pre-Turnout	28	28	-
Post 1st Grazing	60	60	-
Post 2nd Grazing	50	0	56[1]
Post 3rd Grazing	40	40	-
Post 4th Grazing	30	30	-
Post 5th Grazing	30	0	32[2]
Post 6th Grazing	22	22	-
Post 7th Grazing	20	20	-
		200	**88**
Total N Applied	**280 kg/ha**	**288 kg/ha**	

[1] *1st slurry application = 31m³/ha (2,800 gallons/acre)*
[2] *2nd slurry application = 19m³/ha (1,700 gallons/acre)*

Effects on herbage quality and grazing efficiency:

- The metabolisable energy (ME) and crude protein content of herbage grown was not affected by the application of slurry.
- Pre- and post-grazing sward heights were similar with both treatments (Table 3), suggesting similar levels of grass growth.
- Herbage utilisation was unaffected by slurry applications. The average herbage utilisation rate (above 4 cm) during the grazing rotations following slurry application was approximately 70% for both treatments.

Table 3 Average pre- and post-grazing sward heights during Study 1

	Fertiliser only Treatment	Fertiliser & Slurry Treatment
Pre-grazing sward height (cm)	10.1	10.5
Post-grazing sward height (cm)	5.7	5.9

Effects on cow performance:

- Grass intakes were not measured in this study. However, the cows on both treatments grazed for a similar amount of time and at a similar rate, indicating that the cows were not discouraged from grazing due to the presence of slurry.
- Average daily milk yield and milk composition was unaffected by treatment (Table 4).
- Cow liveweight and body condition score at the end of the study was unaffected by treatment.
- As cow performance was unaffected by slurry, this suggests that dry matter intake was also unaffected.
- The results of Study 1 confirm that two applications of slurry can be applied on dairy cow grazing paddocks during the grazing season using a trailing-shoe tanker without any loss of performance.

Table 4 Treatment effect on cow performance and grazing behaviour within Study 1

	Fertiliser only Treatment	Fertiliser & Slurry Treatment
Grazing behaviour		
Number of bites per minute	51	52
Time spent grazing each day	7 hrs 28 mins	7 hrs 10 mins
Cow performance		
Daily milk yield (kg)	19.2	18.8
Total milk output (kg/cow:150 days)	2,882	2,820
Milk fat (%)	4.22	4.21
Milk protein (%)	3.53	3.52
Fat + protein yield (kg/day)	1.48	1.43
End of study condition score	2.3	2.3
End of study liveweight	531	532

STUDY 2

The results of Study 1 highlight that cow performance was unaffected when two applications of slurry were applied under 'normal grazing.' Study 2 was conducted to examine the impact on cow performance of four slurry applications under either a normal or tight grazing system.

Cows: This study involved 60 spring calving dairy cows. Cows were offered an average of 3.1 kg concentrate daily throughout the study.

Treatments: Four treatments were examined as follows:

1) Normal grazing + fertiliser only.
2) Normal grazing with approximately 50% of fertiliser N replaced by slurry N.
3) Tight grazing + fertiliser only.
4) Tight grazing with approximately 50% of fertiliser N replaced by slurry N.

Normal vs tight grazing:

- Paddock size with the tight grazing treatment was 10% smaller than with the normal grazing treatment.
- Mean stocking rates over the whole season were 5.4 cows/ha and 6.5 cows/ha with the Normal and Tight grazing treatments, respectively.

Fertiliser only (Treatments 1 and 3):

- Inorganic (bagged) fertiliser N was applied after each grazing.
- Total N input during the study = 285 kg/ha (8.5 bags/acre CAN).

Fertiliser plus slurry (Treatments 2 and 4):

- Total input of bagged fertiliser was reduced to 133 kg N/ha (4.0 bags/acre CAN).
- On four occasions (after the first, third, sixth and seventh grazings) fertiliser N was replaced by slurry.
- Slurry was applied using a trailing-shoe tanker at 40, 27, 18 and 19 m^3/ha (3,600, 2,400, 1,600 and 1,700 gallons/acre). These rates were chosen so that the quantities of available N supplied from slurry would be similar to N inputs within the fertiliser only treatment.
- The minimum interval between slurry application and the following grazing was 10 days.

Details of fertiliser and slurry applied during Study 2 are presented in Table 5.

Table 5 Details of fertiliser N and slurry N applied during Study 2

	Fertiliser Only Treatment	Fertiliser & Slurry Treatment	
	Fertiliser N applied (kg/ha)	Fertiliser N applied (kg/ha)	Available N applied in slurry (kg N/ha)
Pre-Turnout	28	28	0
Post 1st Grazing	60	0	83[1]
Post 2nd Grazing	50	50	0
Post 3rd Grazing	40	0	68[2]
Post 4th Grazing	30	30	0
Post 5th Grazing	25	25	0
Post 6th Grazing	30	0	32[3]
Post 7th Grazing	22	0	48[4]
		133	**231**
Total N Applied	**285 kg/ha**	**364 kg/ha**	

[1] 1st slurry application = 40m^3/ha (3,600 gallons/acre)
[2] 2nd slurry application = 27m^3/ha (2,400 gallons/acre)
[3] 3rd slurry application = 18m^3/ha (1,600 gallons/acre)
[4] 4th slurry application = 19m^3/ha (1,700 gallons/acre)

Effect on herbage quality and grazing efficiency:

- The slurry used had a higher than expected N content, and as such the available N supplied from the slurry was higher than that supplied by the fertiliser only treatment.
- The metabolisable energy (ME) content of grass was not affected by treatment. However, there was a trend for grass grown within the fertiliser plus slurry treatment to have a lower crude protein content (18% vs 19%).
- The mean residual sward height with the 'normal grazing' treatments was 6.1cm.
- As expected, there was a lower residual sward height with the tight grazing treatments (Table 6).
- However, cows on the 'tight grazing' + slurry treatment did not graze as tightly as those on the tight grazing + fertiliser treatment
- The application of slurry had no effect on the efficiency of herbage utilisation.

Table 6 Average pre- and post-grazing sward heights during Study 2

	Normal Grazing Treatment		Tight Grazing Treatment	
	Fertiliser only	Fertiliser & Slurry	Fertiliser only	Fertiliser & Slurry
Pre-grazing sward height (cm)	11.5	11.7	10.3	11.3
Post-grazing sward height (cm)	6.1	6.1	5.1	5.4
Herbage utilised by grazing cows[1] (%)	71	74	82	82

[1] *Average utilisation during 2nd, 4th, 7th and 8th grazing rotations (above 4 cm)*

Effect on cow performance:

- On average, cows on the tight grazing treatments produced 1.0 kg/day less milk than those on the normal grazing treatment, while milk composition was not affected by grazing intensity (Table 7).
- Replacing fertiliser with slurry had no effect on cow performance within the normal grazing treatments.
- Within the tight grazing treatments, milk yield was reduced by an average of 1.5 kg/day with the fertiliser plus slurry treatment. The reduction in milk yield became apparent during the second grazing cycle and remained until the end of the study. Milk composition was not affected by treatment.
- Cow liveweight and body condition score was similar between all four treatments at the end of the study.

Table 7 Treatment effect on cow performance within Study 2

	Normal Grazing Treatment		Tight Grazing Treatment	
	Fertiliser only	Fertiliser & Slurry	Fertiliser only	Fertiliser & Slurry
Daily milk yield (kg)	20.2	19.6	19.1	17.6
Total milk output (kg/cow:161 days)	3,225	3,141	3,051	2,815
Milk fat (%)	4.22	4.18	4.37	4.27
Milk protein (%)	3.49	3.46	3.46	3.40
Fat + protein yield (kg/day)	1.56	1.50	1.44	1.39
End of study condition score	2.7	2.6	2.6	2.4
End of study liveweight	547	546	542	528

Financial impact of replacing inorganic fertiliser N with slurry

A total of 80 and 152 kg of inorganic (bagged) N was replaced by slurry in Studies 1 and 2, respectively, resulting in savings in fertiliser costs. The extent of this saving will be determined by the cost of fertiliser. To examine this, the financial impact of replacing two applications of CAN (300 kg CAN/ha or 80 kg N/ha) with two applications of slurry (as in Study 1) are presented in Table 8 for a range of fertiliser price scenarios.

Table 8 The financial impact of replacing bagged fertiliser N with slurry

	Fertiliser cost		
	£180/t	**£240/t**	**£300/t**
Saving in cost of CAN (£/ha)	54	72	90
Extra charge for spreading slurry, less saving in fertiliser sowing charge (£/ha)[1]	-40	-40	-40
Net saving per hectare (£/ha)	14	32	50
Net saving per 100 cows (£)[2]	350	800	1,250

[1]Slurry spreading charge of £25/hour and assuming a work rate of 6,000 gallons applied/hour
[1]Saving in fertiliser spreading cost (£10/ha) deducted from slurry spreading cost
[2]100 cow herd stocked at 4.0 cows/ha (Apr-Sept) = 25 hectares

Thus for a 100 cow dairy herd, replacing 80 kg fertiliser N/ha with slurry during the grazing season can result in a saving of up to £1,250 (CAN at £300/t).

When a similar calculation is undertaken for Study 2, the net saving per 100 cows is £275, £1,100 and £1,950 at a CAN cost of £180, £240 and £300/t, respectively. This financial analysis was based on the fertiliser N saving alone. If there was an additional soil requirement for P and K, then the financial benefits would be increased.

Full nutrient content of slurry must be considered

The two studies within this booklet focused on N utilisation, and demonstrate that slurry can be applied using the trailing-shoe technique during the grazing season with no adverse effect on cow performance. However, slurry applications should always be prioritised towards those areas with the largest requirement for its full nutrient content. The requirement for P and K within predominantly grazed fields tends to be low on many farms, as nutrient 'recycling' occurs within a grazing system, with N, P and K being returned onto the grazing area by grazing animals. Thus the levels of slurry used in the second study could ultimately lead to an accumulation of P and K in the soil, especially if the soil was not deficient in these nutrients (soil index 3 or above).

CONCLUSIONS

- At a 'normal' grazing intensity cow performance was unaffected when up to 50% of fertiliser N was replaced by slurry N.
- Under a tight grazing scenario milk yield was reduced when part of the fertiliser N was replaced by slurry.
- Replacing 80 and 152 kg/ha of bagged fertiliser N by slurry in Studies 1 and 2 achieved a net saving of £32 and £44/ha (CAN £240/t), after the cost of applying the slurry is taken into account.

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