The influence of feeding strategy on growth and rejection of herbage around dung pats and their decomposition

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SUMMARY

Fresh cattle dung from four farms with different feeding strategies was used to create artificial dung pats in a continuously grazed pasture in order to compare the rejection of herbage growing around the pats, the effect on undisturbed herbage growth under cages and pat decomposition. The first farm was an extensive organic farm (ORGE) with young steers grazing on a biodiverse sward. The second was an intensive organic farm (ORGI) with dairy cattle grazing on a grass/clover sward during the day and fed low-protein forages indoors. The third dung used was from an integrated farm (INT), where the feeding strategy was aiming for high dung quality by including straw in the diet. The fourth examined dung was from a conventional farm (CONV) aiming for a high milk production per cow, where fertilized grazed grass was the main component of the diet. A human smell test was performed to rank the odour of the four dungs.

After 6 weeks of continuous grazing with dairy cattle, herbage yield around INT pats tended to be lowest, whilst undisturbed herbage yield in and around caged INT pats was highest ($P < 0.05$). Therefore, it could be concluded that rejection was lowest for INT. The CONV pats gave highest rejection ($P < 0.05$). However, herbage yield around the dung pats under grazing showed no significant correlation with both the human smell test and the contents of total-N and sugar in the rejected herbage.

The feeding strategy had a significant effect on the decomposition of dung pats under the cages. After 6 weeks, the most liquid and least fibrous dung (CONV) showed highest decomposition ($P < 0.05$), whilst decomposition of the most solid and fibrous dung (ORGE) tended to be lowest. However, no relationship was found between the decomposition of dung and the rejection of herbage around the dung pats.

When combining a number of parameters determined in the experiment and comparing them using index figures for dung quality in terms of rejection, herbage growth and decomposition, the index figures of ORGI (102) and especially INT (113) were above average (100), while those of ORGE (94) and CONV (90) were below average. The difference between ORGI and INT might be explained by the addition of straw to the diet in the latter. The study showed that there are possibilities to improve dung quality by altering feeding strategy.

INTRODUCTION

Fouling of pasture by dung is an important problem in grassland and cattle husbandry through its influence on growth and botanical composition of pasture, and as a breeding medium for many cattle pests. Bare areas remaining after dung decomposition can take up to 2 years to recover, allowing the invasion of weeds (Castle & MacDaid 1972).

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Rejection due to fouling by cattle is a frequently observed phenomenon in pasture studies. Marten & Donker (1964) found that dung was present in 93% of areas completely ungrazed by cattle, on 68% of the partly grazed areas and on only 1% of the totally grazed area. Norman & Green (1958) observed that herbage around dung pats was partly neglected for a period varying between 13 and 18 months. In general, the odour of the dung is thought to be the main reason for the rejection of herbage around dung pats (Marten & Donker 1966; Marsh & Campling 1970). Next to odour, the degree of rejection may also be

Table 1. *Feeding strategy (kg dry matter/cow per day) on the four farms*

Farm	Straw	Maize silage	Whole crop oat silage	Dried grass	Beet pulp	Concentrates	Grazed grass	Total
ORGE							8·0*	8·0
ORGI		2·4	4·8			2·0	10·6	19·8
INT	1·0	8·5		2·0	1·9	2·9	5·2	21·5
CONV		2·5				3·2	17·0	22·7

* Biodiverse pasture.
ORGE, extensive organic; ORGI, intensive organic; INT, integrated; CONV, conventional.

influenced by differences in botanical composition of the sward. Marten & Donker (1964) found that dung deposited on a monoculture of bromegrass gave greater refusal of forage than that deposited on a mixture of bromegrass and alfalfa. Furthermore, changes in morphological and chemical composition of the herbage around dung pats may influence rejection due to effects on palatability (Plice 1952).

Dung pats in a pasture function as a breeding medium for many cattle pests (Gittings *et al.* 1994). Therefore, a rapid disappearance of the dung pat is desirable. The time required before dung has visually disappeared from a pasture is on average 3 months, leaving a bare area (Lantinga *et al.* 1987). Decomposition of faeces consists of a fast and a slow phase (Kirchmann 1991). The amount of fibrous material in dung might give an indication of the fraction of slowly decomposable residues in the faeces, and hence the rate of decomposition of dung. Sørensen & Jensen (1998) found that undigested feed residues with a relatively low N concentration decompose slowly in soil. The decomposition rate of dung pats is also influenced by the formation of a hard crust and whether a dung pat disintegrates into smaller pieces (Weeda 1967). Finally the soil fauna and microbial biomass contribute to the breaking down of the structure and the decomposition of the dung (Marsh & Campling 1970).

Recently, attempts have been made to modify dung quality in order to reduce nitrogen losses and promote decomposition by means of adapting the feeding strategy. On the integrated mixed farm of the Minderhoudhoeve in Oostelijk Flevoland, the Netherlands, the diet of the dairy cattle includes wheat or maize silage, straw and beet pulp to increase the C : N ratio of the slurry so as to reduce ammonia emission and nitrate leaching, stimulate microbiological activity in the soil and increase soil organic matter content (Lantinga 2000). Despite the inclusion of straw in the diet, average milk production per cow was at a relatively high level in 1999 and 2000 (*c.* 8500 kg/cow per year). Visual observations suggested that the rejection of herbage growing around the dung pats by grazing cattle on this integrated farm was considerably less and the rate of decomposition of these dung pats was faster than usually observed on conventional farms.

In the present experiment, the influence of feeding strategy on growth and rejection of herbage around dung pats and pat decomposition was studied. Dung from four farms with different feeding strategies was used to create artificial dung pats. The objectives were to determine: (1) the effect of feeding strategy on the rejection of herbage around dung pats, (2) the relationships between the N and sugar content of herbage growing around dung pats and rejection by cows, (3) the relationship between a human smell test and rejection, (4) the effect of feeding strategy on decomposition of dung pats, (5) the relationship between the neutral detergent fibre (NDF) content of dung and decomposition in the field, (6) the relationship between decomposition of dung pats and rejection of herbage growing around them, and (7) the effect of feeding strategy on herbage growth in and around the pat area under undisturbed growing conditions.

MATERIALS AND METHODS

Dung

For the sub-experiments, cattle dung from four farms with different feeding strategies was used (Table 1). The first farm was an extensive organic farm (ORGE) with young steers grazing on a sward, which was biodiverse compared with the swards on the other farms. The second was an intensive organic farm (ORGI) with dairy cattle grazing on a grass/clover sward during the day and fed low-protein forages indoors. The third used dung was from an integrated farm (INT), where the feeding strategy was aiming for high dung quality by including straw in the diet. The fourth examined dung was from a conventional farm (CONV) aiming for a high milk production per cow, where fertilized grazed grass was the main component of the diet.

On each of the farms about 60 kg of freshly voided dung was collected from a herd of approximately 50 animals, except for ORGE where the herd consisted of only 15 animals. All the dung was collected on the

Table 2. *Characteristics of dung collected on farms with different feeding strategies*

Dung	Dry matter (g/kg)	N-total* (g/kg)	C-total* (g/kg)	C:N ratio	NDF* (g/kg)
ORGE	137	14·1	452	32·0	513
ORGI	118	19·7	436	22·1	471
INT	134	22·9	420	18·4	422
CONV	108	25·8	434	16·8	299

* Content in the dry matter.
ORGE, extensive organic; ORGI, intensive organic; INT, integrated; CONV, conventional.

same morning, thoroughly homogenized and applied on the field within 4 h. These four samples formed the basic material for the field experiment and the smell test. Total N and C in the dung were determined by element analysis, using a EA 1110 CHN analyser (CE Instruments, Milan, Italy). Neutral detergent fibre (NDF) of the faeces was determined according to Van Soest (1963) (Table 2).

Field experiment

The field experiment was performed in the summer of 2000 using a pasture of the organic part of the A. P. Minderhoudhoeve in Oostelijk Flevoland (experimental farm of Wageningen University) situated in an area reclaimed from the sea in the 1960s. The soil is a well-drained young sedimentary calcareous silty loam with 75% clay and silt, 5% organic matter and a pH-KCl of 7·1 in the top 5 cm. The experiment was performed on the organic farm rather than on the integrated part, because earth worms, which play a significant role in decomposition of dung (Holter 1979; Gittings *et al.* 1994; Hirschberger & Bauer 1994), were not present on the integrated farm.

The experiment was performed on a 10 ha pasture consisting of two different parts. The first part (old field) had been under grass for more than 30 years, and was resown once in 1985 with diploid perennial ryegrass (*Lolium perenne* cv. Wendy). Next to perennial ryegrass, the sward consisted of invaded rough-stalked meadowgrass (*Poa trivialis*) and several cultivars of white clover, which were slit-seeded in 1995. The other part (new field) had the same history, but was resown again in 1999 with a mixture of tetraploid perennial ryegrass (*Lolium perenne* cv. Montagne) and white clover (*Trifolium repens* cv. Alice). In spring, 15 m³ per ha liquid manure was applied and on 20 July, 10 days before the beginning of the experiment, the whole paddock was topped at a height of about 8 cm. During the experiment a herd of 55 dairy cattle was grazed during the day; during the night they were

in the stable, where they were fed protein-poor products (Table 1; ORGI).

The dung, collected as described before, was used within 4 h to create artificial pats on both the old and the new field by pouring an amount of 2·5 kg fresh weight of the homogenized dung in a 9 cm deep × 31 cm diameter polythene collar, with a distance of 5 m between each of the pats. Every pat was marked with a PVC tube at a distance of 1 m, as it was found that marking dung pats at a distance of 1 m had no influence on the grazing behaviour of cattle (Castle & MacDaid 1972). On both the old and new field the experiment was carried out with four completely randomized blocks (Fig. 1).

To examine the effect of dung on herbage growth, separate plots with pats on both the old and the new field, applied as described above, were covered with grass cages of 3·75 m × 1·05 m (four different pats per cage). Herbage growing up to 15 cm from the edge of a dung pat can derive N from the region under the pat owing to lateral spread of grass roots (Lantinga *et al.* 1987). Therefore, the distance between the pats was set at 80 cm in order to prevent mutual interference. The cages were at least 15 m away from the uncaged pats in order to prevent influences from the cages on the grazing behaviour of the cows. There were four completely randomized blocks on both the old and new field (Fig. 1).

Sampling and analyses

Herbage height around the dung pats was measured at the start of the experiment and weekly thereafter, using a falling plate meter with a diameter of 50 cm and a weight of 435 g. After 6 weeks, sampling rings with a diameter of 32 cm (R1) and 64 cm (R2) were placed around the pats and the herbage from each concentric ring was cut separately just above soil level. R1 and R2 of the caged pats were harvested together, because of very low yields in R1. Fresh weight of the samples was determined and the samples were dried at 70 °C for 48 h. The remainder of the dung pats were collected using a small shovel and fresh and dry weight (after heating at 105 °C for 24 h) were determined.

Total N and C of the herbage were determined by element analysis, using the CE instruments EA 1110 CHN analyser. Sugar content (fructose + glucose + sucrose) was measured by grinding the air-dried plant material, extracting with 80% ethanol at 80 °C for 20 min, drying the extract and redissolving in water, and analysing with a Dionex HPAEC system with a Dionex Carbopac PA-1 column, a Dionex PED detector and a 100 mM NaOH + wash step eluent.

Smell test

Fifty people, 20–60 years of age, were recruited to form an untrained smell panel. The smell test was
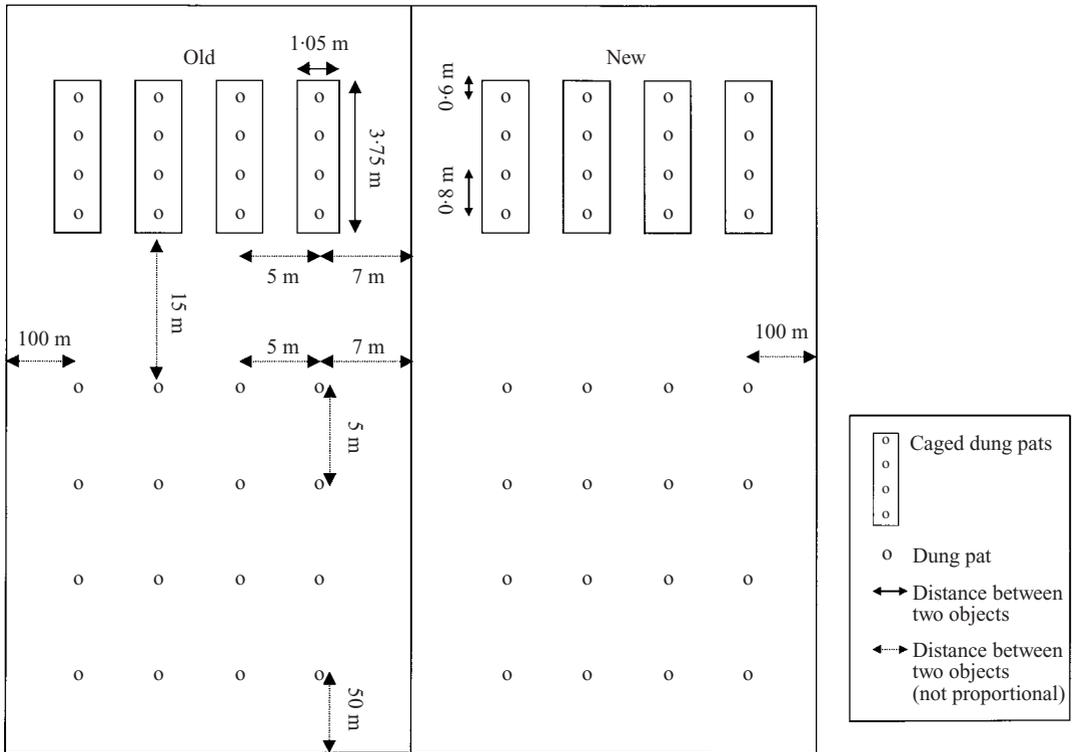
Fig. 1. The experimental design of the field experiment.

performed in a fume hood. The four dung samples were presented in 250 ml darkened polyethylene pots with lids, in order to exclude external characteristics of the dung such as colour and structure, which might influence the ranking. The pots were kept closed except when briefly presented to the panellists. To each panellist samples of the different dungs were presented in randomly numbered pots during a test session of about 15 min. The panellists were asked to rank the four samples from most pleasant (1) to least pleasant (4). They were asked to smell every sample once, put the two most pleasant and the two least pleasant apart and then smell again to determine the final order.

Statistical analyses

The field experiment was analysed with an ANOVA in Genstat (MacConway *et al.* 1999). Block × field was taken as main plot error to test field effects, and block × field × dung treatment as subplot error to test for effects in dung treatment and field × dung interaction. Initial grass height was used as a co-variable in the analysis of herbage yields. Possible correlations between parameters were examined through Genstat. The smell test was analysed using the method of Friedman (Steel & Torrie 1960).

RESULTS

Proportion of dung disappeared

Underneath the cages the mean proportion of dry matter of dung pats disappeared (PDD) of CONV was significantly higher ($P < 0.05$) than of ORGE and ORGI (Table 3). Mean PDD of all caged pats on both fields was similar. PDD for the uncaged pats showed a significant interaction ($P < 0.05$) between the field and dung treatments. PDD of CONV pats on the grazed new field was significantly lower ($P < 0.05$) compared with ORGI and INT pats. On the old field there were no significant differences between the dung treatments. No correlation was found between the NDF content of the dung and PDD of the uncaged pats (Fig. 2 *a*), but the PDD of the caged pats showed a significant correlation with the NDF content of the dung ($P < 0.01$, $r = -0.55$; Fig. 2 *b*). Underneath the cages the mean proportion of fresh weight of dung pats disappeared (PFD) was significantly lower ($P < 0.001$) for ORGE compared with the others, and PFD was significantly higher ($P < 0.05$) on the old field compared with the new field (data not shown). A significant interaction ($P < 0.05$) was found between field and dung treatment for PFD in the case of the uncaged pats. On both the old and the new field PFD was significantly lower ($P < 0.05$) for ORGE,

Table 3. *Proportion of dung disappeared (on dry weight basis; s.e. in parentheses, n = 4) of the four different dung treatments on an old and a new grassland sward, with and without cages*

	Caged*			Uncaged†		
	Field			Field‡		
Dung	New	Old	Mean§	New	Old	Mean
ORGE	0·39 (0·06)	0·37 (0·09)	0·38 (0·05)[a]	0·50 (0·05)[ab]	0·57 (0·03)[a]	0·53 (0·03)
ORGI	0·43 (0·04)	0·41 (0·06)	0·42 (0·03)[a]	0·53 (0·03)[b]	0·53 (0·08)[a]	0·53 (0·04)
INT	0·46 (0·06)	0·51 (0·05)	0·48 (0·04)[ab]	0·53 (0·08)[b]	0·67 (0·11)[a]	0·60 (0·07)
CONV	0·53 (0·05)	0·62 (0·08)	0·58 (0·05)[b]	0·36 (0·06)[a]	0·67 (0·06)[a]	0·51 (0·07)
Mean	0·45 (0·03)	0·48 (0·04)		0·48 (0·03)	0·61 (0·04)	

* No significant interaction between field × dung treatment underneath the cages was found.
† A significant interaction ($P < 0.05$) between field × dung treatment without the cages was found.
‡ Significant differences (L.S.D. = 0·11, $P = 0.05$) are values within columns without the same letter.
§ Significant differences (L.S.D. = 0·14, $P = 0.05$) are values within columns without the same letter.
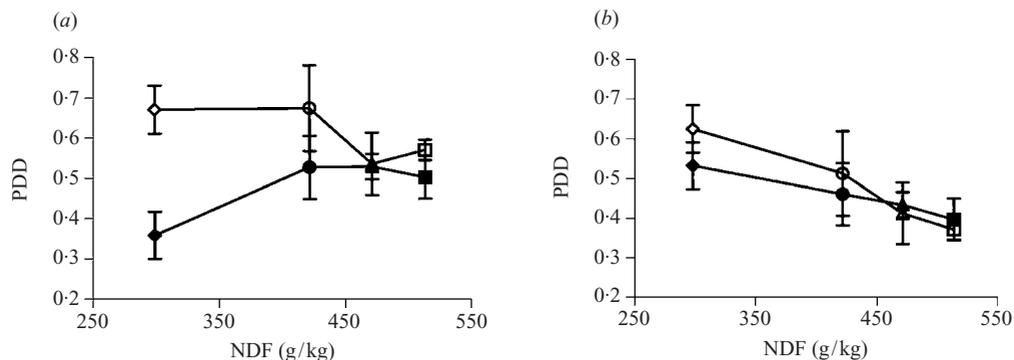ORGE, extensive organic; ORGI, intensive organic; INT, integrated; CONV, conventional.

Fig. 2. The relationship between the neutral detergent fibre (NDF) content in the dung dry matter and the proportion of dry weight of dung pats disappeared (PDD) (*a*) without a cage and (*b*) with a cage of four farms with different feeding strategies (◆, conventional (CONV); ●, integrated (INT); ▲, intensive organic (ORGI); ■, extensive organic (ORGE)) on an old (open symbols) and a new (closed symbols) grassland sward. Mean and standard deviation of four replicates are shown.

but PFD of the other treatments was similar (data not shown).

Herbage yield

The ANOVA revealed no dung × field treatment interaction for both herbage yield underneath the cages and herbage yield in both R1 and R2 for the uncaged pats (Table 4). Underneath the cages mean herbage yield of INT was significantly higher ($P < 0.05$), while the others were similar. In the area of the uncaged pats (R1), mean herbage yield of INT differed significantly ($P < 0.05$) from ORGE and CONV. The mean yield in the area around the dung pats (R2) tended to increase in the order: INT < ORGE < ORGI < CONV. However, only the CONV

treatment differed significantly from the others ($P < 0.05$).

Differences in sugar and N-content between the dung treatments were relatively small (data not shown). No significant correlations were found between the sugar content or the N-content of the herbage and the yield in R2 (data not shown).

Smell test

The smell test revealed significant differences ($P < 0.05$) in pleasantness of the odour between the dung treatments. The mean ranks of ORGE, CONV, ORGI and INT were 1·84, 2·14, 2·54 and 3·48, respectively. No significant correlation between the yield in R2 and the human smell test (Fig. 3) was found.

Table 4. *The yield of herbage (g dm/m^2; s.e. in parentheses,* n $=4$*) growing through (R1,* d $=32$ cm*) and around (R2,* d $=64$ cm*) the artificially formed dung pats from four farms with different feeding strategies on an old and new grassland sward, with or without a cage*

	Caged*			Uncaged						
				R1*			R2*			
	Field			Field			Field			
Dung	New	Old	Mean†	New	Old	Mean‡	New	Old	Mean§
ORGE	295·5 (32·1)	245·7 (13·7)	270·6 (18·2)[a]	100·1 (11·5)	138·1 (25·4)	119·1 (14·7)[a]	236·7 (15·7)	222·0 (16·1)	229·3 (13·6)[a]
ORGI	314·6 (17·7)	265·3 (9·0)	289·9 (11·2)[a]	157·2 (20·3)	166·1 (19·0)	161·7 (13·2)[ab]	255·0 (32·9)	215·9 (20·4)	235·5 (20·4)[a]
INT	381·4 (22·1)	265·4 (33·2)	323·4 (25·0)[b]	169·9 (16·4)	192·5 (11·6)	181·2 (10·8)[b]	240·9 (30·7)	198·2 (16·0)	219·5 (19·1)[a]
CONV	315·7 (24·0)	254·8 (10·2)	285·3 (14·7)[a]	120·2 (16·5)	129·5 (13·3)	124·9 (10·0)[a]	288·4 (19·0)	283·1 (26·7)	285·8 (16·4)[b]
Mean	326·8 (12·8)	257·8 (9·1)		136·9 (9·7)	156·6 (10·3)		255·3 (13·2)	229·8 (12·5)	

* No significant interaction between field × dung treatment was found. Underneath the cages yields of R1 and R2 were added up because of low yields in R1.
† Significant differences (L.S.D. $=32·0$, $P=0·05$) are values within columns without the same letter.
‡ Significant differences (L.S.D. $=43·5$, $P=0·05$) are values within columns without the same letter.
§ Significant differences (L.S.D. $=47·5$, $P=0·05$) are values within columns without the same letter.
ORGE, extensive organic; ORGI, intensive organic; INT, integrated; CONV, conventional.
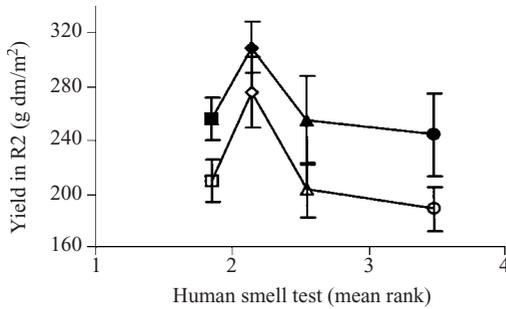
Fig. 3. The relationship between herbage yield around the uncaged dung pats (R2) and a human smell test of dung from four farms with different feeding strategies (■, extensive organic (ORGE); ◆, conventional (CONV); ▲, intensive organic (ORGI); ●, integrated (INT)) on an old (open symbols) and a new (closed symbols) grassland sward. Mean and standard deviations of four replicates are shown.

Strikingly, the dung from CONV caused the highest rejection by the cows, but was considered the second most pleasant one by the panel.

DISCUSSION

From the results it may be concluded that rejection of herbage around dung pats was lowest for INT. The tendency to the lowest herbage yield around the pats under grazing combined with the highest undisturbed herbage growth under the cages indicates that herbage consumption around INT pats was highest and therefore rejection lowest. In line with expectations, the rejection of herbage was highest around the CONV pats. During the experiment, the herbage growing around dung pats was never completely neglected and no clumps of long rank herbage were observed. This might indicate that overall level of rejection is lower in a grass-clover mixture, like in the present experiment, than in a grass monoculture. This is supported by the findings of Marten & Donker (1964), who observed that dung deposited on a grass monoculture gave greater refusal of forage than that deposited on a grass/legume mixture.

The hypothesis that differences in palatability of the herbage surrounding a dung pat cause differences in rejection, as suggested by Plice (1952), could not be proved for both the contents of sugar and N in the herbage. This is in line with Marten & Donker (1966), who concluded that the factor, or factors, causing non-acceptability of dung-affected pasture grass were associated directly with the dung itself and were not inherent in the forage. The hypothesis that a human smell test, ranking the smell of the four dung treatments from most to least pleasant, is correlated with the rejection of herbage surrounding dung pats could also not be proved. A smell test with cows is probably

a better way to determine whether the odour of the dung is causing rejection. Garstang & Mudd (1971) found a relationship between the amount of herbage rejected by cattle and the amount of contamination of the herbage with slurry. Besides odour, visual characteristics of dung pats, such as colour and form, may also influence rejection. A third possible cause of differences in rejection may be the abundance of cattle pests in the dung pats (Michel 1955). These factors were not assessed in the current study and differences may have affected the results obtained.

The feeding strategy had a significant effect on the proportion of dung dry matter disappeared (PDD) under the cages. The most liquid pat, from CONV, had highest PDD, and the most solid pat, from ORGE, had lowest PDD. This is in line with Weeda (1967) and Dickinson *et al.* (1981), who found that the initial consistency of the dung is related to the rate of the pat decomposition.

NDF as a measure of the fibre content of the faeces showed a significant but not high correlation with the proportion of dung dry matter disappeared (PDD) for the caged pats (Fig. 2 *b*). The decomposition pattern of faeces can be interpreted as being derived from a fast and a slowly decomposable fraction (Kirchmann 1991). Undigested feed residues with a relatively low N concentration decompose slowly in soil (Sørensen & Jensen 1998). Differences in feeding strategy may therefore result in differences in the fibre content of the dung and thus in the fraction of feed residues which is relatively slowly decomposable in the soil. For the uncaged pats, however, differences in PDD showed no correlation at all with NDF content of the dung (Fig. 2 *a*). This suggests that in addition to NDF other factors such as physical characteristics play an important role in the disappearance of dung. Weeda (1967) stated that besides the consistency of the dung pat, decomposition is largely influenced by the formation of a hard crust on top of the dung pat and whether a dung pat will disintegrate into smaller pieces. However, these factors were not assessed in the current study. The re-growth through the uncaged pats, measured as the yield in R1, was highest for INT and ORGI (Table 4). This might also be explained by visual observed differences in disintegration into smaller pieces, which allows regrowth through the pat.

The hypothesis that decomposition of dung, expressed as proportion of fresh weight of dung pat disappeared, and rejection, expressed as herbage yield around a dung pat, are correlated could not be proved. This suggests that other factors, like the odour of dung and its physical characteristics, play a more important role in rejection and decomposition, respectively.

The undisturbed herbage growth showed a significantly higher yield in and around INT pats (Table 4), while the yields in the other treatments were similar. This might be explained by differences in C:N ratio.

When dung decomposes to soil, initially all the inorganic N released from dung is immediately immobilized by the microbial biomass (Whitehead 1995). For decomposing material with a C:N ratio greater than 30, like in dung from ORGE in our experiment, immobilization of N is likely to continue for several weeks or more (Whitehead 1995). A C:N ratio below 25, as was the case in dung from ORGI, INT and CONV, will probably stimulate mineralization within a period of a few weeks (Whitehead 1995). The lower the C:N ratio, the more rapidly the mineralization will occur. Also, the balance between immobilization and mineralization is influenced by the composition of the manure. In some cases, cattle dung with a C:N ratio of 19 showed immobilization after 10 weeks (Whitehead 1995). This implies that the lower yields of ORGI compared with INT might be attributed to prolonged immobilization. However, herbage yields of CONV were lower compared with INT while the C:N ratio was also lower. This might be due to a phytotoxic effect of CONV pats on plant growth and soil microbial biomass (SMB). Hoekstra *et al.* (2002) found total N to be the major factor determining differences in phytotoxicity between the four dungs. The adapted feeding strategy of INT, where beet pulp and straw were included to increase the C:N ratio, resulted in a lower N content of the dung than in CONV. Van Bruchem *et al.* (2000) stated that low C:N ratio manure produced on fertilized grass can contain significant amounts of phytotoxic components, which may have a harmful effect on soil biota and soil health, and the functioning of the rhizosphere. On the other hand, Sørensen (1998) found a stimulating effect of the addition of straw on soil microbial activity. In the dung from INT straw residues were present. These two features might explain differences in undisturbed herbage growth between INT and CONV.

Although the importance of determining the effect of feeding strategy on several dung quality aspects is without doubt, the overall dung quality is determined by the combination of them. In the current study several quality aspects were examined. Decomposition of dung pats, rejection of herbage, regrowth through dung pats and undisturbed herbage growth around them have been selected to determine overall dung quality. They were chosen because of their relevance for practical grassland management. The results obtained for these quality aspects were transformed into index figures for two reasons. First, a more clear view is obtained when comparing results of quality aspects with different units or magnitudes. Second, an average index figure for dung quality, based on the quality aspects examined in the current study, can be assessed. The average index figure was highest for INT, followed by ORGI (Table 5). The difference between INT and ORGI might be attributed to the inclusion of straw in the diet of the former. The

Table 5. *Index figures for effects of the four dung treatments on undisturbed herbage yield (Cage), herbage yield within dung area (R1), herbage yield around dung area (R2) and proportion of dung disappeared (PDD). Values of R1, R2 and PDD are from the grazed area. Mean of each column is 100*

	Herbage yield			PDD	
Dung	Cage	R1	R2*	No cage	Average
ORGE	93	81	105	98	94
ORGI	99	110	103	97	102
INT	111	124	109	110	113
CONV	98	85	82	94	90

* R2 represents rejection, therefore high index figures correspond with low yields.
ORGE, extensive organic; ORGI, intensive organic; INT, integrated; CONV, conventional.

index figures of CONV were always below 100, while ORGE had the lowest index figures for undisturbed herbage growth and herbage growth through the dung pats.

The average index figures could be completed and refined by adding other quality aspects such as the effects on SMB, soil fauna and ammonia volatilization. As some quality aspects may be more important than others, their relative importance could be adapted by using impact factors.

CONCLUSION

Different feeding strategies led to differences in rejection of herbage surrounding dung pats, pat decomposition, regrowth through the pats and undisturbed herbage growth in and around the pats. These effects are relevant for practical grassland management in terms of grassland productivity and utilization. They may therefore be considered as indicators for dung quality in a field experiment. The dung from the integrated farm where straw was included in the diet scored best regarding the four quality indicators. However, no relationships could be established between (1) rejection and a human smell test; (2) rejection and contents of total-N and sugar in the herbage; and (3) rejection and dung decomposition. When protected from grazing, the most liquid and least fibrous dung showed highest decomposition, whilst the most solid and fibrous dung showed lowest decomposition. However, no such relationships could be established for the unprotected dung pats in the continuously grazed area. Other factors like the formation of a hard crust on top of the dung pat and whether the pat will disintegrate into smaller pieces seem also to be important, but

they were not assessed in the present experiment. The current study showed that there are opportunities to improve dung quality by altering feeding strategy. In particular the inclusion of straw appeared to be promising.

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