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# Cattle slurry as a fertilizer of whole crop cereal silage (WCCS) when renewing ley

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## Introduction

Cattle farms with long-term leys have had difficulties spread slurry without problems with fodder hygiene. A new approach is to shorten the ley rotation and found the new ley in barley intended for WCCS. This would provide a more frequent opportunity to use slurry without need to apply in ley during the productive years. The other opportunity would be the use of annual meadow grasses like Italian rye-grass to improve the feed value and yield of WCCS. In both cases the potential leaching of nutrients following a large rate of slurry used in the spring are mitigated by the uptake of meadow grass. However, a large rate of slurry at least applied in the growing crops might harm the establishment of perennial leys. The maximum application rate of slurry is on nitrate vulnerable zones usually limited by the limit for total nitrogen from animal manures stated in the Nitrate directive, 170 kg per ha and its national implementation. The whole Finland is declared to belong to the zone.

The aim of study was to find out feasible technologies to use slurry as a fertilise in WCCS production when establishing perennial leys or using Italian as a co-cultivar.

## Materials and methods

In this study we applied cattle slurry the same maximum amount according to the Nitrate directive and its national implementation when seeding barley WCCS (cv. Inari in 2002 and Saana in 2003) field, at 1 to 2 or 3 to 4-leaf phase with or without timothy or Italian rye-grass. The experimental design was a split-plot design. The whole plot treatments were no co-cultivar, timothy as a co-cultivar or Italian rye-grass as a co-cultivar. The sub-plot treatments were application of slurry when seeding, at 1 to 2 (7$^{th}$ June 2002 and 18$^{th}$ June 2003) or 3 to 4-leaf phase (18$^{th}$ June 2002 and 3$^{rd}$ July 2003). When seeding barley the slurry was injected at the same pass with seeding with the method developed by Kapuinen (2001). In the growing crops the slurry was applied with the same machinery imitating trailing hoses. The amount of slurry was 68 $m^3$ $ha^{-1}$ in 2002 and 63 $m^3$ $ha^{-1}$ in 2003. The nutrient contents of slurry in pre-samples were in kg $m^{-3}$ tot. N 2.5, sol. N 1.0, P 0.45 and K 2.5 in 2002 and tot. N 2.7, sol. N 1.6, P 0.57 and K 3.3 in 2003. 40 kg $ha^{-1}$ of mineral nitrogen was drilled in all the treatments in combination with seeding to meet the requirement of soluble nitrogen. The field was ploughed in the previous autumn and leveled in the spring. The final cultivation before seeding was performed with a rotary cultivator with vertical shafts cross the plots. The seeding took place on 21$^{st}$ May 2002 and 2$^{nd}$ June 2003. In 2002 Italian rye-grass was seeded only on the next day. The amount of grain seed was reduced by 25% of the normal amount (500 grains per square meter) to ensure the establishment of perennial ley. The co-cultivars were seeded after rolling in the corresponding plots. The WCCS was harvested on 5$^{th}$ and 6$^{th}$ of July 2002 and 11$^{th}$ and 12$^{th}$ of August 2003. Yield components, feed value and hygiene will be reported elsewhere. The yield were analysed for amount and dry matter content (Table 1). In statistical analyses SAS mixed procedure and Tukey-Kramer multiple comparison were used.

The establishment of perennial ley was measured as yields of the first cut of the next year (Table 2 and 3). In 2002 the applied nitrogen rates for the leys established previous year were 100 kg ha$^{-1}$ (8$^{th}$ May), 100 kg ha$^{-1}$ (23$^{rd}$ June) and 50 kg ha$^{-1}$ (1$^{st}$ August). The cuts took place on 17$^{th}$ June, 29$^{th}$ July and 6$^{th}$ October. In 2003 the appied nitrogen rates were 100 kg ha$^{-1}$ (5$^{th}$ May), 100 kg ha$^{-1}$ (15$^{th}$ June), 100 kg ha$^{-1}$ (Italian rye-grass)/ 50 kg ha$^{-1}$ (Timothy) (19$^{th}$ July), 100 kg ha$^{-1}$ (Italian rye-grass) (13$^{th}$ August) and 100 kg ha$^{-1}$ (Italian rye-grass) (20$^{th}$ September). Timothy was cut thrice (10$^{th}$ June, 16$^{th}$ July, 13$^{th}$ September) and Italian rye-grass five times (in addition 12$^{th}$ August and 14$^{th}$ October).

## Results and discussion

**Table 1**. Dry matter yields and their dry matter contents of whole crop cereal silage in 2002 and 2003

| | | | Whole crop cereal silage | | | |
|---|---|---|---|---|---|---|
| | | | Dry matter yields, kg ka ha$^{-1}$ | | Dry matter contents, % | |
| | | | 2002 | 2003 | 2002 | 2003 |
| Co-cultivar | No co-cultivar | | 5570$^{ab}$ | 4216 | 36.82$^{a}$ | 44.67$^{a}$ |
| | Timothy | | 5423$^{b}$ | 5092 | 38.71$^{a}$ | 44.67$^{a}$ |
| | Italian rye-grass | | 6043$^{a}$ | 5100 | 32.60$^{b}$ | 39.47$^{b}$ |
| | | F value | 5.32 | 5.81 | 19.29 | 11.31 |
| | | DF | 2, 6 | 2, 6 | 2, 6 | 2, 6 |
| | | p value | 0.0469* | 0.0395* | 0.0024** | 0.0092** |
| Time of application | When seeding | | 6346$^{a}$ | 5186$^{a}$ | 35.88 | 46.50$^{a}$ |
| | At 1 to 2 leaf phase | | 5431$^{b}$ | 4752$^{ab}$ | 35.77 | 40.50$^{b}$ |
| | At 3 to 4 leaf phase | | 5260$^{b}$ | 4470$^{b}$ | 36.48 | 41.80$^{b}$ |
| | | F value | 31.93 | 3.64 | 0.63 | 18.74 |
| | | DF | 2, 17 | 2, 18 | 2, 17 | 2, 18 |
| | | p value | <.0001*** | 0.0470* | 0.5435 | <.0001*** |
| Co-cultivar * time of application | No co-cultivar | When seeding | 6123 | 4561 | 37.03$^{ab}$ | 49.99 |
| | | At 1 to 2 leaf phase | 5201 | 4166 | 36.55$^{ab}$ | 40.30 |
| | | At 3 to 4 leaf phase | 5387 | 3921 | 36.87$^{ab}$ | 43.72 |
| | Timothy | When seeding | 6271 | 5409 | 40.00$^{a}$ | 48.47 |
| | | At 1 to 2 leaf phase | 5123 | 4931 | 37.34$^{ab}$ | 41.73 |
| | | At 3 to 4 leaf phase | 4874 | 4936 | 38.78$^{a}$ | 43.80 |
| | Italian rye-grass | When seeding | 6643 | 5587 | 30.59$^{c}$ | 41.05 |
| | | At 1 to 2 leaf phase | 5967 | 5159 | 33.41$^{bc}$ | 39.46 |
| | | At 3 to 4 leaf phase | 5518 | 4554 | 33.80$^{bc}$ | 37.88 |
| | | F value | 1.31 | 0.28 | 3.43 | 2.71 |
| | | DF | 4, 17 | 4, 18 | 4, 17 | 4, 18 |
| | | p value | 0.3064 | 0.8886 | 0.0315* | 0.0632o |

In 2002 the WCCS yield was the best when the slurry was applied in combination with seeding of barley and Italian rye-grass. However, the difference to no co-cultivar was not significant. Application at seeding time yielded 18.7% better than in growing crops on an

average. In 2003 barley-timothy combination yielded about the same as barley-Italian rye-grass combination. Application of slurry at 1 to 2-leaf phase did not yield significantly differently than at seeding time or at 3 to 4-leaf phase. However, application at seeding time yielded 16.0% better than at 3 to 4-leaf phase. The regrowth of Italian rye-grass was minimal in both the years.

Dry matter contents were significantly lower in 2002 when using Italian rye-grass as a co-cultivar because the proportion of grass in it was larger than in the other treatments. In 2003 this was true only when slurry was applied when seeding.

In 2003, the first and third yield of timothy were 150.4% and 81.7%, respectively, better when slurry was injected in 2002 at seeding time than in crowing crops on an average (Table 2). There was no significant difference in the second cut. Italian rye-grass did not survive over the winter.

**Table 2**. Dry matter yields of timothy in the first productive year 2003 when the slurry was applied previous year when seeding, at 1 to 2 or 3 to 4 leaf phase.

| | | Dry matter yield, kg ha$^{-1}$ | | |
|---|---|---|---|---|
| | | 1st cut | 2nd cut | 3rd cut |
| Time of application | When seeding | 2733[a] | 2381 | 557[a] |
| | At 1 to 2 leaf phase | 1527[b] | 2092 | 347[b] |
| | At 3 to 4 leaf phase | 656[b] | 2425 | 266[b] |
| | F value | 20.40 | 3.59 | 55.20 |
| | DF | 2, 6 | 2, 6 | 2, 6 |
| | p value | 0.0021** | 0.0942o | 0.0001*** |

In 2004, the first yield of timothy was significantly better 25.4% when slurry was applied in 2003 at 3 to 4-leaf phase instead of 1 to 2-leaf phase (Table 3). Application at seeding time did not differ significantly from the application at either phase in growing crops. For some reason also Italian rye-grass survived over the winter 2003 - 2004. Therefore, its yields were measured as well. Italian rye-grass was cut five times totally. The yield of Italian rye-grass was significantly higher than that of Timothy. The largest yield was that of the second cut. The yield of ley was lowest when the slurry was applied when seeding previous year. The reason to that is most likely the best growth of barley on the year of establishment, which a negative effect on the establishment. It is not normal that Italian rye-grass survives over a Finnish winter. Therefore the results does not suggust that Italian rye-grass should be used this way in Finland but rather that it could produce a reasonable yield in case the weather in the winter regualarly facilitates its survival, maybe more south in Scandinavia.

**Table 3**. Dry matter yields of timothy and Italian rye-grass in the first productive year 2004 when the slurry was applied previous year when seeding, at 1 to 2 or 3 to 4 leaf phase.

| | | | Dry matter yield, kg ha$^{-1}$ | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | 1st cut | 2nd cut | 3rd cut | 4th cut | 5th cut | Total |
| Co-cultivar of previous year | Timothy | | 3266$^{a}$ | 3693$^{b}$ | 3850 | | | 10808$^{b}$ |
| | Italian rye-grass | | 2742$^{b}$ | 5023$^{a}$ | 3976 | 1972 | 692 | 14405$^{a}$ |
| | | F value | 12.02 | 178.18 | 1.38 | | | 244.90 |
| | | DF | 1, 3 | 1, 15 | 1, 15 | | | 1, 3 |
| | | p value | 0.0404* | <.0001*** | 0,2577 | | | 0.0006*** |
| Time of application | When seeding | | 2651$^{c}$ | 4234 | 3860 | 985 | 342 | 12071$^{b}$ |
| | At 1 to 2 leaf phase | | 2972$^{b}$ | 4514 | 3915 | 994 | 353 | 12747$^{a}$ |
| | At 3 to 4 leaf phase | | 3388$^{a}$ | 4326 | 3964 | 980 | 344 | 13001$^{a}$ |
| | | F value | 20.78 | 2.78 | 0.31 | | | 7.57 |
| | | DF | 2, 12 | 2, 15 | 2, 15 | | | 2, 12 |
| | | p value | 0.0001*** | 0.0973$^{o}$ | 0.7364 | | | 0.0075** |
| Co-cultivar * time od application | Timothy | When seeding | 3216$^{ab}$ | 3604 | 3685 | | | 10505 |
| | | At 1 to 2 leaf phase | 2920$^{b}$ | 3803 | 3835 | | | 10559 |
| | | At 3 to 4 leaf phase | 3662$^{a}$ | 3671 | 4029 | | | 11361 |
| | Italian rye-grass | When seeding | 2087$^{c}$ | 4864 | 4035 | 1969 | 683 | 13637 |
| | | At 1 to 2 leaf phase | 3024$^{ab}$ | 5224 | 3994 | 1987 | 706 | 14936 |
| | | At 3 to 4 leaf phase | 3114$^{ab}$ | 4982 | 3898 | 1960 | 687 | 14641 |
| | | F value | 14.48 | 0.23 | 1.69 | 0.06 | 0.18 | 3.78 |
| | | DF | 2, 12 | 2, 15 | 2, 15 | 2, 6 | 2, 6 | 2, 12 |
| | | p value | 0.0006*** | 0.8006 | 0.2171 | 0.9466 | 0.8367 | 0.0533$^{o}$ |

## Conclusions

Application of slurry at seeding time produces the best WCCS yield without significant drawback in the first cut of timothy next year. Only Italian rye-grass contributes the WCCS yield. Neither Timothy nor Italian rye-grass produce significant yield the same autumn after harvesting the WCCS. Italian rye-grass ley could be established in barley harvested as WCCS in favourable conditions.

## References

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