High feed value grass silage: its importance and production

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Introduction

In a recent paper presented at this meeting (Keady and Hanrahan, 2006) it was reported that, if ewes are housed during the winter feeding period, grass silage feed value was the third most important factor, following ewe genotype and grassland management, that effects profitability in sheep production. Subsequently papers were presented at this meeting on over wintering ewes on deferred pasture (extended grazing) (Keady and Hanrahan 2007), improving technical efficiency in the sheep industry, including ewe genotype (Hanrahan 2010), and finishing lambs from grazed grass (Keady 2010).

Grass silage forms the basal forage for the majority of ruminant livestock during the winter indoor feeding period in Ireland. The feed value of grass silage is a combination of its intake potential and nutritive value, which is determined primarily by digestibility. Grass silage feed value impacts on ewe body condition at lambing, lamb birth weight, colostrum supply and subsequently on lamb survivability and labour demands during the busy period around lambing. Furthermore previous studies at Athenry have shown that each 0.5 kg increase in lamb birth weight increases weaning weight by 1.5 kg.

The objective in this paper is to present the effects of silage feed value on ewe and lamb performance and to highlight the key factors involved in the production of high feed value silage.

Variability in silage feed value

The composition of silage produced on farms in Ireland varies dramatically in terms of feed value and chemical composition (Table 1). The variation in feed value is dependent on the composition of the herbage harvested, regrowth interval, sward type, harvest date, harvest number, wilting period, prevailing weather conditicions, additive treatment and ensiling management. The chemical composition of silage produced in Ireland and offered to livestock in the winter of 2011-2012, as analysed by the Hillsborough Feeding Information System is presented in Table 1. Silage composition is extremely variable as indicated by the data for concentrations of dry matter, ammonia nitrogen and crude protein, and by dry matter digestibility (DMD). Silages with low digestibility have low intake characteristics. The effect of silage feed value on animal performance is also presented in Table 1. The poorer quality silages would not even support animal maintenance whilst the best silages, when offered as the sole diet would sustain 23 litres of milk per cow daily, a daily live-weight gain of 1.1 kg per finishing steer daily, a daily liveweight gain of 173g/day per finishing lamb. The data presented in Table 1 clearly indicate the importance of producing high feed value silage to support high levels of animal performance.

Table 1. Chemical composition of silages ensiled in 2011

	Minimum	Maximum	Mean
Predicted silage DM intake (g/kg $W^{0.75}$ per day)	60	115	92
pH	3.6	6.3	4.2
Dry matter (g/kg)	119	657	272
Ammonia N (g/kg N)	50	200	84
Crude protein (g/kg DM)	80	241	124
Dry matter digestibility (DMD)(g/kg DM)	520	820	703
Metabolisable energy (MJ/kg DM)	8.3	12.3	10.8
Potential animal performance supported under ad-libitum feeding			
Milk yield (kg/d)	0	23	11
Steer live weight gain (kg/d)	0	1.1	0.6
Lamb live weight gain (g/d)	0	173	71

(Hillsborough Feeding Information System)

Grass silage feed value

To obtain the optimum level of performance from pregnant ewes, finishing lambs, beef cattle and dairy cows grass silage is normally supplemented with concentrates. The level of concentrate supplementation depends on the feed value of the grass silage. The feed value of grass silage is a combination of intake potential and nutritive value, which is determined primarily by digestibility.

Silage digestibility: the key determinant of silage feed value

Digestibility is the most important factor influencing silage feed value, and consequently the performance of animals offered silage. The impact of digestibility on animal performance is well documented.

For dairy cows, Gordon (1989) concluded from a review of the literature that each 10 g/kg (1 percentage unit) increase in digestibility increased daily milk yield of lactating dairy cows by 0.37 kg/cow. Keady and Mayne (1998) and Keady et al. (2008a) reported that each 10 g/kg increase in digestibility increased milk protein concentration by 0.14 and 0.16 g/kg, respectively.

For beef cattle Steen (1987) concluded from a review of the literature that each 10 g/kg (1 percentage unit) increase in digestibility increased daily carcass gain of beef cattle by 28 g when concentrate constituted between 20 and 37% of total dry matter intake. More recently with beef cattle Keady et al. (2008b) reported that when concentrate constituted 52% of total dry matter intake each 10 g/kg increase in D-value resulted in an increase in daily carcass gain of 23 g. Consequently a 50 g/kg (5 percentage unit) increase in digestibility increases carcass gain by 140 g/day, which is equivalent to 21 kg carcass weight (valued at €86) over a standard 150 day finishing period

Silage digestibility impacts on the performance of ewes in mid and late pregnancy and of finishing lambs. The effects of silage digestibility on the performance of pregnant ewes and the subsequent performance of their lambs are presented in Table 2. The data in Table 2 is collated from 3 studies undertaken at Athenry in which ewes received an average of 20 kg concentrate during late pregnancy. Each 10 g/kg (1 percentage unit) increase in silage digestibility increased ewe weight immediately post lambing by 1.3 kg, lamb birth weight by 50 g and lamb weaning weight by 190 g. Therefore a 50 g/kg (5 percentage unit) increase in silage DMD increases lamb birth weight by 250 g and weaning weight by 0.95 kg, respectively.

Table 2. The effects of silage feed value on performance of pregnant ewes and of their lambs

	Silage feed value	
	Medium	High
Chemical composition		
Dry matter (g/kg)	230	259
DMD (g/kg DM)	702	765
Ewe weight post lambing (kg)	58.7	66.7
Lamb weight (kg) - birth	4.35	4.67
- weaning	30.5	31.7

(Keady and Hanrahan, 2009, 2010, 2012a)

The effects of silage digestibility on the performance of finishing lambs, which were offered 0.5 kg concentrate daily, are summarised in Table 3. Each 10 g/kg increase in silage digestibility increased daily live weight gain by 19 g and daily carcass gain by 8.3 g. Therefore a 50 g/kg (5 percentage unit) increase in silage digestibility increases daily carcass gain by 41 g and carcass weight by 4.1 kg, valued at €22 over a 100 day finishing period.

Table 3. The effect of silage feed value on the performance of finishing lambs (offered 0.5 kg concentrate/lamb daily

	Silage feed value	
	Medium	High
Chemical composition		
Dry matter (g/kg)	240	266
DMD (g/kg DM)	740	775
Lamb performance		
Live weight gain (g/d)	81	147
Carcass gain (g/d)	39	68
Carcass weight	19.2	21.1

(Keady and Hanrahan, 2011, 2012b)

The effect of silage digestibility on animal performance declines as concentrate feed level increases because silage accounts for a declining proportion of total daily intake. This is clearly illustrated in Table 4 based on a study in which finishing lambs were offered differing levels of concentrate. However, whilst the impact of silage feed value on lamb performance declined as concentrate feed level increased, even when lambs were offered 1 kg concentrate daily silage feed value altered daily carcass gain by 21 g equivalent to 2.1 kg carcass after a 100-day finishing period.

Table 4. Effect of silage feed value and concentrate feed level on carcass gain of finishing lambs

	Concentrate (kg/day)		
	0.30	0.65	1.0
Silage DMD (g/kg DM)			
740	15	72	98
775	62	91	119
Additional carcass weight after 100 day finishing period	4.7	1.9	2.1

(Keady and Hanrahan, 2011, 2012b)

Digestibility is the most important factor in determining silage intake. For beef cattle, each 10 g/kg increase in digestibility increases silage intake by 1.5% (Steen et al., 1998).

In summary, digestibility is the most important silage characteristic determining the performance of pregnant ewes, finishing lambs, beef cattle and dairy cows offered diets based on grass silage. Whilst the impact of silage digestibility on animal performance declines as concentrate feed level increases, the impact of silage feed value is still evident even when concentrate accounts for 70% total dry matter intake.

Factors affecting silage digestibility

Most of the factors that determine silage digestibility can be controlled by the producer.

Harvest date

Harvest date is the most important factor affecting herbage digestibility and yield. Yield increases as harvest date is delayed, but as harvest date is delayed digestibility (which is the major factor effecting feed value) declines. The effect of harvest date on silage digestibility and intake potential is presented in Table 5. Delaying harvest reduced silage feed value (as indicated by digestibility), crude protein concentration and silage intake potential. With each 1 week delay in harvest date silage digestibility declined by 29 g/kg DM (2.9 percentage units), silage crude protein concentration by 14.7 g/kg DM (1.47 percentage units) and daily silage dry matter intake by a 500 kg steer by 0.55 kg DM. Other studies have reported similar declines in silage digestibility due to delayed harvest date.

Table 5. Effect of harvest date on silage feed value

	Harvest date				
	10 May	17 May	24 May	31 May	7 June
Crude protein (g/kg DM)	154	136	118	107	95
DMD (g/kg DM)	802	786	760	719	689
Potential DM intake (kg/ 500k steer/day)	9.5	9.3	8.5	8.0	7.4

(Keady et al., 2000)

Therefore if harvest date is delayed with the intention of increasing herbage yield, increased concentrate supplementation will be required to maintain annual performance. For each week delay in harvesting additional concentrate inputs of 1.5 kg/day, 1.2 kg/day, 8 kg in late pregnancy and 0.3 kg/day of concentrate are required to sustain milk yield of dairy cows, carcass gain of beef cattle, lamb birth weight, and carcass gain of finishing lambs, respectively.

Crop lodging

Lodging or flattening of the grass crop prior to harvest accelerates the rate of decline in herbage digestibility. The accelerated decline in digestibility is due to the accumulation of dead leaf and stem at the base of the sward. Digestibility may decline by as much as 9 percentage units per week in severely lodged crops (O'Kiely et al 1987).

Sward type

Normally, silage produced from old permanent pastures has a lower digestibility than silage produced from a perennial ryegrass sward. However, the negative impact of old permanent pasture on silage digestibility is dependent on botanical composition. However if old permanent pastures are harvested at the correct stage of growth, they are capable of consistently producing high feed value silage.

A 2 year study was undertaken at Grange to evaluate the effects of sward type on silage feed value. In the first year of the study, beef carcass output (kg/ha) was similar for silage produced from old permanent pasture (45% meadow grass, 26% bent grass, 10% perennial ryegrass, 6.5% meadow foxtail, 2% docks, 10.5% other) and silage from a perennial ryegrass sward. However, in the second year of the study beef carcass output was lower for the silage produced from the first harvest of the old permanent pasture due primarily to the lower digestibility (Keating & O'Kiely 2000).

The effects of sward type on feed value of silage harvested from the second re-growth (third harvest) are presented in Table 6. Silage produced from an old permanent pasture (52% perennial ryegrass, 28% creeping bent, 10% meadow grass, 10% yorkshire fog) and that from a perennial ryegrass pasture resulted in silages that had similar (high) feed values. Consequently, high feed value silage can be produced from old permanent pasture provided it has a moderate level of perennial ryegrass and is ensiled at the correct stage of maturity using good ensiling management.

Table 6. Effect of sward type on silage composition, digestibility and intake

	Sward Type	
	Old permanent pasture	Perennial ryegrass
Silage Composition		
pH	4.1	4.0
Ammonia nitrogen (g/kg N)	75	74
DMD (g/kg DM)	789	769
Silage DM intake (kg/day)	3.66	3.56

(Keady et al., 1994)

Perennial ryegrass varieties are classified according to heading date. Whilst the general recommendation is to harvest swards at approximately 50% ear emergence, the actual date of emergence depends on the varieties of grass in the sward and thus on their heading date. The effect of heading date (intermediate or late) of perennial ryegrass and date of harvest on animal performance, using beef cattle, is presented in Table 7. The intermediate and late heading swards each consisted of 3 different varieties of perennial ryegrass. Whilst the mean heading date of the intermediate and late heading swards differed by 24 days (19 May and 12 June) herbage from the late heading swards had to be ensiled within 8 days of that from the intermediate varieties to give the same silage digestibility and carcass gain of finishing beef cattle. If the harvest of the late heading sward was delayed until 50% ear emergence the silage DMD would be 7 percentage units lower than the intermediate heading sward, consequently reducing silage intake and carcass gain (from 0.63 to 0.40 kg/day).

Table 7. Effect of grass variety heading date at harvest date on annual performance

	Variety heading date					
	Intermediate (19 May)			Late (12 June)		
Harvest date	20 May	28 May	5 June	28 May	5 June	13 June
Silage DMD(g/kgDM)	765	725	680	762	719	692
Silage DM intake (kg/d)	6.8	6.2	6.3	6.6	6.4	5.9
Carcass gain (kg/d)	0.63	0.51	0.46	0.61	0.55	0.40

(Steen, 1992)

Similarly results from studies using small scale silos show that herbage from late heading varieties (heading date 10 June) must be ensiled on 31 May to produce similar silage DMD as that for intermediate varieties (heading date 22 May) (Humphreys and O'Kiely 2007). However these authors also noted that the rate of decline in digestibility with harvest date was not as rapid for late-heading varieties as for intermediate-heading varieties.

Silage fermentation

Relative to well-preserved silage, poorly preserved untreated silage with low lactic acid concentrations and high concentrations of ammonia nitrogen normally has lower digestibility. The decline in digestibility due to deterioration in silage fermentation may be as high as 5 to 6 percentage units of DMD.

Fertiliser nitrogen (N) application

Excess fertiliser N application alters silage digestibility. Increasing fertiliser N rate from 72 to 168 kg/ha for first cut silage reduced silage DMD by 13 g/kg (1.3 percentage units) (Table 8).

Table 8. Effect of level of fertilizer N application on silage composition and feed value

	Nitrogen (kg / ha)				
	72	96	120	144	168
pH	3.9	3.9	4.0	4.0	4.0
Ammonia nitrogen (g/kg N)	67	68	74	73	78
Crude protein (g/kg DM)	109	111	123	131	136
DMD (g/kg DM)	758	754	753	745	745
Potential silage intake (kg/500kg steer/day)	8.7	8.6	8.6	8.4	8.4

(Keady et al., 2000)

Wilting

Wilting reduces silage digestibility due to a loss of available nutrients and an increase in ash concentration. The rate of decline in digestibility due to wilting depends on the length of time between mowing and ensiling herbage, and soil contamination due to tedding. Rates of loss in digestibility vary from 2.3 to 9.0 g/kg per 10 hour wilting period. Thus each day (24 hours) of wilting will reduce silage DMD by between 0.6 and 2.2% units.

Table 9. Effect of wilting on silage digestibility

	Treatment	
	Unwilted	Wilted
Dry matter (g/kg)	199	320
Dry matter digestibilty (g/kg DM)	773	746

(Keady et al., 1999)

Wilting

Wilting herbage prior to ensiling has many advantages including reducing effluent production and fuel consumption, improved ensilibility characteristics, reduced quantities of silage for transport during feed out and reduced straw requirement for bedding livestock. When wilting, a rapid wilt is desirable to minimise the decline in digestibility. The most important weather and management factors influencing drying rate are duration and intensity of sunshine and the density of the herbage (swath). The lower the density of the sward the higher the drying rate. Reducing the density of the cut herbage involves covering the total ground area with herbage which results in a higher drying rate. Herbage mown in autoswaths has a higher density than when the herbage is tedded out: thus management practices have a big impact on herbage drying rate (Table 10). The data in Table 10 show that to increase herbage dry matter from 160g/kg to 250g/kg required 65, 30 and 14 hours respectively for herbage which was mown auto swathed (6 metres of herbage in one swath), single swaths (3 metres of herbage in one swath) or tedded out to cover the total ground area immediately post mowing, respectively

Table 10. Effects of swath treatment and wilting period on herbage dry matter concentration (g/kg) (Yield = 29.4 t/ha)

	Wilting period (hours)		
	0	24	48
Swath treatment			
Auto swathed	160	192	228
Single swath	160	229	317
Tedded out	160	304	500

(Wright, 1997)

Results from many studies have shown that wilting increases silage intake by sheep, beef cattle and dairy cows, without any major improvement in animal performance thus reducing the efficiency of conversion of forage to animal product. The effects of wilting on silage intake and on the performance of pregnant ewes are presented in Table 11. Wilting herbage to increase silage dry matter concentration from 219 to 314g/kg increased silage intake by 7% but had no beneficial effects on lamb birth weight. More recent data from the mean of 11 studies, summarised by Keady (2000), involving dairy cows show that rapid wilting of herbage from a dry matter concentration of 160g/kg to 320g/kg increased silage intake by 17% and milk solid output by 3% but reduced cow feeding days per hectare by 174 and milk output by 3074 litres. Data from another study (Table 12) showed that rapid wilting increased of herbage dry matter concentration from 187 g/kg to 277 g/kg, increased silage intake by 41 % and milk fat plus protein yield by 3.5 %.

Table 11. Effect of wilting on the performance of pregnant ewes

	Treatment	
	Unwilted	Wilted
Silage dry matter (g/kg)	219	314
Silage dry matter intake (kg/d)	1.21	1.30
Lamb birth weight (kg)	5.21	5.16

(Chestnutt, 1989)

Many producers delay harvesting in showery weather conditicions, with the intention of getting dry weather for wilting. However, in a prolonged period of showery weather crop digestibility is declining, whilst there may be opportunities to harvest. The effects of direct cutting, ensiling following water application and wilting on animal performance were evaluated in a recent study (Table 12). The wilted herbage was ensiled at a dry matter concentration of 277 g/kg following a 30 hour wilting period. Whilst wilting increased silage intake it had no effect on animal performance. Application of water at ensiling reduced herbage dry matter at ensiling reduced the dry matter concentration from 187g/kg to 131g/kg but had no effect on silage intake or animal performance, illustrating that ensiling during showery conditions has no negative impact on animal performance.

Table 12. Effect of herbage dry matter at ensiling on dairy cow performance

	Herbage dry matter at ensiling (g/kg)		
	131	187	277
Silage dry matter intake (kg/day)	9.7	9.6	13.6
Milk yield (kg/day)	20.1	20.0	20.0
Fat plus protein yield (kg/day)	1.47	1.46	1.51

(Keady et al., 2002)

The data clearly show that whilst wilting reduces effluent production, fuel required during the ensiling process and, bedding requirements for ewes, it increases daily silage dry matter intake and reduces the number of feeding days and animal product output per hectare.

Fertiliser management

Nitrogen (N)

To achieve the maximum response to fertiliser N, soil P (phosphorous), K (potassium) and pH need to be at the optimum levels. The response in herbage yield to inputs of fertiliser N is presented in Table 13. The response varied form 5.2 to 10.2 kg herbage dry matter per 1 kg N. The response varies depending on the base level of nitrogen applied, prevailing weather conditicions and harvest date. Fertiliser N also affects herbage composition. Increasing the rate of fertiliser N applied increases herbage crude protein concentration and reduces herbage dry matter and water soluble carbohydrate (sugar) concentrations (Table 14). Therefore applying excess fertiliser N can have a negative impact on herbage ensilibility. However, inadequate levels of fertiliser N reduces herbage yield and the crude protein concentration of the subsequent silage. The optimum level of N for the first, second and third harvests are 120, 100 and 80 kg/ha, respectively. If closing paddocks after grazing, assume that between 20 and 30% of the N applied for grazing is available for the silage crop. Also allow for N that is contained in any slurry that has been applied. For example, the quantity of nitrogen from slurry that is available to the sward will be greater in dull damp conditions than in warm dry conditions at the time of application.

Table 13. Effect of fertiliser (N) application on herbage dry matter (DM) yield in the primary growth

Source	Range in N application (kg/ha)	kg DM per kg nitrogen
Long et al (1991)	100 - 150	10.2
Keady and O'Kiely (1998)	120 - 168	5.2
Keady et al (2000)	72 - 168	7.9

Table 14. Effect of level of fertiliser N on herbage composition

	Nitrogen (kg/ha)				
	72	96	120	144	168
Dry matter (g/kg)	190	188	179	172	169
Crude protein (g/kg DM)	106	108	118	129	137
Water soluble carbohydrate (g/kg DM)	264	259	238	229	217
Buffering capacity (mEq/kg DM)	227	225	224	227	228
Nitrate (mg/kg DM)	223	212	275	392	469

(Keady et al., 2000)

Potassium

Large quantities of potassium are required, and removed, by silage crops. Each tonne of herbage dry matter removes 25 kg of potassium. Level of potassium fertilizer affects herbage yield (Table 15). Increasing potassium application increased herbage yield at both the first and second harvests. The mean response, between the two harvests, was 4.5 kg herbage dry matter per 1 kg potassium applied. Excess potassium fertiliser application can result in luxury uptake of potassium by the crop. However excess potassium application has no effect on herbage composition or ensilability (Table 15). The quantity of potassium fertilizer which should be applied for silage production depends on the soil potassium index and expected herbage yield (Table 16). Reduce the quantity of inorganic potassium application if slurry is been applied to the sward. Each 1 tonne (222 gallons) of undiluted cattle slurry contains 4.3 kg of potassium.

Table 15. Effect of potassium (applied on 2 March) on herbage yield at the first and second harvest (K soil index = 3) and composition of the herbage from the first cut

	Potassium applied (kg/ha.)				
	0	60	120	180	240
Herbage dry matter yield (t/ha)					
- first harvest	6.31	6.57	6.74	6.93	6.93
- second harvest	2.56	2.73	2.83	2.94	2.99
Dry matter (g/kg)	179	170	169	171	169
Buffering capacity (mEq/kg DM)	430	442	454	445	442
Water soluble carbohydrate (g/kg DM)	101	93	94	100	96
Nitrate (mg/kg DM)	35	18	18	13	15

(Keady & O'Kiely, 1998)

Table 16. Effect of potassium soil index on the quality of potassium required for silage

Soil index	Silage Harvest	
	First	Second/Third
1	175	70
2	150	50
3	120	30
4	0[1]	0[1]

[1] No K required in year of soil sampling; for subsequent years use index 3 advice

(Coulter & Lalor, 2008)

Chop length

Whilst chop length has no effect on silage intake or the performance of beef cattle or dairy cows, chop length affects the intake characteristics of silage when offered to pregnant ewes or finishing lambs. The effect of silage chop length, determined by harvester type, on the performance of finishing lambs is presented in Table 17. Reducing silage chop length increased silage intake by up to 34% and liveweight gain by up to 242% respectively.

Table 17. Effect of silage harvester type on the performance of finishing lambs

	Harvester type		
	Single	Double	Precision
Mean chop length (cm)	12.4	8.4	2.9
Silage dry matter intake (kg/day)	0.68	0.77	0.91
Liveweight gain (g/day)	35	49	85
Carcass gain (g/day)	-3	18	26

Fitzgerald, (1996)

The effect of silage chop length, determined by harvester type, on the performance of pregnant ewes is present in Table 18. Relative to single chop, use of a precision chop harvester reduced chop length leading to increased silage intake and lamb birth weight and reduced weight loss by ewes during late pregnancy. Furthermore use of precision chop silage enabled concentrate feed level to be reduced by 66% (12kg) while delivering similar ewe performance and lamb birth weight as the longer single-chopped silage.

Table 18. Effect of harvester type on the performance of pregnancy ewes

	Harvester type			
	Precision-chop		Single chop	
Conc in late pregnancy (kg)	18	6	18	6
Silage dry matter intake (kg/d)	1.06	1.09	0.84	0.66
Ewe weight change (kg)	+1.8	-2.4	-2.9	-8.0
Lamb birth weight (kg)	5.4	5.1	5.2	4.8

(Chestnutt, 1989)

In a more recent study big-bale and precision-chop silage systems were compared (Table 19) in both the first and second harvests using herbage that had been ensiled at a mean dry matter concentration of 249g/kg. Results showed that system of ensiling had little impact on silage intake or lamb birth weight. However weaning weight was 1.8 kg higher for lambs from ewes on precision chopped silage which was due to higher daily live weight gain in weeks 0 to 5 and 5 to 10. Ewes offered the big bale silage were able to select out and consume the leaf and reject the stem portion of the silage.

Table 19. Effect of silage harvester system on ewe performance

	System	
	Big Bale	Precision
Silage dry matter intake (kg/d)	0.95	0.97
Lamb weight - birth (kg)	4.7	4.8
- weaning (kg)	32.5	34.3
Lamb weigh gain (g/day) - 0 to 5 weeks	314	338
- 5 to 10 weeks	314	332

(Keady and Hanrahan, 2008)

Additive management

Silage additives, if used, should be used as an aid and not a substitute for good management. Animal performance is the most important measure of the efficacy of a silage additive, as producers are paid for animal product and not for the preservation quantity of silage as measured by conventional laboratory analysis. When applying additives it is important to apply them at the correct rate, taking account of changes in the moisture content of the herbage ensiled. For example, if the dry matter of the herbage is increased from 180 to 250g/kg, the fresh weight of herbage will be reduced from 29.5 to 21 t/ha consequently reducing additive requirement by 40% per hectare. Whilst few studies have been undertaken on the effects of silage additive on ewe performance many studies have been undertaken to evaluate their effects on the performance of beef cattle and lactating dairy cows. From a review of 95 comparisons (Keady, 1998) in which different types of additives were compared to untreated silages it was concluded that use of proven effective inoculants under a wide range of ensiling conditions or formic acid under difficult conditions increased animal performance. Whilst use of other additives improved silage fermentation, they had no effect on animal performance.

Production of high feed value silage

The following are some practical pointers for the production of high feed value silage.

1. *Closing date*: If closing in late autumn graze to a residual sward height of between 4 and 4.5 cm. If closing in spring graze to 4 cm. Excess herbage left at closing will result in decayed material at the base of the sward and this will reduce subsequent silage digestibility.
2. *Fertiliser N*: Apply 120 and 100 kg/ha (100, 80 units/acre) for the first and second harvests, respectively. If the sward has already been grazed prior to first cut and has received fertiliser N, assume that 20 to 30% of the previously applied N is still available and therefore deduct this from the target fertiliser N required. If undiluted slurry has been applied to silage ground prior to 1 February apply the full quantity of inorganic N. If slurry is applied later in dull weather for the first cut reduce fertiliser N by 0.7 kg /t (3kg/1000 gls) applied slurry. If slurry is been applied for the second cut in warm weather assume little N is available to the crop.

3. *Should fertiliser N application be split?* From a herbage yield view point there is no benefit to splitting the N application. However, from a farm management viewpoint for swards that have not been grazed in spring prior to closing apply 50% of the fertilizer N in early March and the remainder in late March, weather depending. If the sward has been grazed in spring prior to closing apply all N in the one application, immediately post closing.

4. *Source of N*: Urea is usually the cheapest source of nitrogen. However if N is been applied to bare swards in April or during dry weather CAN is the preferable source of N due to the lower risk of volatisation.

5. Phosphorous and Potassium: Apply adequate quantities to maintain soil fertility and to meet crop requirements. Inadequate quantifies of phosphorous and potassium will reduce herbage yield and reduce the response to fertiliser N. Allow for nutrients from slurry and farmyard manure when calculating the amounts to be applied.

6. Maintain soil pH by applying adequate quantifies of lime. Base lime applications on soil analysis. Apply lime after the last harvest of the season.

7. Digestibility: Target at <u>least</u> 75% DMD for ewes in mid and late pregnancy, finishing cattle and lactating dairy cows. For swards closed in late autumn target harvest in mid

May. For swards closed post spring grazing, harvest after a regrowth interval of 6 to 7 weeks. Do not delay harvest by more than 4 to 5 days with the hope of achieving a wilt in dull weather as digestibility is declining. Later maturing varieties should be harvested within 8 days of intermediate varieties (prior to ear emergence) to maintain digestibility and subsequent animal performance.

8. Wilting: If wilting then ensile after a 24 to 30 hour period. Spread the herbage over as large an area as possible immediately post mowing. There is not benefit to increasing herbage dry matter concentration above 25%. Wilting to a higher dry matter concentration may result in aerobic instability problems at the time of feed out, particularly during mild weather. Prolonged wilting reduces digestibility.

9. Stubble height: Mow to a stubble height of 5 to 6 cm. Mowing to lower heights results in the ensiling of stem and dead leaf (and potentially soil contamination) which is low in digestibility therefore reducing feed value.

10. Additives: Additives are an aid, not a remedy for poor management. Choose an additive based on it proven ability to increase animal performance. Proven bacterial inoculants under a wide range of ensiling conditions, or formic acid under a difficult ensiling conditions have been shown to increase animal performance.

11. Chop length: Chop length has no effect on the performance of beef cattle or dairy cows. However chop length affects silage intake by sheep. Shorter chop lengths are desirable, however the impact of chop length is minor compared to the impact of digestibility. If using a contractor, precision chop is choice, provided it does not impact on date of harvest or the cost of ensiling, and suits the storage system on the farm

12. Sward type: Base harvest date on inspection of the sward. During inspection check for the proportion of seed head emergence, but it is just as important to check the base of the sward for dead/decaying leaf and stem. What happens at the base of the sward has as great an effect on feed value as seed head emergence. Well-managed old permanent pasture, harvested at the correct stage, can consistently produce high feed

value silage. If using later heading varieties, ensile prior to seed head emergence to maintain digestibility.

13. Ensiling management: Ensile rapidly into a clean silo. Side sheet the walls prior to silo filling to aid sealing post ensiling. Cover the silo with 2 sheets of polythene and weigh down with tyres (touching) or other adequate material.

14. Apply fertilizer and/or slurry immediately post harvest to maximise annual herbage production from the sward.

Conclusions

1. Silage feed value has a major impact on the efficiency of the ewe enterprise.
2. Silage digestibility is the most important factor effecting silage feed value.
3. For pregnant ewes, finishing lambs, finishing beef cattle and lactating dairy cows target at least 75% DMD.
4. Increasing silage digestibility by 5 percentage units increases
    a. Carcass gain of beef cattle by 140g/head daily
    b. Carcass gain of finishing lambs by 41g/head daily
    c. Lamb birth weight and weaning weights by 190g and 0.95 kg respectively.
5. To maintain animal performance due to delay of harvest by one week requires an additional
    a. 8 kg concentrate per ewe in late pregnancy
    b. 0.3 kg concentrate per finishing lamb daily
    c. 1.2 kg concentrate per finishing beef animal daily
    d. 1.5 kg concentrate per lactating dairy cow daily.
6. If wilting a rapid wilt is essential. Prolonging wilting decreases silage digestibility.
7. Wilting results in increase silage intake, little change in animal output and a reduction in the number of animal feeding days per hectare.
8. Chop length effects silage intake by sheep.
9. Additives should be used to aid, and not replace, good management. Base additive decisions on their proven ability to increase animal performance. Effective bacterial inoculants across a wide range of conditions and formic acid under difficult conditions increase animal performance relative to untreated silos.

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