SHEEP PRODUCTION

Effects of grass silage harvest system, concentrate feed level and maize silage maturity and soyabean supplementation on ewe and subsequent lamb performance

Ewes housed during the winter feeding period are predominantly offered grass silage as the sole forage. Approximately 55% of grass silage is ensiled in big bales on Irish sheep farms. The objective of the present study was to evaluate the effects of grass silage harvest system, maturity of maize at harvest and protein supplementation of maize silage diets on the performance of ewes in mid and late pregnancy and subsequent lamb performance. The potential concentrate sparing effect of maize silage was also determined.

Four grass silages were harvested from the primary growth (H1) and regrowth (H2) of predominantly perennial ryegrass swards and ensiled either precision chopped (PC) or in big bales (BB). Two maize silages were produced, either grown in the open [sown on May 10, (LDM)], or under the complete plastic mulch system [sown on April 10, (HDM)] and harvested on the same date. Each grass silage was offered *ad libitum* and was supplemented with either 18 or 27 kg concentrate in late pregnancy whilst the maize silages were offered *ad libitum* and supplemented with either with 0 or 200 g soyabean meal/ewe daily and 18 kg concentrate in late pregnancy. The 12 treatments were offered to 180 ewes (Belclare x Scottish Blackface, Chamoise x Scottish Blackface), during mid- and late-pregnancy, penned in groups of five, with 3 replicate pens per treatment. The data were analysed using mixed model procedures.

Table 1: Chemical composition of the grass and maize silages

	Grass silage				Maize silage	
	H1 BB	H1 PC	H2 BB	H2 PC	LDM	HDM
Dry matter (g/kg)	236	221	273	265	247	392
pH	3.9	4.2	4.2	4.4	3.8	3.9
Crude protein (g/kg DM)	139	137	134	132	82	85
Predicted ME (mj/kg DM)	11.3	11.1	11.8	11.7	11.0	11.5
Starch (g/kg DM)	-	-	-	-	200	270

The chemical composition of the grass and maize silages are presented in Table 1. The effects of grass silage harvest system, maturity of maize at harvest and soyabean supplementation on ewe and subsequent lamb performance are summarised in Table 2. Relative to ensiling in big bales, precision chopping did not alter forage intake but increased subsequent lamb growth rate, weaning weight and number of lambs reared. Increasing concentrate feed level in late pregnancy increased lamb birth weight. Increasing maturity of maize at harvest tended to decrease lamb birth weight (P=0.08). Ewes offered precision chopped silage tended (P=0.06) to rear larger litters relative to ewes offered high dry matter maize silage. Supplementing maize silage with soyabean significantly increased forage intake but did not affect litter size, birth weight or subsequent lamb performance. Relative to maize silage (without soyabean supplementation), grass silage increased forage intake. Silage from harvest 2 resulted in a higher forage intake. There were no effects of forage type, grass silage harvest number or soyabean supplementation of maize silage on ewe or subsequent lamb performance. The potential concentrate sparing effect of LDM and HDM maize silages, as determined by lamb weaning weight were approximately 3 and 16.5 kg and -11 and -2.5 kg relative to baled and precision chopped silages, respectively.

It is concluded that regardless of stage of maturity at harvest, maize silage resulted in the same level of subsequent lamb performance as high feed value grass silage. Ensiling grass in big bales reduced subsequent lamb performance relative to precision chopping. The potential concentrate sparing effect of maize silage was up to 16.5 kg/ewe, depending on maturity at harvest and grass ensiling system.

Table 2: The effects of treatment on ewe and subsequent lamb performance

	Forage intake (kg DM/d)	Litter size	Number reared	Birth weight (kg)	Weaning weight (kg)	Gain (Birth-Weaning) (g/d)
Mean	0.92	2.0	1.93	4.74	31.9	278
Conc. feed level: 18v27 kg	+0.05±0.037	+0.20±0.115	-0.04±0.089	+0.31±0.127*	0.90±0.672	+7..9±6.30
Harvest system: bale v precision	+0.02±0.037	+0.05±0.114	+0.18±0.088	+0.06±0.124	1.80±0.672**	+16.9±6.31**
Maize type: LDM v HDM	-0.05±0.053	-0.25±0.159	-0.19±0.124	-0.31±0.176	+1.06±0.972	+12.2±9.12
Soya with maize: no v yes	+0.31±0.053***	+0.05±0.159	+0.029±0.123	+0.23±0.178	-0.18±0.984	-2.9±9.23
Forage type: maize v grass	+0.24±0.046***	+0.20±0.143	+0.10±0.111	+0.17±0.160	-0.05±0.87	-2.7±8.15
Harvest number: 1 v 2	+0.23±0.037***	+0.18±0.114	+0.00±0.088	+0.06±0.124	+0.40±0.679	+4.4±6.36

Keady, T.W.J. and Hanrahan, J.P. *RMIS No. 5657*

A comparison of the grassland based systems for mid season prime lamb production from two ewe genotypes

In mid-season prime-lamb production increasing litter size and good grassland management are the main factors affecting efficiency of production. Previously a 4-year study at this centre (published in 1972) reported lamb carcass outputs of 203 and 301 kg/ha from grass-based systems which received 77 kg N/ha and were stocked with 10 or 15 Galway ewes (mean litter size of 1.4 lambs) per hectare, respectively. Subsequently the Belclare breed was developed as a genetic resource for increased prolificacy. Recently there has been interest in either reducing or eliminating the winter indoor feeding period by extended grazing. Recent studies at this Centre have shown that extended grazing in mid, late or throughout pregnancy increased lamb birth and weaning weights relative to progeny from ewes which have been housed unshorn. The primary objective of this study was to evaluate two contrasting grass-based systems for prime-lamb production. The systems adopted involved stocking rates and fertilizer N inputs at levels similar to those used in the study reported in 1972 but increased lamb carcass output through improved genetic capacity and either housing the flock during the winter period or maximising the use of grazed grass by year-round grazing. Two ewe genotypes were used to examine if there were any interactions between level of prolifacy and the grassland-based systems.

Ewes (n = 284)of two genotypes (Belclare, Belclare x Cheviot (BxC)) were allocated at random to two systems [grazing and winter feeding (GWF) or year round grazing (YRG)] and remained on the same system for the duration(4 years) of the study, or until they were culled. The YRG system involved extended grazing throughout pregnancy, outdoor lambing, a stocking rate of 10.4 ewes/ha and fertilizer N input of 92 kg /ha. In the GWF system the ewes were housed in mid-December and offered grass silage, lambed indoors, turned out at lambing, stocked at 14.1 ewes/ha and a fertiliser N input of 92 kg /ha. The same group of terminal sires were used in both systems in each year. The mean lambing dates for the YRG and GWF systems were 30 March and 20 March, respectively. Lambs were weaned at 14 weeks of age. Ewes on both systems were shorn at the same time (May) and received the same treatments for internal and external parasites. The data were analysed using mixed model procedures.

The effects of system and genotype on ewe and lamb performance are presented in Table 3. There was no evidence for any ewe genotype x system interaction for ewe or progeny performance. Ewes on the YRG system had a higher condition score (P<0.001) at lambing. Relative to Belclare, BxC ewes had a higher (P<0.001) condition score post mating and at weaning. Lambs from ewes on the YRG system were heavier (P<0.001) at birth and weaning and slaughtered at a younger age. System had no effect on lamb carcass weight. Relative to the BxC genotype, Belclare produced larger litters (P<0.001) and reared more lambs per ewe mated. Lambs from Belclare ewes were lighter at birth (P<0.01) but had similar growth rate and weaning weight to lambs from the BxC ewes. Lamb carcass outputs for the Belclare genotype on the GWF and YFG systems, and the BxC genotype on the GWF and YFG systems were 492, 448, 362 and 330 kg/ha, respectively.

Table 3: The effects of system and ewe genotype on ewe and lamb performance

	System (S)			Genotype (G)			Significance	
	GWF	YRG	s.e.	Belclare	BxC	s.e.	S	G
Ewe condition score at:								
post mating	3.58	3.58	0.026	3.50	3.66	0.022	NS	***
lambing	3.19	3.40	0.023	3.27	3.33	0.023	***	(P=0.06)
weaning	3.22	3.25	0.025	3.14	3.32	0.026	NS	***
Litter size	2.17	2.24	0.038	2.34	2.07	0.038	NS	***
Number reared per ewe mated	1.77	1.78	0.042	1.86	1.69	0.043	NS	**
Lamb birth weight (kg)	3.97	4.67	0.055	4.24	4.41	0.049	***	**
Lamb weaning weight (kg)	27.9	30.8	0.25	29.2	29.6	0.26	***	NS
Carcass weight (kg)	18.75	18.75	0.068	18.69	18.82	0.070	NS	NS
Age at slaughter (days)	168	156	1.4	162	163	1.5	***	NS

It is concluded that the YRG provides an alternative system of producing mid season prime lamb but requires a reduction in stocking of about 25% relative to the GWF system. Use of genotypes producing litters up to 2.34 lambs/ewe are suitable for both YRG and GWF systems. Lamb carcass output of 492 kg/ha was achieved (from the GWF system stocked with Belclare ewes) which is an increase of 63% in approximately 30 years using similar stocking rate and N fertiliser input. Genetic changes in ewe prolifacy accounts for approximately 60% of the increased carcass output.

Keady, T.W.J., Hanrahan, J.P. and Flanagan, S. *RMIS No. 4925*

Effect of season of shearing on ewe and progeny performance

Ewes are normally shorn once yearly, usually in early summer for sheep husbandry and welfare reasons. Winter conditions in Ireland are characterised as relatively mild. Consequently, ewes which are housed unshorn may have difficulty dissipating body heat due to the insulating properties of the fleece, leading to ineffective heat regulation. Results from previous studies at Athenry showed that shearing at housing increased lamb birth and weaning weights by up to 0.63 and 2.5 kg, respectively. Shearing at housing may require a greater management input as ewes are normally housed in smaller groups and need to be dry prior to shearing. However, shearing in the autumn prior to mating enables the total flock to be assembled under more favourable conditions. The number of lambs weaned per ewe mated is the major factor influencing efficiency of prime lamb production. It is unknown if shearing prior to mating, in a temperate climate, impacts on subsequent ewe fertility and litter size or on lamb birth weight relative to shearing at the conventional time in early summer. The aim of this study was to evaluate the effect of the season of shearing on ewe fertility of March-lambing ewes and subsequent lamb birth and weaning weights.

Ewes (Belclare x Scottish Blackface, Chamoise x Scottish Blackface; 66 first crop, 64 second crop) were allocated to four shearing treatments as follows: Conventional (C), prior to mating (M), housing (H) and twice yearly (MH) and were shorn on 29 May, 9 September, 30 November and 29 May and 9 September, respectively. The ewes on the M and H treatments had been shorn the previous December whilst the ewes on the C and MH treatments had been shorn the previous May. The ewes were managed as one flock from the parturition prior to the study. All ewes had a synchronised oestrus (using progesterone impregnated sponges) prior to joining the rams on 9 October for syndicate mating. The ewes were housed in slatted pens during the winter feeding period and offered silage based diets supplemented with a total of 21 kg concentrate during the last 6 weeks prior to lambing. Ewes were turned out to pasture within 3 days of lambing. Triplet rearing ewes received 1 kg concentrate daily for 5 weeks post lambing and triplet lambs were offered concentrates to a maximum of 300 g/day from birth to weaning. Ewes rearing single or twins and their lambs received no concentrate post lambing. Lambs were weaned at 14 weeks of age. Animal performance data were analysed using mixed model procedures.

The effects of shearing treatment on ewe and subsequent lamb performance are presented in Table 4. Ewes shorn twice yearly had a significantly higher condition score pre-mating then ewes on the other three treatments. Treatment did not alter condition score at lambing, litter size or number of lambs reared per ewe joined. Lambs from ewes shorn at housing were heavier ($P < 0.001$) at birth relative to lambs from ewes shorn at the conventional time or twice yearly. Lambs from ewes shorn prior to mating and at housing tended to be heavier at weaning (P=0.09) relative to lambs from ewes shorn at the conventional time.

Table 4: The effects of shearing treatment on ewe and subsequent lamb performance

	Shearing treatment					
	Conventional	Prior to mating	Housing	Twice yearly	s.e.	Sig
Ewe condition score at:						
pre-mating	3.40^{ab}	3.49^{b}	3.34^{a}	3.60^{c}	0.037	***
lambing	4.02	3.99	3.73	3.96	0.130	NS
Fertility	0.96	0.89	0.92	0.99	0.039	NS
Litter size	2.02	2.17	2.04	2.05	0.107	NS
Lambs reared per ewe joined	1.71	1.97	1.94	1.83	0.132	NS
Birth weight (kg)	4.27^{a}	4.58^{ab}	4.81^{b}	4.43^{a}	0.102	***
Weaning weight (kg)	30.7	32.7	32.0	31.4	0.62	P=0.09

It is concluded that season of shearing did not alter ewe fertility, litter size or number reared. Shearing at housing increased lamb birth weight. Shearing prior to mating provides an alternative to shearing at housing.

Keady, T.W.J. and Hanrahan, J.P. *RMIS No. 5674*

An on-farm evaluation of the effect of season of shearing on ewe productivity and subsequent lamb performance

Sheep are shorn at least once per year for animal husbandry and welfare reasons. Previous studies at Athenry have shown that season of shearing impacts on lamb birth and weaning weights and subsequent age at slaughter. Undertaking studies on commercial farms enables technology to be evaluated across a greater range of management systems. Furthermore greater numbers of animals are available and potential interactions with production system (farm) can be evaluated.

The objective of the current study is to evaluate the effects of season of shearing and potential interactions with ewe characteristics (eg breed type) on ewe and subsequent lamb performance. This study involves approximately 600 ewes and their progeny on two commercial farms and shorn at different stages during the annual production cycle.

Keady, T.W.J. and Hanrahan, J.P. *RMIS No. 5674*

Effects of altering the plane of nutrition during different stages of the rearing phase on growth and reproductive performance of ewes of two genotypes

Ewe replacements are a major cost in sheep production. This cost is influenced by replacement rate and rearing cost, which is a function of plane of nutrition offered during the first winter and subsequent spring/summer prior to joining at 18 months of age (typical age at first joining). There is a paucity of data on the impact of plane of nutrition between 6 and 18 months of age on ewe body size and subsequent productivity. Litter size is the main factor affecting output per ewe and interactions between rearing system and genetic potential for prolificacy may be important. The aim of the current study was to evaluate effects of plane of nutrition during the first winter and subsequent grazing season, and potential interactions, on body size and ovulation rate at ~18 months of age using two breed types with contrasting prolificacy potential.

Ewe lambs (60 Chamoise x S. Blackface, 34 Belclare x S. Blackface; mean initial live weight 34.8 and 39.9 kg, respectively) born and reared in the same flock were allocated, at random within breed type, to two herbage dry matter (DM) allowances daily (0.75 kg (L) and 1.75 kg (H) per head), on winter grazing, from 25 Nov to 29 Mar. From 29 Mar to 30 Aug half of the ewe lambs from each winter treatment were allocated one of two planes of summer nutrition by set stocking to maintain sward heights of 4 cm (L) or 6 cm (H). Thus, there were four treatment groups - HH, HL, LH, LL (the sequence indicates winter and summer treatment). All animals were grazed together from 30 Aug and synchronised (progesterone impregnated sponges) to facilitate ovulation rate measurements at consecutive oestrous cycles (12 and 30 Oct). Weight and condition score, and measurements of girth, length, height and cannon bone diameter were recorded at the start and finish of winter grazing and at the end of the summer grazing periods. Live weight at mating was also recorded. Pre-experimental measurements were used as covariates in the analyses of weight and linear measurements.

Table 5: The effects of plane of nutrition during the rearing phase, and genotype, on body measurements and ovulation rate of ewes at 18 months

		Treatment (T)					Contrasts (H v L)			Breed (B)			Significance	
		HH	HL	LH	LL	s.e.	Winter (W)	Summer (S)	W x S	Cham x	Bel x	s.e.	B	T x B
Liveweight (kg)	- Mar	42.4	42.0	32.9	33.0	0.60	***	-	-	35.3	39.8	0.42	***	**
	- Aug	62.9	54.3	52.9	49.7	0.83	***	***	**	51.3	58.7	0.58	***	NS
	- Mating	62.1	57.4	53.7	53.4	0.95	***	**	*	54.8	58.4	0.80	*	NS
Condition score	- Mar	3.1	3.0	2.5	2.5	0.06	***	-	-	2.7	2.8	0.05	P=0.06	NS
	- Aug	3.8	3.4	3.2	3.2	0.06	***	***	***	3.4	3.4	0.05	P=0.07	NS
	- Mating	3.8	3.4	3.3	3.2	0.06	***	***	*	3.4	3.5	0.04	P=0.06	NS
Cannon bone (cm)	- Mar	7.27	7.34	7.03	7.06	0.064	***	-	-	7.10	7.25	0.048	*	NS
	- Aug	8.15	7.93	8.01	7.76	0.064	*	***	NS	7.85	8.07	0.047	**	NS
Girth (cm)	- Mar	76.5	75.1	71.5	70.2	0.78	***	-	-	72.3	74.3	0.58	*	NS
	- Aug	88.9	82.8	82.2	80.6	0.75	***	***	**	82.2	80.0	0.56	***	NS
Length (cm)	- Mar	51.0	51.8	46.2	46.4	0.80	***	-	-	47.9	49.9	0.06	*	NS
	- Aug	56.5	53.3	52.1	52.2	0.57	***	*	**	52.4	54.8	0.43	***	NS
Height (cm)	- Mar	59.9	59.7	59.1	57.7	0.60	*	-	-	58.1	60.1	0.47	**	NS
	- Aug	63.1	61.7	61.3	62.1	0.59	NS	NS	NS	61.0	63.1		**	NS
Ovulation rate		1.81	1.79	1.64	1.87	0.124	NS	NS	NS	1.49	2.01	0.087	***	NS

During winter grazing for the L and H treatments, organic matter intakes were 0.23 and 0.48 kg/head daily and utilisation rates were 0.35 and 0.31, respectively. The effects of plane of nutrition on body weight, body condition score and linear body measurements at the end of the winter and summer are presented in Table 5 which also shows results for ovulation rate, and weight and condition score at mating. Increasing herbage allowance during the winter significantly increased live weight, condition score and all linear measurements at the end of the winter treatment period. The high plane of nutrition during summer also increased live weight, condition score, girth, length and cannon bone diameter at the end of summer grazing period. There was a significant interaction between the winter and summer treatments effects for live weight, condition score, girth and length. This interaction showed that animals that were on the high plane during the winter exhibited a greater response to the high plane of nutrition in summer. Belclare-X ewe hoggets were significantly heavier than Chamoise-X and had significantly greater linear measurements at all time points. There was a significant treatment x breed interaction ($P<0.01$) for liveweight at the end of winter grazing due to a significantly larger difference between the genotypes on the high herbage allowance (39.0 v 45.5 kg) than on the low allowance (31.7 v 34.2 kg). Plane of nutrition during the previous winter and summer grazing periods did not affect ovulation rate. The Belclare-X ewes had a significantly higher ($P<0.001$) ovulation rate (0.52) than the Chamoise-X. The differences in live weight at mating reflected the differences at the end of the treatment period in August although animals on the low plane of nutrition during the summer gained more weight between 30 Aug and mating than those on the high plane of nutrition in summer.

It is concluded that altering the plane of nutrition during the first winter and second grazing season altered body size and condition but did not alter ovulation rate at 18 months of age. Herbage allowance during winter grazing had the greater effects on body measurements. Except for liveweight at the end of winter grazing there were no interactions ($P>0.05$) between plane of nutrition and ewe genotype. Relative to the Chamoise-X the Belclare-X ewes were heavier, taller, longer and had higher ovulation rate.

Keady, T.W.J. and Hanrahan, J.P. *RMIS No. 5682*

The effects of grazing management of autumn saved pasture on subsequent herbage yield and ground cover

Recent studies at Athenry have shown that ewes extended (winter/deferred) grazing either in mid, late or throughout pregnancy produce lambs of similar birth weight as ewes housed shorn. More recently it was shown that a system based on year round grazing required stocking rate to be reduced approximately 25%. Grazing management of autumn saved pasture impacts on herbage yield during the subsequent grazing season. Results from a previous study at this centre showed that whilst frequency of herbage allocation during extended grazing did not alter subsequent herbage yield, each one day delay in grazing date after mid December reduced subsequent herbage DM yield by 54.2 kg/ha. The aim of the present study was to further evaluate the effects of grazing date and management of extended grazed pastures on subsequent herbage yield.

Permanent, predominantly perennial ryegrass, swards which were harvested for silage on 6 September received N (34 kg/ha) fertiliser. The pasture was grazed *in situ* at daily dry matter (DM) allowances of 1.0 or 1.8 kg from 28 Nov to 4 Dec, 12 to 18 Dec, 2 to 8 Jan and 23 to 29 Jan, respectively. Within each herbage allowance the herbage was allocated daily or twice weekly. Thus there were 16 “grazing treatment” blocks. Within each block two representative plots were allocated at random for harvesting at each of four dates (4 Apr, 18 Apr, 2 May and 16 May). The plots received 60, 24.5 and 105 kg/ha of N, P and K fertiliser, respectively, on 14 Feb. The plots were mowed with an Agria mower to a height of 4 cm. Herbage was weighed and pre harvest grass height was also determined. Bare ground was determined for each plot following harvesting on 4 Apr and 16 May at 100 points using a point quadrat. The data were analysed with blocks considered random and with fixed effects for herbage allowance, frequency of allocation, grazing date, harvest date and 2-factor interactions. As bare ground was not normally distributed, data points were classified into one of four categories (0<5, 5<15, 15 <30, >30%) and analysed assuming a poisson distribution and log link function. Herbage DM yield data was square root transformed prior to analysis.

The effects of herbage allowance, frequency of allocation, date of extended grazing and subsequent harvest date on herbage height, DM yield and bare ground are presented in Table 6. Herbage DM yield was increased by increasing herbage allowance, earlier grazing, and delaying harvest. The proportion of bare ground was decreased by increasing herbage allowance at grazing and delaying harvest date. Frequency of herbage allocation did not alter subsequent DM yield, sward height or bare ground proportion. There was a significant interaction between date of extended grazing and harvest (Figure 1). At harvest dates up to early May, herbage yield was higher for plots which were grazed earlier. However, by 15 May, plots grazed on 5 and 19 Dec, and 2 Jan had similar herbage yield, being higher than from plots grazed on 23 Jan.

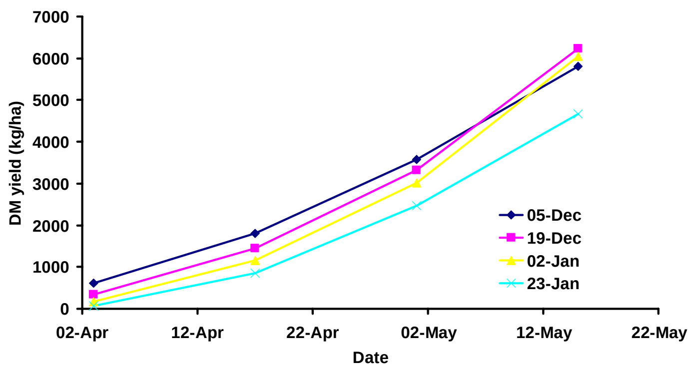

Figure 1. The effects of dates of extended grazing and subsequent harvest on herbage yield.

It is concluded that delaying grazing had a significant negative impact on herbage yield up to early May. By mid May, the impact of extended grazing date between 5 Dec and 2 Jan had disappeared. However, herbage yield in mid May was reduced due to delaying grazing date to 23 Jan. Reducing herbage allowance at grazing increased the proportion of bare ground which may impact on subsequent sward composition. Differences in bare ground due to grazing date were associated with differences in rainfall during grazing.

Keady, T.W.J. and Hanrahan, J.P. *RMIS No. 4925*

Table 6: Effects of grazing date and management of autumn saved pasture, and harvest date on subsequent yield

	HA(kg/d)[1]		FA[2]		Grazing date (GD)				Harvest date (HD)				Significance[6]				
	1.0	1.8	Daily	Twice weekly	5 Dec	19 Dec	2 Jan	23 Jan	3 April	17 April	1 May	15 May	HA	FA	GD	HD	GD *HD
DMY[3]	1.80	2.40	2.07	2.11	2.50	2.56	1.85	1.53	0.26	1.29	3.08	5.67	*	NS	*	***	***
SH[4]	11.1	12.6	12.0	11.7	13.4	13.0	11.2	9.8	4.9	8.5	15.7	18.1	NS	NS	*	***	NS
BG[5]	14.1	6.0	9.9	10.1	15.1	2.4	13.9	8.6	13.3	-	-	6.7	*	NS	NS	*	**

[1]HA = Herbage DM allowance; [2]FA = Frequency of herbage allocation; [3] DMY= DM yield (t/ha); [4]SH= Sward Height (cms); [5]BG= Bare Ground (%); [6]There were no HA x FA, GD x HGA, HGA x HD, HD x FA interactions.

Effect of level and type of supplementation of pregnant ewes offered maize silage
A previous study at this centre showed that maize silage could replace high feed value grass silage in the diet of ewes during mid and late pregnancy. Maize silages normally have lower crude protein concentration relative to grass silage. A recent study at this centre reported that supplementation of maize silage based diets with soyabean when fed to ewes in mid and late pregnancy increased forage intake and ewe condition score but did not alter lamb birth weight or subsequent performance.

The objective of the current study was to evaluate the effects of level and type of supplementation of maize silage based diets on ewe and progeny performance. The study was established in autumn 2007 and involves 3 treatments consisting of maize silage offered *ad-libitum* and supplemented with either

(a) soyabean in mid and late pregnancy plus 15 kg concentrate in late pregnancy
(b) soyabean in mid and late pregnancy
(c) soyabean in late pregnancy

Keady, T.W.J. and Hanrahan, J.P. *RMIS No. 5657*

Effect of maturity of maize at harvest, grass silage feed value and concentrate feed level on ewe performance and subsequent progeny performance
Forage quality offered during the housing period is the third most important factor (after ewe prolificacy and grassland management) affecting the cost of producing lamb in mid season flocks as it impacts directly on the quantity of concentrate supplementation required in late pregnancy. A previous study at Athenry showed that maize silage could replace high feed value grass silage in the diet of mid and late gestation ewes. Furthermore there was no benefit to protein supplementation of maize silage based diets.

The objective of the present study is to further evaluate the effects of maturity of maize, grass silage feed value and concentrate feed level on ewe performance and subsequent lamb growth rate. Furthermore the potential concentrate sparing effect of offering maize silage and high feed value grass silages will be determined.

The study was established in autumn 2007 and involves a total of 9 treatments consisting of two grass silage harvests (high and low feed value) by two concentrate feed levels (medium, high) plus two maize silages (low DM, high DM), by two levels of protein nutrition (low and high), plus high feed value grass silage at a low concentrate feed level.

Keady, T.W.J. and Hanrahan, J.P. *RMIS No. 5657*

An evaluation of pour-on treatments for the control of fly strike in ewes
Blowfly larvae are is the main ectoparasite of ewes during the summer months in Ireland. Blow fly strike compromises animal welfare and in severe cases causes death. In addition it reduces animal performance and consequently the financial performance of the flock.

In the past fly strike was controlled by dipping which is labour intensive. However, in recent years pour-on treatments have been developed which substantially reduce labour requirements. However, pour-on treatments can be expensive, particularly if a second treatment is required during the season.

Cypermethrin is the main active ingredient in some of the pour-on treatments. The objective of the current study is to evaluate the effect of using an alternative source of cypermethrin to control fly strike.

The current study consists of 5 treatments as follows

(1) Untreated animals (negative control)
(2) Vetrazin once (positive control)
(3) Vector once (contains cypermetrin)
(4) Alternative source of cypermetrin once
(5) Treatment 4 applied every 5 weeks.

Keady, T.W.J. and Hanrahan, J.P. *RMIS No. 5674*

Establishment of Technology Evaluation and Transfer for Hill sheep production in the west of Ireland

The objective of this project is to select three strategically located hill sheep and develop, in conjunction with the farm operator, management programmes based around the implementation of known technologies that can significantly impact on the physical and financial performance whilst improving product quality (marketing) and labour efficiency consistent with maintaining/improving the environment. These farms will be used to demonstrate the impacts of breed improvement/substitution, forage production, utilisation and conservation technologies as well as strategies to improve sheep health and welfare on physical and financial outputs. The TET farms will involve active collaboration/involvement of the farmer and the process is also expected to identify new technology needs the hill sector. Electronic animal identification (EID) will be used to enable intensive data collection to provide the evidential basis for the impact of the programme and also to develop and demonstrate the potential of EID in the context of national breeding programmes. The farms will be closely linked with research and advisory programmes and provide a platform for delivery of technical and practical information on the potential of available technology through involvement of Discussion Groups led by advisers.

Applications were invited through the media and a set of 3 farms were selected from a total of 9 applications. These farms are in Donegal, Mayo and Leitrim. A contract for the programme was developed with each individual which includes developing an annual management and production plan, including single-sire matings to produce pureberd S Blackface ewe replacements. All ewes and rams and replacements will be electronically tagged prior to the 2008 joining. Strategic recording of ewe live weights will be undertaken and all lambs will be electronically tagged at birth and linked to their dam so that full pedigree can be developed over time. Lambs will be weighed at birth and at around 10 weeks of age and at weaning. Full farm accounts will be maintained and these will be recorded by NFS field staff so that performance can be compared with comparable flocks in the National farm Survey.

Hanrahan, J.P. *RMIS No. 5726*

Hill sheep farm : performance of ewes 2007

The management system consisted of a Hill flock (2 to 4 year old ewes only) and a Lowland flock (ewes older then 4 years plus a small number of 2 year old ewes). Ewes in the Hill flock were joined with purebred S. Blackface rams (n=5) in single-sire groups. The Lowland flock ewes were joined into either Belclare (n=4) or Suffolk rams in single sire groups. The management procedures were essentially the same as in previous years *(see Research Report 2004, p146*).

The information on ewe reproductive performance and lamb mortality is summarized in Table 7. The performance of the flocks was similar to previous years with the exception that the incidence of barren ewes was noticeably higher in both flocks. Average incidence of barren ewes over previous the previous 3 seasons was 6.5% in the Hill flock and 5% in the Lowland flock. Analysis of the data for 2007 did not indicate that the increase was due to any individual ram and statistical analysis failed to show that the differences among rams were significant. In the Lowland flock 5-year-old ewes accounted for a large proportion of the barren ewes (9/55), whereas, for younger ewes the incidence was only 1/41. The range of differences among age groups was less marked in the Hill flock. There was no major difference between years in either live weight or body condition score at joining or in the change in these traits over the joining period. It is not possible at this stage to offer any reasonable hypothesis to explain the increased incidence of barrenness in 2007.

Table 7: Performance of ewe flocks at Hill sheep farm-2007

	Flock	
	Hill	Lowland
Ewes joined (no.)	192	141
Ewes died [+] (%.)	4.7	2.8
Ewes barren (%)	12.2	9.3
Litter size	1.16	1.50
Lambs reared per ewe joined	0.98	1.25
Lamb mortality (%)	3.0	7.4

[+] Includes ewes declared as missing at the end of the season.

A small number of crossbred ewe lambs (sired by Belclare and Charmoise rams) have been retained as replacements at Leenane to establish their survival and performance potential in that environment. The first cohort of these ewes lambed in 2007. The survival of crossbred replacements during their first season in the flock was analysed using data on the 2005- and 2006-born cohorts. These ewe lambs are managed with the purebred replacements. The mortality of the crossbred replacements was 11.3 % compared with 2.3 % for the purebred Scottish Blackface ewe lambs. This difference was significant ($P < 0.05$).

Table 8: Performance (± s.e.) of 2-year old ewes at Hill sheep farm in 2007

Ewe breed	No. of lambs	Litter size	Lambs reared per ewe joined
S. Blackface	11	1.60 ± 0.156	1.36 ± 2.199
Belclare X S.Blackface	9	1.44 ± 0.165	1.22 ± 0.220
Charmoise X S.Blackface	10	1.20 ± 0.156	1.10 ± 0.208

The crossbred ewes are managed with the Lowland flock from the time of first joining at 18 months of age. The reproductive performance of the 2005-born crossbred ewes at 2 years of age is summarised in Table 8 along with the set of purebred ewes that are managed with them as controls. The results indicate that the performance of the crossbreds was inferior to that of contemporary purebred ewes. While the volume of evidence is still rather limited it does suggest that crossbred ewes are severely disadvantaged in this environment relative to contemporary purebred S. Blackface ewes.

Hanrahan, J.P. and O'Malley, L. *RMIS No. 5080*

Environmental impact of hill sheep systems

The relevant objective of the sub-programme 'Grassland and Grazing Management in Teagasc 2000 – Sheep Production' was to develop hill sheep production systems that ensure the continued viability of producers while reducing environmental impacts. An important concern in agri-environmental management is the impact of grazing on soils and vegetation that receive no additional agricultural improvements and have a high erosion risk. Upland and peatland in western Ireland are particularly susceptible to erosion and are typically dominated by the habitats, blanket bog and wet heath. Both habitats are designated as Annex

I-listed under the EU Habitats Directive and are thus recognised as important for conservation.

Teagasc established several projects on its Hill Sheep Farm near Leenane, Co. Mayo, to monitor the impact of grazing. The site consists of upland and peatland. The annual stocking rate was ~0.9 ewes per ha from 1993 to 1998, and ~0.8 ewes per ha in subsequent years. Reports on the current projects follow.

The impact of hill sheep activity on the population dynamics and diet of small mammals

The project is based on the Teagasc Hill Sheep Farm, and the background is outlined in *Research Report 2005, p. 119.* The overall aim is to integrate biodiversity-promoting strategies and general agricultural practices. The objective is to assess the impact of hill sheep activity on the diet and populations of small mammals especially the wood mouse and the pygmy shrew.

Activities pertaining to wood mice were reported in *Research Report 2006, p. 163-164.* Pygmy shrews were captured in summer 2007 using Longworth live traps. Population density and fitness were examined in wet heath habitats with and without hill sheep grazing, and compared with those in a protected woodland habitat. The latter, perceived as a more favourable habitat for the pygmy shrew, was used to provide baseline information. Captures were marked with fur clips and records were made of trap number, time of capture, weight, sex, hind foot length, age group and breeding condition. The shrews were then released immediately at point of capture.

The incidence of first and repeat captures was assessed using the chi-square procedure. The effect of habitat and month on breeding condition was analysed using generalised linear model procedures. Body weight was analysed using least squares procedures. The model included effects for habitat, month, breeding condition and relevant interactions.

A total of 390 captures of pygmy shrews were made throughout the trapping season of which 82 were first (individual) and the remainder repeat captures. While the vast majority of first captures (72%) were, as expected, in the woodland, their occurrence in what are perceived as inhospitable habitats was of interest. Furthermore, those in the wet heath habitats exhibited a behavioural difference with those in the woodland habitat in having a much lower propensity to re-enter the traps (Table 9).

Table 9: Number of first and repeat (in brackets) captures in the habitats by month

Habitat	June	July	August	% Repeats of total
Wet heath - grazed	1 (0)	7 (6)	4 (2)	40
Wet heath - un-grazed	n/a	8 (4)	13 (34)	64
Woodland	30 (62)	31 (65)	23 (100)	73

Table 10: Least squares means (s.e.) for body weight (g) of pygmy shrews by habitat by month

Habitat	June	July	August
Wet heath - grazed	3.9 (0.89)	3.6 (0.33)	3.1 (0.44)
Wet heath - un-grazed	n/a	3.6 (0.31)	4.1 (0.25)
Woodland	5.2 (0.16)	4.1 (0.16)	3.9 (0.20)

There was evidence for overall effects of habitat (P=0.08) and month (P=0.10) on body weight (Table 10) and breeding condition appeared to be attained earlier in the year in the woodland habitat.

Diverse small mammal populations with particular characteristics enhance the bio-diversity of landscapes that are dominated by wet heath habitats.

Quinn, N., Walsh, M. and Lawton, C.[1] *RMIS No. 5382*
[1]Department of Zoology, NUI Galway

Sustainable agri-environmental management of hill and mountain peat land

The project is part of a large, EPA-funded, programme outlined in *Research Report 2005, p.119-120.* The aim is to achieve sustainable agri-environmental management of hill and mountain peat land. The objective of this study is to quantify the physical impact of hill sheep at low, medium and high levels of grazing by quantifying changes in micro soil erosion, plant cover and soil nutrient content over time.

Locations representing three grazing intensities (low, medium, and high) were selected in the Connemara region of Galway and Mayo based on altitude and physiography. Four areas associated with sheep activity, namely, high and low densities of occupation, sheep 'rests' and movement corridors were selected both on the upper steep slope and on the lower gentle slope in each of the three locations. These were identified largely by random selection from existing databases for the medium level of grazing and by field examination of physiographic transects in the low and high levels of grazing. Purple moor-grass (*Molinia caerulea*) is the dominant species in the low and high densities of sheep occupation on the Teagasc Hill Sheep Farm. Its frequency of occurrence, however, increased by over 8 percentage points in areas of low activity compared with almost 5 percentage points in areas of high activity in the period 1995-2004.

Table 11: Mean difference in reference marker pins values by location and activity; the minus and plus symbols denote deposition and erosion of soils respectively

Location[1]	Activity	n	Mean (mm)	Std
C	HA	8	+15.02	9.44
C	RA	8	-11.92	26.62
NP	HA	12	-0.45	2.58
L	HA	58	-2.21	5.03
L	RA	47	- 3.31	9.05
L	LA	23	-1.30	6.14

[1] C = Commonage, L = Teagasc Hill Sheep Farm, Leenaun, NP = Connemara National Park.

Methods to measure changes in micro-erosion and deformation of soil surface include rainfall detachment trays (constructed), Gerlough troughs, splash cups, micro-topographic pin profilers (designed) and reference marker pins. All sites were sampled for soil fertility analysis. Interim results are presented.

Both sheep activity and location had a significant effect on surface soil levels. Erosion and deposition featured in these changes (Table 11). Initial data from exposed, localised, vertical faces showed no significant change.

A total of 56 sites were sampled for surface soil nutrient analysis in spring, winter and autumn. Sheep activity was significantly associated with soil P and pH in all seasons (P <0.05) while location and slope were significant only for P in spring. However, location, slope and activity had no effect on seasonal differences in soil P. The P and pH values are summarised by activity and season (Table 12).

Table 12: Mean winter, spring and autumn soil P and pH values by activity and season

Activity[1]	n	P (mg/l)	s.d.	pH	s.d.
HA w	14	3.79	1.40	4.43	0.16
HA s	14	6.31	5.93	4.40	0.28
HA a	14	4.90	2.93	4.36	0.15
LA w	14	4.09	1.73	4.48	0.23
LA s	15	4.71	2.87	4.50	0.14
LA a	14	4.21	2.26	4.57	0.23
MC w	14	2.52	1.08	4.64	0.18
MC s	15	3.5	1.45	4.64	0.18
MC a	14	4.18	3.46	4.65	0.20
RA w	14	6.09	3.84	4.29	0.23
RA s	14	12.29	7.02	4.29	0.23
RA a	14	8.81	7.01	4.48	0.25

[1]HA (high activity) LA (low activity) MC (movement corridor) RA (rest area) w, s and a = winter, spring and autumn, respectively.

Differences in grazing intensity, represented by location and sheep activity had a significant effect on changes in surface soil levels. Data from the reference marker pins clearly indicated active micro-erosion and deposition but the net overall effect appears to have been minimal. In relation to soil and water nutrient data, grazing intensity had the greatest effect, but not significant, on seasonal differences followed by sheep activity and slope. This was especially the case in relation to soil P followed by SO_4 and SUS in run-off water.

Lynch, G., Walsh, M., Schulte, R. and Moles, R.[1] *RMIS No. 5547*
[1]Chemical and Environmental Science Department, University of Limerick

Pedigree Galway sheep – population size and performance details

All flocks registered with the Galway Sheep Breeders Association Ltd. and located in the Republic of Ireland participate in the Galway Sheep Breed Improvement programme operated by the Department of Agriculture, Fisheries and Food. This programme involves the recording of litter size data with the objective of calculating a merit index for prolificacy for individual ewes and their progeny. Breeders are encouraged to use this information in the selection of breeding stock so as to bring about genetic improvement in prolificacy. The data are entered, validated and processed by the Sheep Production Department at Athenry.

A total of 40 flocks returned mating lists for the autumn of 2006 and all but one of these flocks returned lambing details for spring 2007. There were 6 new flocks and 9 flocks present in 2006 were no longer participating in the recording programme and all of the latter were recently established flocks. A total of 698 ewes produced purebred Galway lambs representing 80% of the ewes on the mating lists. The number of pedigree ewes and flocks participating in the programme is now similar to the peak values in 2000 as shown in Figure 2. A total of 52 rams, from 20 different flocks, sired progeny in 2007; 11 were born in 2006, 15 were born in 2005 while 14 were born in 2004. These numbers indicate that the genetic base of the breed and the effective size of the population are increasing at present. The proportion of the new flocks that persist with the Galway breed and the continued presence of the core of long-established Galway flocks are both vital to the long-term prospects for conservation of the breed.

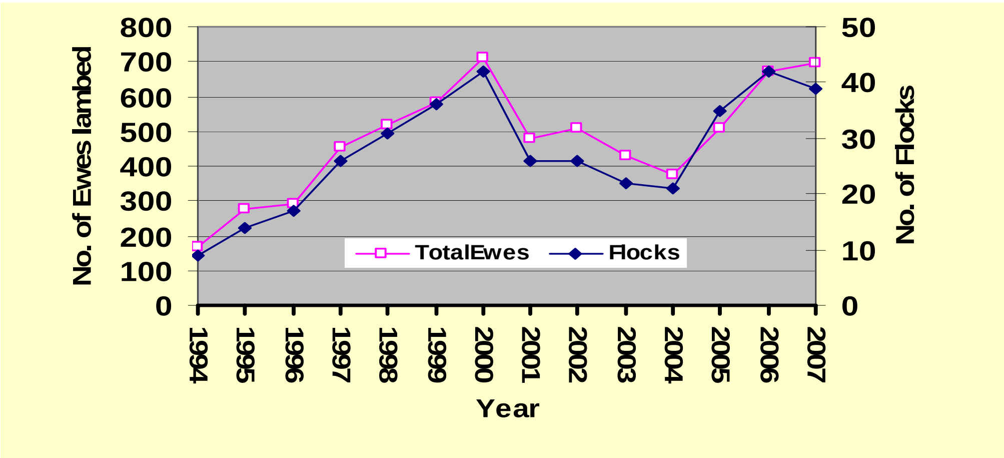

Figure 2. The evolution of the number of pedigree Galway flocks and the number of ewes that lambed : 1994 to 2007.

The litter size data for all ewes are summarised in Table 13 by age of ewe and the performance is consistent with results for recent years *(see Research Report 2006, p165).*

Table 13: Litter size in 2007 for pedigree Galway ewes in 39 flocks

Ewe	*No. of ewes*		*Litter size*	
age[+]	*Joined*	*Lambed*	*Total*	*Live*
1	18	2	1.28	0.56
2	289	209	1.49	1.23
3	154	130	1.61	1.39
4	177	147	1.65	1.42
5	231	153	1.62	1.45
Overall	***893***	***674***	***1.60***	***1.40***

[+] Age at lambing.

Hanrahan, J.P. and Curley, A. *RMIS No. 5254*

Performance of pedigree Belclare sheep flocks

A total of 27 pedigree flocks recorded performance data for the 2006/7 season. Total ewes with litter size information was 823 and weights on 1389 lambs were also recorded. Ewes older than 5 years at lambing were classified as 5 years and the performance, by ewe age, is summarised in Table 14. The results are consistent with previous years (see Research Reports for 2005, p 1128 and 2006, p 170-171). The average litter size for all ewes, excluding ewe lambs was 2.08; over 80% of flocks had a mean litter size between 1.9 and 2.3.

Table 14: Reproductive performance of pedigree Belclare sheep

Ewe age	No. of ewes	Litter size	
		Total born	Live born
1	64	1.76 ± 0.106	1.20± 0.123
2	266	2.06 ± 0.053	1.82± 0.055
3	240	2.11 ± 0.053	1.78 ± 0.056
4	162	2.16 ± 0.064	1.90 ± 0.068
5+	91	2.00 ± 0.081	1.74 ± 0.080

The incidence of lamb mortality was higher for single births (12.0%) than in 2006 but lower for twins (10.5%). There is no obvious explanation for the changing patterns recorded in recent years. There was a very poor relationship across flocks between lamb mortality and average litter size and flock was a significant source of variation when mortality was adjusted for effects of ewe age and litter size.

Table 15: Lamb birth weight and growth rate to about 8 weeks of age

Birth type	No. of records	Birth weight (kg)	Growth rate (g/day)
1	149	4.5 ± 0.07	346 ± 5.8
2	598	3.9 ± 0.04	297 ± 3.4
3	317	3.4 ± 0.05	279 ± 4.4
≥4	110	2.9 ± 0.08	261 ± 7.5

Results for lamb growth are in Table 15 and are based on 1389 birth weight records and 1251 growth rate values. The birth weight and growth performance were similar to those reported for recent years. Flock was a major source of variation in growth rate and mean values adjusted for dam age and litter size varied from around 220 g/day to 420 g/day.

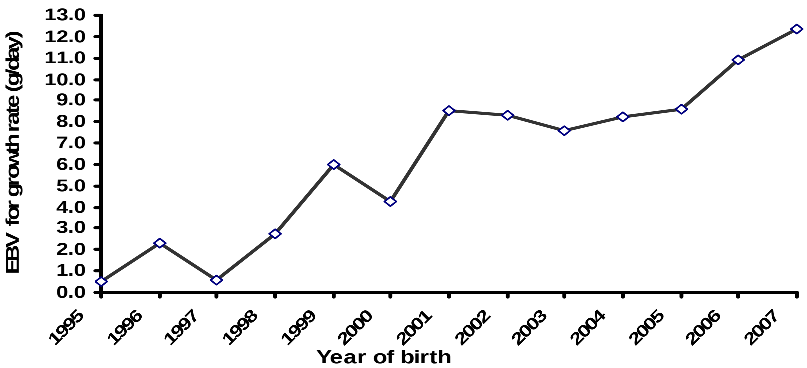

Figure 3. Expected breeding values (EBV) for growth rate by year of birth.

The growth rate records are used to estimate breeding value (EBV) for Belclare sheep using a full animal model. The results are provided to individual breeders each year. The trend in breeding value is shown in Figure 3; breeding values are expressed relative to a base year of 1995. The clear upward trend in EBV means that breeders are using the EBVs to select replacement stock.

Hanrahan, J.P. and Curley, A. *RMIS No. 4785*

Evaluating the impact of pedigree sheep breed improvement programme (PSBIP) for terminal sire breeds

The background and context of this project were given in the Research Report 2005 (p126-127). Rams used either come from PSBIP flocks, and thus have a lean meat index (LMI; rams with high index values are chosen), or they represent flocks that do not participate in the PSBIP and their sires did not come from PSBIP flocks. The panel of rams used in autumn 2006 also included 7 Texel rams with high accuracy breeding values in the PSBIP but chosen to represent extreme EBVs (LMI values were 45, 88,78, 176,162,192,233) in order to provide a direct estimate of the response to selection in the Texel breed, which has a high level of participation in the performance recording programme. In the production year 2006/2007 five commercial flocks were used and 38 rams yielded progeny-test data (2322 lamb records). Of the set of rams tested 11(7 Charollais and 4 Suffolk) were also involved in the panel tested in previous years. This was done to increase the number of progeny for particular sires but also provided some linkage across years and flocks. Details on the panel of rams tested in 2007 are set out in Table 16. The mean LMI values were similar to those of the panel used for the 2006 test.

Mean values for selected lamb growth traits are given in Table 17 as an indication of the general level of performance at which the rams were tested.

Table 16: Pedigree Suffolk and Charollais rams tested in 2007 categorized by breed and LMI status

Breed	LMI status	No. of rams	Mean LMI	Mean no. of progeny
Charollais	High	8	144	53
	None	12	-	64
Suffolk	High	5	160	63
	None	6	-	54

The association between LMI values and lamb weight at 14 weeks of age (W14A) is summarised for each breed in Figures 4 and 5. These show the individual sire effects on W14A; the corresponding LMI value is shown for each sire (a zero indicates rams from flocks that were not involved in the PSBIP).

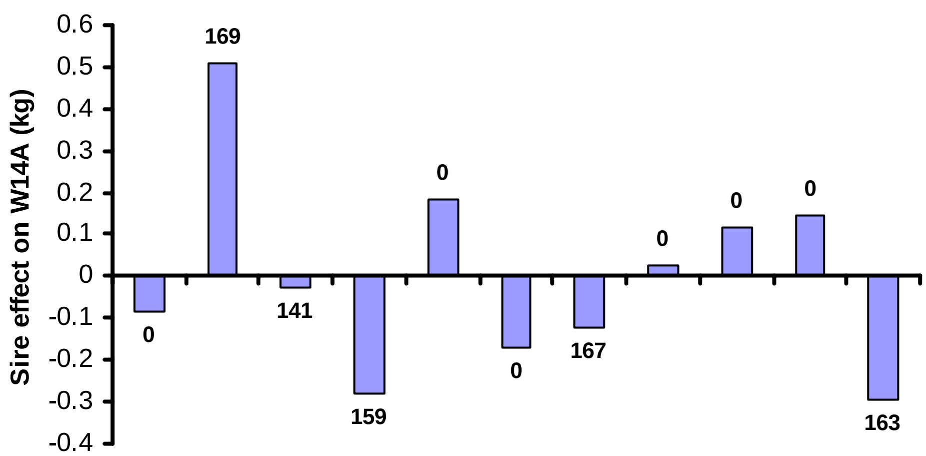

Figure 4. Effect of individual sire on weight at 14 weeks of age – Suffolk (the number associated with each column is the individual's LMI and 0 indicates non-LMI ram).

Table 17: Mean values for lamb growth traits in 2006 adjusted for birth type effects

Breed of sire[§]	Weight (kg) at Birth	14 weeks	120 days	Growth rate(g/day) 0 to 14 weeks
Charollais	4.9	31.0	36.5	270
Suffolk	4.9	30.1	36.2	256
Texel	4.5	30.0	35.5	259

[§] Note that breed is confounded with flock.

The differences between LMI and non-LMI sires were estimated and were not statistically significant for any growth trait in either breed. The estimated difference (LMI minus non-LMI) for W14A was 0.27 (s.e. 0.195) kg for Charollais and -0.13 (s.e. 0.255) kg for the Suffolk breed. These differences are very small and are consistent with the results from previous years. The estimated difference (LMI minus non-LMI) for W120 was 0.01 (s.e. 0.199) kg for Charollais and -0.27 (s.e. 0.287) kg for the Suffolk breed. The difference between the progeny of high and low LMI Texel rams for W14A and W120 were 0.15 (s.e. 0.322) kg and 0.24 (s.e. 0.386), respectively. The weighted average across 3 years for the effect on W14A was 0.05 (s.e. 0.141) kg for Charollais and 0.08 (s.e. 0.141) kg for the Suffolk breed. The weighted average difference across breeds (Suffolk and Charollais) and years was 0.005 kg for birth weight, which was not significant despite indications in earlier years that there was a significant effect on birth weight.

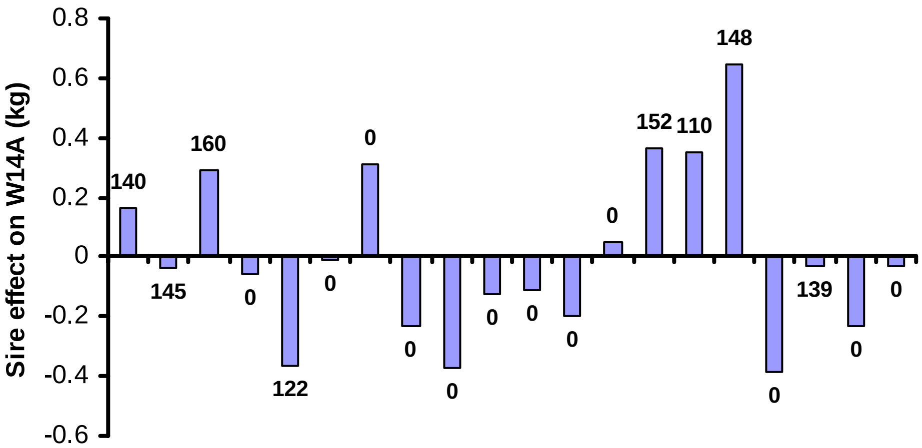

Figure 5. Effect of individual sire on weight at 14 weeks of age – Charollais (the number associated with each column is the individual's LMI and 0 indicates non-LMI ram).

The pattern of results to date indicate that the differences in progeny performance between sire with high LMI values and those with none or low LMI values are very small and of the order of not more than 0.1 kg at 14 weeks of age. A summary of all sire effects for Suffolk and Charollais rams tested to date in this project shows that the estimated effects for 90% of the individual rams are within ± 0.5 kg.

Hanrahan, J.P. *RMIS No. 5389*

Source of rams used on lowland flocks: implications for genetic improvement

The genetic improvement of the lowland sheep population depends on the availability and use of genetically superior stock from ram suppliers, as the likelihood of effective within flock selection is very low. The ram breeds used, the rate of genetic progress in ram supplier flocks and the age profile of stock rams determine the genetic merit of the lowland sheep population for specific breeding objectives. The performance traits that impact on profitability of lowland sheep systems include ewe productivity, lamb growth and carcass traits, with ewe productivity having a much greater impact than lamb traits. The delivery of genetic improvement services to the sheep sector is being reorganised arising from the recommendations contained in the Sheep Industry Development Strategy (2006). Information on the breed composition of the national flock and the breeding practices of commercial producers are important inputs to this redevelopment process.

A survey of breed composition and breeding practices of the sheep sector was conducted in the autumn of 2006 through the National Farm Survey. Details on the breed and age profile of stock rams and on the source of these rams were obtained for all farms (384) with a sheep enterprise in the sample of farms in the National Farm Survey. The information on source of rams included whether rams were purchased at sales organised by pedigree breed societies, purchased at mart sales, bought privately or borrowed. The ram:ewe ratio was also calculated. Weighted totals were obtained using the weighting coefficients for the National farm Survey. In addition to the survey data, information was extracted from sales catalogues for the principal sire breeds to estimate the proportion of rams that were offered for sale with information on breeding value and the genetic index values of such rams.

The breed profile and details on source of rams on lowland farms are summarised in Table 18. The Suffolk breed was predominant, with Texel and Charollais breeds next most important. The proportion of Belclare rams, a breed with the potential to significantly increase ewe productivity, was low. This breed profile strongly suggests that very little attention is paid, when selecting rams, to the genetic potential of flock replacements for prolificacy. The data also show that only a small proportion of rams, to some extent depending on breed, are actually purchased at pedigree sales, with higher proportions represented by rams sourced either at mart sales, where information on breeding potential would not be available, or private sales. It is most unlikely that there is any reference to objective performance information in the selection of rams sold privately. Thus, the evidence shows that for the principal terminal sire breeds only 20% of rams are sourced at pedigree sales, where information is available on breeding value for performance recorded flocks.

Table 18: Breed and source of stock rams used on lowland farms

Breed	Percent	Source (%)		
		Pedigree sale	Private sale	Mart
Suffolk	54.5	20.2	32.9	39.6
Texel	17.7	26.5	40.1	29.9
Charollais	14.2	14.5	56.3	28.4
Belclare	4.3	22.6	52.1	7.0
Vendeen	4.2	42.3	47.9	0
Continental	1.9	-	-	-
Other	3.3	-	-	-

Table 19: Proportion of rams with breeding value information in society sales catalogues

Breed	No. of rams catalogued	Rams with breeding value information (%)	Mean breeding index
Suffolk	1146	37.8	136
Texel§	-	-	134
Charollais	1755	19.8	124

§Texel society rules only permit rams with breeding value information at their premier sale.

The profile of rams at pedigree sales was compiled for the Suffolk, Texel and Charollais breeds (Table 19). The results show that the percentage of rams with objective genetic index values is low to very low. The information in Tables 18 and 19, when taken together, shows that less than 10% of rams used in lowland flocks have objective information about breeding merit for growth and carcass traits. Consequently, while the index values in Table 19 show that the mean breeding value is about 1 s.d. above the base (equivalent to ~5% of the mean), there is very little genetic improvement flowing from the selection of stock rams for use on lowland farms. The current level of genetic merit in the recorded pedigree flocks represents an annual genetic improvement of ~0.5%. The age profile of rams used will determine the genetic merit of lambs born in commercial flocks. Since a large proportion of the rams used on lowland farms are aged 3.5 years (23%) or more (26%) the lag between genetic merit in recorded pedigree flocks and commercial flocks is around 3.5 years. The ram:ewe ratio (mean 32.4) was lower than is necessary and this further reduces the potential to exploit the available pool of rams with above average genetic merit.

The results show that the vast majority of rams used on lowland flocks are purchased without any reference to objective genetic evaluation. This will have to be addressed if reorganisation of genetic evaluation services for the sheep sector is to impact on the genetic merit of sheep on lowland farms.

Hanrahan, J.P. *RMIS No. 5389*

Effect of sperm dose on pregnancy rate in sheep

Rapid genetic progress in sheep is dependent on the availability of effective and efficient techniques for artificial insemination (AI). Currently, only a small number of inseminations per ejaculate (~10) are possible for use in cervical inseminations given that standard procedures usually employ between 200 x10^6 and 400 x10^6 sperm per inseminate. The ability to use low sperm doses would facilitate greater use of high genetic merit rams in breeding programmes. Further data on the effect of sperm dose on pregnancy rate in ewes cervically inseminated with fresh semen were collected in autumn 2007 using procedures described for 2006 *(Research Report 2006 p172-173).* Semen was collected from 4 rams on the morning of insemination and diluted with a skim-milk-egg yolk extender to give an insemination dose of i) 25 x 10^6, ii) 50 x 10^6, iii) 100 x 10^6 and iv) 200 x 10^6 spermatozoa and held at 15°C (approximately 6 h) until insemination at 52 h post pessary removal. Standard quality control checks on sperm motility and concentration were applied. Ewes in good body condition but culled for normal husbandry reasons, excluding reproductive problems such as vaginal prolapse, from the flocks at Athenry and Leenane were inseminated in three batches with random allocation, within breed type (S Blackface, Belclare-x-S. Blackface and a group consisting of Texel, Cambridge, Suffolk and Texel-cross types), to batch and sperm dose. Ewes were slaughtered between 30 and 40 days later. Reproductive tracts were recovered at the abattoir and the number of foetuses was recorded. Despite the fact that semen from all 4 rams was deemed acceptable for AI one ram failed to yield any pregnancy out of 40 ewes inseminated while a second ram yielded only 9 pregnancies out of 38 ewes inseminated. The remaining two rams gave overall pregnancy rates of 54% (20/37) and 44% (17/39). These results are well below the rate expected from fresh semen even allowing for any effect of sperm dose *(see Research Report 2006, p 173).* No explanation of these unexpectedly poor results can be advanced as the procedures used were the same as in previous years and involved the same personnel and ewe type. The outcome means that the value of the data as evidence on the effect of sperm dose is limited. When the data for the three rams that yielded pregnancies were analysed the effect of sperm dose was significant (P=0.02) but, surprisingly, the maximum pregnancy rate (57%) was from the sperm dose of 100x10^6 sperm. This pattern was reflected in a significant cubic effect (P<0.05) of dose. Effect of ewe breed was also significant (P< 0.01) and the highest pregnancy rate was for Belclare x S Blackface ewes (56%) followed by S Blackface ewes (36%). Differences among rams were highly significant

(P<0.001). These results are of very limited value and given the odd pattern of effects with respect to sperm dose further trials will re required to provide adequately precise estimates of the impact of sperm dose over the range of interest. The evidence for differences among ewe breed types is consistent with the results from the 2006 trial.

Donovan, A., Lally, T. and Hanrahan, J.P. *RMIS No. 5081*

The effect of diluent type and storage temperature on motility and viability of ram sperm

The availability of a protocol for cervical AI that could prolong the shelf life (<24 h) of fresh ram semen would enable faster genetic improvement If fresh semen could be used until 48 h post collection without loss of fertility this would be a very significant improvement on current practice. This study was designed to determine the effects of storage diluent and temperature on sperm motility and viability of fresh ram semen after prolonged storage.

Semen was collected from individual rams (n=9) using an artificial vagina and pooled. Aliquots were diluted to a final sperm concentration of 800×10^6/ml in either a standard skim milk diluent or in each of three commercially available diluents: OviPro (Minitub, Tiefenbach, Germany), AndroMed (Minitub) or INRA 96 (IMV, L'Aigle, France). The diluted semen was loaded into 0.25 ml straws, sealed (anaerobic conditions) and stored at either 5°C (fridge) or 15°C (water bath.) A sample of semen in INRA 96 was also held in a tube as per instructions for this product (aerobic conditions at 15°C). At 5, 10, 24, 30, 48, 56 and 72 h post collection, one straw per treatment was used to evaluate motility and the proportion of live sperm cells. For motility assessment (0-5 scale) a 10 µl sample was placed under a cover slip, on a pre-warmed slide and assessed using phase-contrast microscopy. For viability, semen was diluted to a 1:30 dilution and stained as per instructions for the Live Dead® Sperm Viability Kit (Molecular Probes). Two 4 µl aliquots were then removed to a warmed slide; each aliquot was covered with a cover slip and assessed under a fluorescent microscope (Olympus BX60). Five individual fields of view per aliquot where examined and the number of live (green) and dead (red) sperm in each were recorded (~200-250 sperm counted per aliquot). Six replicates were completed over a 3-week period. Data were analysed using mixed model procedures with fixed effects for replicate, temperature, time, diluent and 2-way interactions; replicate by diluent was random.

The residual correlation between the proportion of live sperm (viability) in duplicate aliquots was 0.28; the mean value was used in the overall analysis. There was no evidence for any difference, in either motility or viability, between aerobic and anaerobic storage in INRA96 (Figure 6). Storage temperature had a highly significant effect on both motility and viability. At 5 °C viability declined gradually between the 24 and 72 h time points (Figure 7) whereas there was a rapid decline after 10 h at 15°C. When sperm were stored at 15°C, there was a significant (P<0.001) diluent by time interaction for viability. This effect was much less evident at 5°C (P>0.14). However, viability was consistently greater for the skim milk diluent than all the other diluents at the later time points (Figure 7). The pattern of results for motility were similar; there was a significant time by diluent interaction when sperm were stored at 15°C (P<0.01), but this effect was not significant (P>0.3) when storage was 5°C. However, unlike viability at 5°C, the skim milk diluent differed little from the other diluents at any time point. (Figure 8).

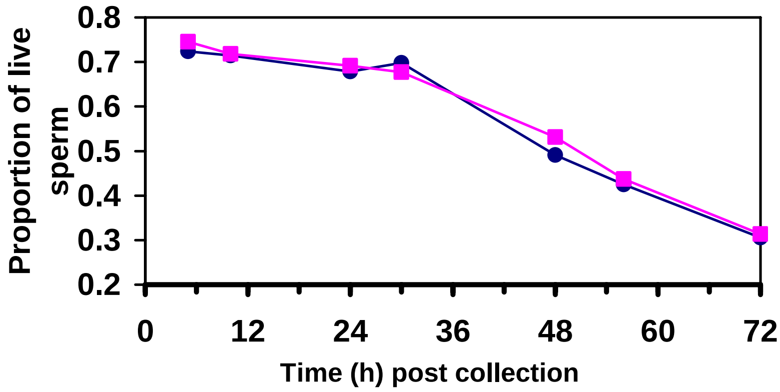

Figure 6. Proportion of live sperm stored in INRA96 under aerobic (●) and anaerobic (■) conditions at 15°C.

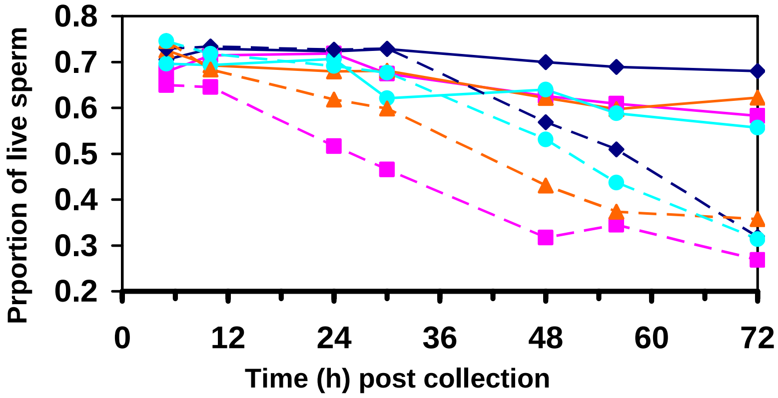

Figure 7. Proportion of live sperm when stored at 5 °C (—) or 15 °C (- -) in skim milk ♦, Ovipro ■, AndroMed ▲ and INRA96 ●

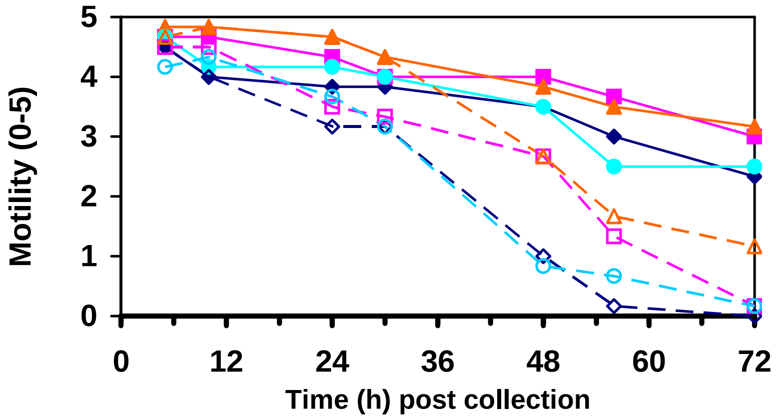

Figure 8. Motility when stored at 5°C (—) or 15°C (- -) in skim milk ♦, Ovipro ■, AndroMed ▲ and INRA96 ●

Storage at 5°C gave the highest sperm viability and motility up to 72 h post collection. Diluent was not an important factor at 5°C but was when the storage was at 15°C. The fertilising capacity of viable sperm after 48 to 72 h storage at 5 °C needs to be determined.

RMIS No. 5696

O'Hara, L., Hanrahan, J.P., Richardson, L., Donovan, A., Fair, S.[2], Evans, A.C.O.[1] and Lonergan, P.[1]

[1]UCD School of Agriculture, Food Science and Veterinary Medicine, Belfield, Dublin

[2]Department of Physiology, NUI Galway

Differences in the number of sperm penetrating cervical mucus from Belclare and Suffolk ewes

In sheep the success of cervical AI using frozen-thawed semen is breed dependent with pregnancy rates ranging from 77% for Finn ewes to 18% for Suffolk ewes. Such breed differences are eliminated when laparoscopic AI is used indicating the cervical barrier is most likely the basis for the low pregnancy rate. Differences in the nature of cervical mucus may be responsible for breed effects on pregnancy rate. The objective was to assess the ability of ram sperm to penetrate fresh cervical mucus collected from Belclare and Suffolk ewes during the peri-ovulatory period.

Multiparous Belclare (n=15) and Suffolk (n=14) ewes were synchronized (intravaginal progestagen pessary for 12 days, 500 IU eCG at removal). Endocervical mucus was aspirated, using a flexible catheter (Aspiglaire, IMV, France) at 30, 48 and 56 h (when AI is normally performed) post pessary removal. The volume of aspirated mucus was recorded. Frozen semen from 3 rams of proven fertility was thawed, pooled and diluted with TALP medium to yield a final sperm concentration of 20 x 10^6/ml. To aid sperm visualisation in the mucus, 500 µl of the diluted semen were incubated with a DNA stain (Hoechst 33342) for 5 min at 37^{o}C. Flat capillary tubes (0.3 mm x 3.0 mm x 100 mm; Composite Metal Services, UK) were marked in 10 mm intervals from 10 to 90 mm and were loaded with mucus using an adapted 3 ml syringe. The tubes were placed vertically (groups of 4; 2 Belclare, 2 Suffolk), in a 1.5 ml eppendorf tube containing 250 µl of the stained sperm solution and incubated (dry oven) for 15 min at 37^{o}C. The tubes were placed on a hot plate (45^{o}C) for 1 min to inactivate all sperm and the number of sperm was counted using a fluorescent microscope (400x; Olympus BX 60). The experiment was repeated three times. At the 30 h time point in replicate 1 all spermatozoa from wall to wall were counted at each interval mark (~6 fields of view) from 40 to 80 mm. Due to high sperm number per field, counts at subsequent time points were restricted to 2 fields of view (at one wall and in the centre) per interval mark. Round tubes (1.00 mm x 1.2 mm x 100 mm; Composite Metal Services, UK) were used in place of flat capillary tubes in replicate 2 and spermatozoa were counted in one (centre) field of view at each interval mark from 40 mm to 80 mm. Tubes used in replicate 3 were identical to those used in replicate 1 and counts were for two fields (wall and centre) of view at all time points. All sperm counts were expressed on a per field of view basis for each interval mark and a square root transformation ($\sqrt{(y+0.5)}$) was applied. Mixed model procedures were used for data analysis with fixed effects for breed, time point, interval mark and replicate. Terms for ewe, ewe x time and ewe x time x replicate were random. A similar model was used for analysis of mucus volume (where no mucus could be aspirated, the volume was set = 0.025 ml.)

Mucus volume varied significantly among replicates (P<0.001) and the replicate x time interaction was also significant (P<0.02); breed effects were not significant (P>0.3). Sperm number was significantly affected by replicate (P<0.001), time (P<0.01) and interval mark (P<0.001) and there was a significant interaction between replicate and interval mark (P<0.01). The effect of interval mark reflected the decline in sperm number as distance from the bottom of the capillary tube increased. The overall breed effect on sperm number was not significant (P=0.25) but there was a breed x time point quadratic effect (P=0.05), reflecting the difference between the breeds at the 48 h time point (Figure 9). This suggests that changes in mucus penetrability are breed dependent and may explain breed effects on pregnancy rate to cervical AI with frozen-thawed semen.

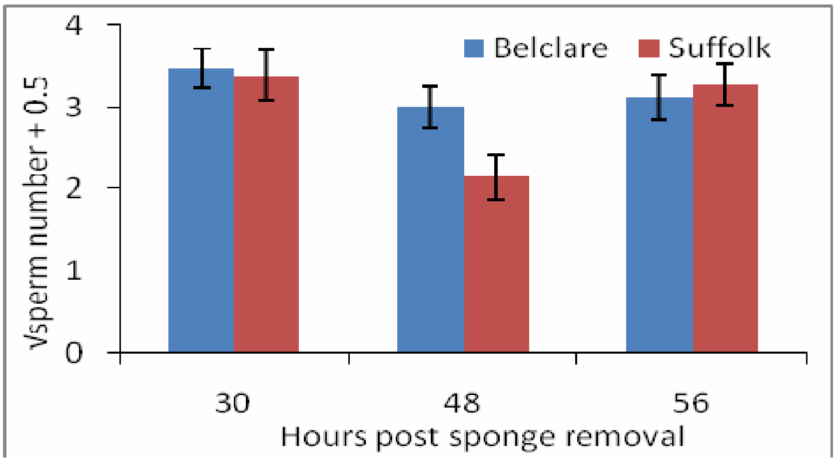

Figure 9. Least squares means for the effect of ewe breed on total number of sperm penetrating cervical mucus. Vertical bars represent s.e.

Mucus volume was not affected by breed. However the penetrability (by sperm) of cervical mucus in the peri-ovulatory period varies with time and this variation is breed dependent.

RMIS No. 5696

Richardson, L., Hanrahan, J.P., Fair, S.[1], O'Hara, L., Donovan, A., Lonergan, P.[2] and Evans, A.C.O.[2]

[1]Department of Physiology, NUI Galway

[2]UCD School of Agriculture Food Science and Veterinary Medicine, Belfield, Dublin

The effect of forage type, concentrate feed level and soyabean supplementation on the periparturient rise in nematode egg output in ewes

The control of gastrointestinal nematodes of sheep is largely dependent on the use of anthelmintics. The increasing evidence for resistance to nematode parasites of sheep to broad-spectrum anthelmintics has prompted a search for alternative sustainable solutions to parasite control. The temporary loss of acquired immunity to gastrointestinal nematodes that is indicated by an increased faecal egg output in late pregnancy and early lactation is a well established phenomenon and is important in the epidemiology of nematodes parasites of sheep. There is substantial evidence for nutritional effects on the expression of immunity to gastrointestinal nematodes. In particular, there is evidence that faecal egg output of parasitised periparturient ewes is reduced, in response to increased dietary metabolizable protein. The objective of the present study was to evaluate the effect of diet during mid and late pregnancy on the peri-parturient rise (PPR) in nematode egg output in ewes.

Grass silage was harvested from the primary growth and regrowth of predominantly perennial ryegrass swards and ensiled either precision chopped or in big bales. Two maize silages were produced, either grown in the open (sown on May 10 (LDM)), or under the complete plastic mulch system (sown on April 10 (HDM)). Each grass silage was offered *ad libitum* supplemented with either 18 or 27 kg concentrate whilst the maize silages were offered *ad libitum* and supplemented daily with either with 0 or 200 g soyabean meal per ewe and 18 kg concentrate in late pregnancy (last 6 weeks). Ewes (Belclare x Scottish Blackface, Chamoise x Scottish Blackface) were housed (slatted pens) in mid December and had not been administered an anthelmintic in the previous year. The 12 treatments were offered during mid and late pregnancy to 180 ewes, penned in groups of five (three pens per treatment). Feed intake was recorded and this information was used to calculate metabolizable protein (MP) intake using published values for the dietary components. Strongyle faecal egg counts (FEC) were determined from faecal samples collected from each ewe at 6 weeks prelambing, at lambing (within 3 days of lambing, prior to turnout to pasture), and at 5, 10 and, 14 weeks post lambing. FEC were distinguished as *Nematodirus* (FEC_N), *Strongyloides papillosus* (FEC_S) and 'other trichostrongyles' (FEC_{OT}). Data were analysed using a model with animal within treatment as a random effect. Prior to analysis, the FEC data were transformed to logarithms (ln (x +1)) to normalise the distribution.

Metabolisable protein (MP) of the diets offered in mid and late pregnancy is shown in Table 20. As FEC_N and FEC_S were negligible, only the results of FEC_{OT} are reported. The effect of contrasting diets on FEC_{OT} (back transformed least squares means) over time are presented in Figures 10 to 12. Regardless of diet, FEC_{OT} was elevated in late pregnancy and early lactation compared to the other time points. The effects of forage type, harvest system, harvest number, concentrate level and protein supplementation on FEC_{OT} are presented in Table 21. None of these factors had a significant effect on FEC_{OT}.

Table 20: Metabolisable protein (g/day) intake for the diets offered in mid and late pregnancy

Treatment		Weeks relative to parturition			
Silage	Supplement	12 to 6		6 to 0	
Low DM Maize	No Soya	38	(39)[1]	89	(84)
High DM Maize	No Soya	31		95	
Low DM Maize	Soya at 200 g /day	117	(132)	169	(153)
High DM Maize	Soya at 200 g /day	116		169	
Grass silage[2]	18 kg conc	75	(85)	129	(117)
Grass silage[2]	27 kg conc	80	(91)	162	(147)
Maize silage[3]	18 kg conc	34	(39)	92	(84)

[1] Figures in parentheses represent % MP requirement met in diet based on AFRC, 1993;
[2] Includes both harvest systems; [3] Includes both Low DM and high DM silage.

Table 21: The effects of forage type, harvest system, harvest number, concentrate feed level and protein

Treatment contrasts	FEC_{OT}
Concentrate feed level: 18 *vs*. 27 kg	-0.02 (0.211)[†]
Harvest system : bale *vs*. precision	-0.21 (0.211)
Maize type : low DM *vs*. High DM	-0.49 (0.297)
Maize + Soya *vs*. Maize - Soya	-0.46 (0.297)
Forage type : Maize *vs*. grass	-0.14 (0.264)
Harvest number 1 *vs*. 2	0.03 (0.211)

[†] s.e.

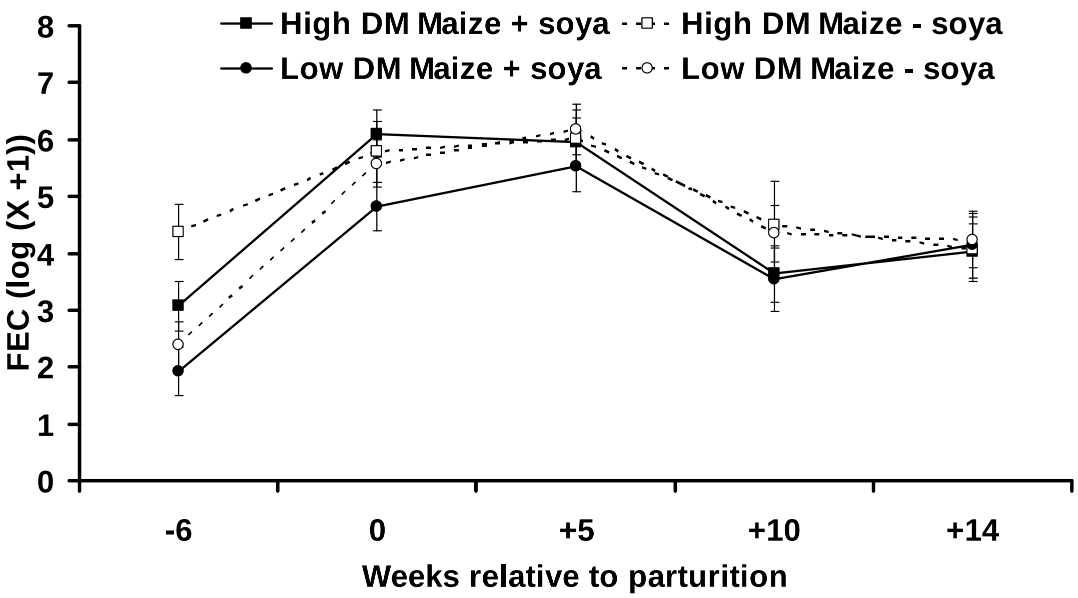

Figure 10. Effect of maize and soyabean supplementation on PPR FEC.

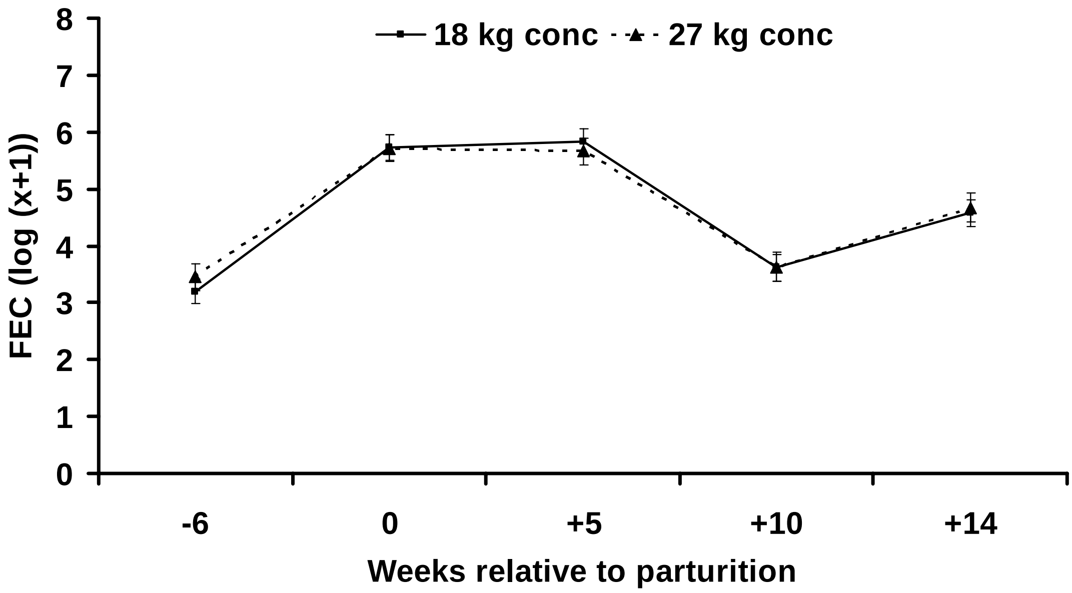

Figure 11. Effect of grass silage with 2 levels of concentrate supplementation on PPR FEC.

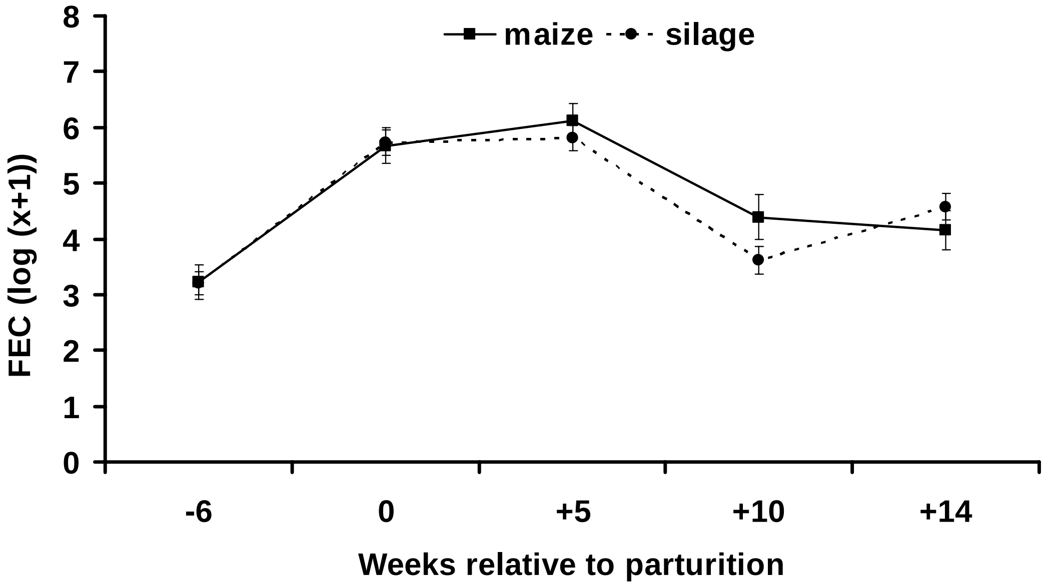

Figure 12. Effect of maize or grass silage with 18 kg of concentrate supplementation on PPR FEC.

The results indicate that differences in concentrate and protein supplementation had no effect on the peri-parturient rise in nematode egg output in ewes.

Good, B., Keady, T.W.J., and Hanrahan, J.P. *RMIS No.5657*

The effect of season of shearing on the periparturient rise in nematode egg output in ewes

Studies at Athenry have shown that shearing ewes at housing increased gestation length and food intake; both indicative of reduced heat stress. The temporary loss of acquired immunity to gastrointestinal nematodes, that is associated with an increased faecal egg output in late pregnancy and early lactation, is a well established phenomenon and is important in the epidemiology of nematodes parasites of sheep. Given the association between nutrition and the periparturient rise in nematode eggs (PPR) in ewes, the increased food intake evoked by shearing at housing, may have an impact on the PPR. The aim of this study was to evaluate the effect of season of shearing on the periparturient rise in nematode egg output of ewes.

One hundred and thirty ewes (66 first crop, 64 second crop) were allocated at random to one of four shearing treatments namely; conventional (shorn 29 May), conventional & pre-mating (shorn 29 May and 9 September), pre-mating (shorn 9 September), and housing (shorn 30 November). Ewes were managed as one flock, had not been administered an anthelmintic in the previous year and were synchronised using progesterone impregnated sponges, for mating. The ewes were housed (slatted pens) in mid December and offered silage based diets and supplemented with a total of 21 kg concentrate during the last 6 weeks of pregnancy. The ewes were turned out to pasture within 3 days of lambing. Triplet rearing ewes were offered 1 kg of concentrate daily for 5 weeks post lambing and triplet lambs were offered concentrate, to a maximum of 300 g/day, from birth to weaning. Ewes rearing singles or twins received no concentrate post lambing. Lambs were weaned at 14 weeks of age. Strongyle faecal egg counts were determined for each ewe prior to the initiation of concentrate feeding at 6 weeks prior to lambing, at lambing (within 3 days of lambing prior to turnout at pasture) and at 5, 10 and 14 weeks post lambing. Faecal egg counts were distinguished as *Nematodirus* (FEC_N), *Strongyloides papillosus* (FEC_S) and 'other trichostrongyles' (FEC_{OT}). Data were analysed using Proc MIXED with animal as a random effect. Prior to analysis, the FEC data were transformed to logarithms (ln (x +1)) to normalise the distribution.

The effects of treatment on FEC_N, FEC_S and FEC_{OT} are presented in Table 22. There was no significant effect of treatment on FEC_N, FEC_S or FEC_{OT}. The effect of time on FEC_{OT} for each treatment is presented in Figure 13 which shows that FEC_{OT} was elevated in late pregnancy and early lactation compared to other time points. There was a significant effect of time for all FEC variables (P<0.001).

Table 22.The effects of shearing treatment on faecal egg count – least squares means (s.e.) on log scale

Shearing treatment	FEC_N	FEC_s	FEC_{OT}
Conventional	0.1 (0.04)	1.0 (0.18)	4.3 (0.20)
Conventional and pre-mating	0.1 (0.04)	1.2 (0.15)	4.7 (0.20)
Pre-mating	0.1 (0.05)	1.0 (0.18)	4.6 (0.23)
Housing	0.1 (0.05)	1.1 (0.18)	4.6 (0.23)

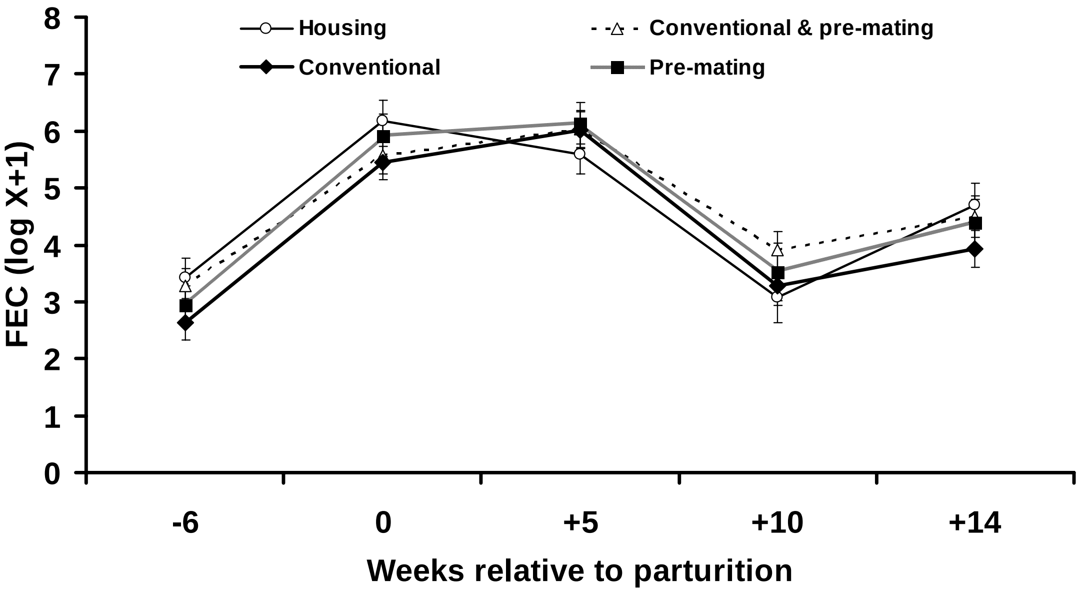

Figure 13. FEC in periparturient ewes for each shearing treatment.

The results indicate that the timing of shearing had no effect on the periparturient rise in nematode egg count in ewes. FEC_{OT} increased between late pregnancy and early lactation and subsequently declined.

Good, B., Keady, T.W.J. and Hanrahan, J.P. *RMIS No. 5674*

The ability of candidate nematophagous fungi to kill ovine nematode *in vitro* following passage through the ovine gastrointestinal tract

In light of increasing evidence for anthelmintic resistant worm populations in small ruminants the need for a multifaceted approach to parasite control is clear. The use of biocontrol agents as an aid to parasite control may be one option. Nematophagous fungi attack and kill nematodes using them as a source of nutrients and have potential as biocontrols. Previous work carried out at Athenry (Research Report 2005 135-137, 2006 173-175) identified 6 fungal species (native to Ireland /UK) with a clear ability to affect the development of *T. circumcincta* eggs but also demonstrated an ability to produce highly resistant spores (chlamydospores). The objective of this present study was to evaluate the ability of these fungi to pass through the gastrointestinal tract of lambs.

Due to time constraints the six candidate fungal isolates were tested in 2 batches. In the first batch, *Fusarium coeruleum, Fusarium incarnatum* and *Verticillium chlamydosporium* were examined while in the second batch, *Haptocillium sphaerosporum, Harposporium anguillulae* and *Paecilomyces lilacinus* were examined. In both batches, *Duddingtonia flagrans* was also tested and 2 lambs acted as controls. Chlamydospores were produced *en masse* for each isolate. Single inoculations of each isolate (5 x 10^5 chlamydospores per 1 kg body weight) were given to 2 lambs. Faecal samples were collected from each lamb at 12 h, 24 h, 48 h and 7 days post-administration and either stored in the refrigerator or frozen and then thawed prior to processing. The number of chlamydospores per gram of fresh refrigerated faeces was determined. Faecal cultures (either 2 x 1 g or 6 x 10 g per animal) were prepared by thoroughly mixing equal quantities of faecal sample from donor lambs (with nematode eggs) with a random sample of individual bulk faecal material (refrigerated / frozen thawed) collected from each animal at 12 h and 24 h post fungal administration. Following incubation periods of either 48 h, 7 or 10 days the number of larvae recovered per treatment was assessed and compared to control treatments.

For each experiment the mean number of larvae recovered from the control treatments was determined for each point and used to calculate the ratio (ratio = treatment : control). The data was analysed using Proc MIXED with animal within batch as a random effect. The model included fixed effects for batch (batch 1 / batch 2), treatment (fungal species), time (GI passage time: 12/24 h) and storage method (faecal storage method pre-culture). The least squares means for ratio for each treatment (species) was tested against the hypothetical mean of 1, using a one tailed test ($\alpha = 0.05$).

Chlamydospores were observed in the faeces for all fungi tested (Figure 14), with the majority of chlamydospores observed at collection times 12 h and 24 h. No chlamydospores were observed on day 7 from any fungal treatment. There was no significant effect of GI passage time (12 h and 24 h) on the number of spores recovered. Fungal species had an effect on the number of spores recovered. *F. incarnatum, V. chlamydosporium* and *P. lilacinus* had the lowest spore recovery (below 10,000/g for any time period).

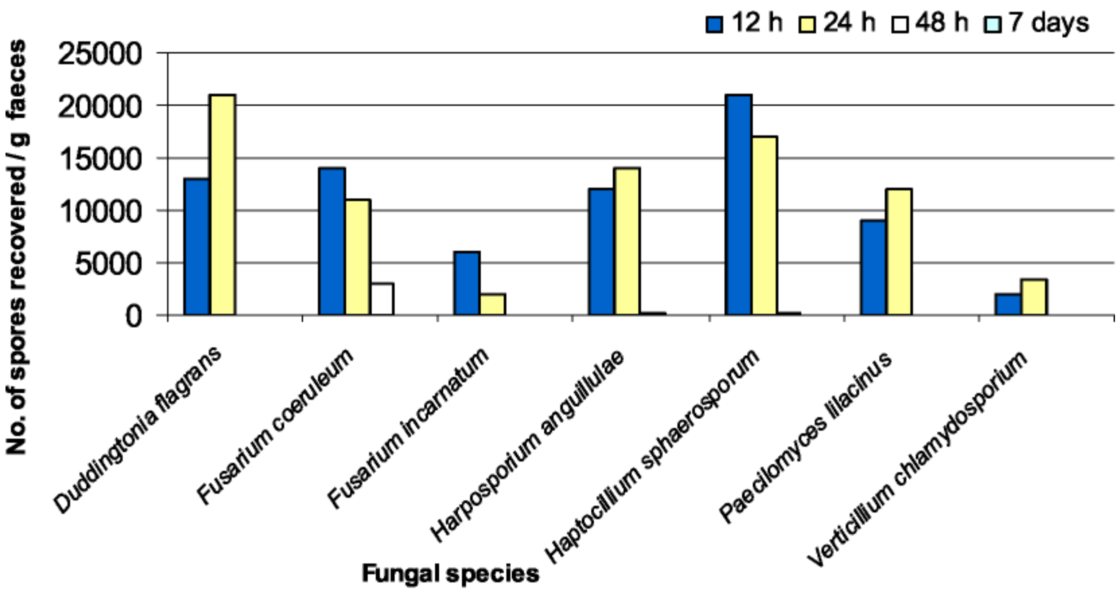

Figure 14. The least squares mean (back transformed) number of spores/g of faeces of each fungal species (Batch 1 and 2) collected at 12, 24, 48 h and 7 days post-administration.

The least squares means for ratio calculated for all treatments over the various experiments are shown in Figure 15. Both treatment and batch has a significant effect on the ratio observed. Neither faecal storage method nor GI passage time was significant. *D. flagrans* was the only species significantly different from 1 (the hypothetical mean).

Gastrointestinal passage had an adverse effect on the ability of the six fungi, namely, *F. coeruleum, F. incarnatum, H. sphaerosporum, H. anguillulae, P. lilacinus* and *V. chlamydosporium,* to reduce larval development in faecal cultures. *D. flagrans* was the only fungus that demonstrated nematocidal capability post gastrointestinal passage.

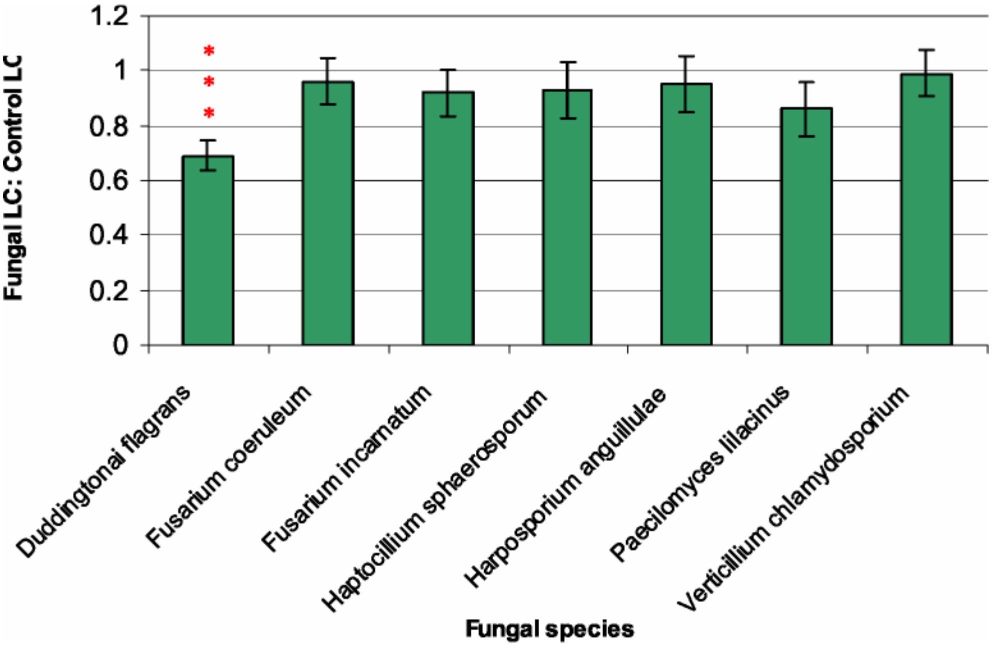

Figure 15. Summary of the least squares mean ratios of larval recovery in fungal cultures compared to control cultures. LC indicates larval counts. Vertical bars on the columns represent standard errors. *** P<0.001 indicates significance from each fungus compared to the control.

Kelly, P., Good, B., Hanrahan, J.P. and de Waal, D.T. [1] *RMIS No. 5387*
[1]UCD School of Agriculture, Food Science and Veterinary Medicine, Belfield, Dublin

Survey of nematophagous fungi on Irish sheep farms

As natural enemies of nematodes, nematophagous fungi offer the possibility of an alternative to the dominant anthelmintic approach for parasite control in ruminants. There is limited data on the presence of nematophagous fungi that may challenge ovine nematodes on Irish farms. The objective of this study was to describe the most common nematophagous fungi present in a range of habitats (soil, old and fresh faeces) on 10 farms with permanent sheep pastures in Ireland. For each sample type, three methods were used to isolate nematophagous fungi. To isolate nematophagous fungi that were predating nematode larvae and eggs, the Baermann technique and flotation technique, respectively, was used. Once recovered the suspension containing larvae/eggs were plated on chloramphenicol-water agar (CHL-WA) plates, air dried, sealed and incubated at 25 ^{o}C for 3 weeks. The third technique, the sprinkling bait technique, involved directly sprinkling/smearing a random sample on CHL-WA plates to which aliquots of bait (2,000 nematode larvae) were subsequently added. Samples were plated and incubated as before. Nematophagous fungi were subsequently identified based on their morphology. A total of 29 nematophagous fungi were observed and 25 were identified to species level. One *Monacrosporium* fungus, two *Harposporium* fungi and a *Nematoctonus* fungus could not be identified to species level. The greatest fungal diversity was observed in the soil (n=21 *spp*) compared to either old (n=9) or fresh faecal samples (n=4). Tables 23 and 24 provide a summary of the predacious (n=12) and endoparasitic fungi (n=17) observed on the ten farms.

Table 23: Occurrence of predacious nematophagous fungi observed on ten farms

Fungi	Soil	Fresh Faeces	Old Faeces	Total	Mode of infection
Arthrobotrys dactyloides	1	0	0	1	Constricting rings
Cystopage cladospora	1	0	0	1	Adhesive mycelia
C. intercalaris	1	0	0	1	Adhesive mycelia
C. lateralis	6	0	0	6	Adhesive mycelia
Duddingtonia flagrans	0	1	0	1	3D Adhesive nets
Monacrosporium cionopaga	0	1	0	1	Adhesive branches
M. lysipage	0	0	1	1	Stalked knobs & rings
M. phymatopagum	0	0	1	1	Unstalked knobs
Monacrosporium spp†.	1	0	0	1	Non constricting rings/adhesive knobs
Stylopage hadra	4	0	0	4	Adhesive mycelia
S. leiohypha	1	0	0	1	Adhesive mycelia
Triposporia aphanopaga	1	0	0	1	Adhesive mycelia
Total	16	2	2	20	

†Not identified to species level.

Table 24: Occurrence of endoparasitic nematophagous fungi observed on ten farms

Fungi	Soil	Fresh Faeces	Old Faeces	Total	Mode of infection
Acrostalagamus zeosporus	1	0	0	1	Adhesive cells
Catenaria anguillulae	2	0	0	2	Encysting spores
Drechmeria coniospora	4	3*	2	9	Adhesive spores
Euryancals obliqua	1	0	0	1	Adhesive cells
Haptoglossa heterospora	3	0	2	5	Encysting spores
H. meristacrus	1	0	0	1	Encysting spores
Harposporium lilliputanum	1	0	1	2	Non –adhesive spores
Harposporium spp.†	2	0	0	2	Non –adhesive spores
Hirsutella rhoissiliensis	2	1	0	3	Adhesive spores
Meristacrum asterospermum	5	0	0	5	Adhesive spores
Myzocytium vermicola	3	0	0	3	Encysting spores
Nematoctonus haptocladus	0	0	1	1	Conidia with adhesive knobs
N. pachysporus	2	0	0	2	Conidia with adhesive knobs
N. tylosporus	0	0	1	1	Conidia with adhesive knobs
Nematoctonus spp. †	0	0	1	1	Conidia with adhesive knobs
Verticillium chlamydosporium	0	0	1	1	Adhesive hyphae
Total	27	4	9	40	

†Not identified to species level. * Two observations were from egg plates using the flotation method.

Due to the diverse range of nematophagous fungi present, permanent sheep pasture represents a rich source of potential fungal biocontrol agents of nematode parasites, some of which demonstrate GI survivability. The greatest diversity of nematophagous fungi was observed in soil. In determining potential biological control agents, fungi that were observed in fresh faeces (e.g. *D. coniospora)* are of particular interest as this would suggest a capacity to survive gastrointestinal tract passage.

Kelly, P., Good, B., Fitzpatrick, R., Hanrahan, J.P. and de Waal, D.T. [1] *RMIS No. 5387*
[1]UCD School of Agriculture Food Science and Veterinary Medicine, Belfield, Dublin

Detecting the presence of nematophagous fungus *Duddingtonia flagrans* on Irish sheep farms using PCR

The nematophagous fungus, *Duddingtonia flagrans* is regarded as the most promising biocontrol agent against nematode parasites of ruminants. While its presence has been documented in many countries worldwide it has not been reported in Ireland. Heretofore, identification has relied on morphological means of assessment. Using the *D. flagrans* specific PCR diagnostic test developed in our earlier study (Research Report 2006, 175-178) the objective of the present study was to determine whether *D. flagrans* was present on Irish sheep farms. Ten sheep farms (Kilkenny n=4, Wicklow n=6) were visited in early September. Faecal (fresh), leaf litter and soil samples were collected at random from permanent sheep pasture (one field) on each farm. Samples from each farm were pooled and mixed prior to removing a random sample for DNA extraction. DNA from each sample type was extracted using methods described earlier (Research Report 2006 175-178). Using the PCR assay described (Research Report 2006 175-178),. *D. flagrans* was detected on 80 % of farms surveyed. The fungus was found in fresh faecal, leaf litter and soil samples, from seven, five and three farms respectively. The data confirmed that there was no significant difference in the occurrence of *D. flagrans* between habitat types (i.e. faeces / leaf litter /soil) (P=0.26) or counties (P=1.0). This is the first report of *D. flagrans* in Ireland. Worthy of note, the PCR diagnostic method detected *D. flagrans* on 80 % of farms sampled compared to 10 % using the conventional morphological technique described in the survey study (Research Report, 2007).

Kelly, P., Good, B., Fitzpatrick, R., Hanrahan, J.P. and de Waal, D.T. [1] *RMIS No. 5387*
[1]UCD School of Agriculture Food Science and Veterinary Medicine, Belfield, Dublin

***Fasciola hepatica* infection in *Lymnaea truncatula* on the Teagasc Hill Sheep Farm**

Understanding the epidemiology of the intermediate molluscan host is important in developing effective liver fluke control strategies. The aim of this study was to examine the abundance of *Lymnaea truncatula* and the prevalence of *F. hepatica*, within snail populations on the Teagasc hill sheep farm in the west of Ireland (lat. 53°37' to 53°38', long. 9°41') in relation to rainfall and temperature. From August 2006 until December 2007, four snail habitats were monitored for *L. truncatula* every fortnight using quadrat and 10 m transect sampling methodology. The habitats sampled consisted of 2 track areas (fields 2 and 7), a drainage ditch (field 9) and a predominantly mossy area (field 10). Snails were identified to species and measured (apex to anterior margin of shell) using digital callipers (±0.01 mm). Two methods were used to assess *F. hepatica* infection in the snails, namely dissection and PCR. Following dissection in 20 µl of nuclease free water and the microscopic examination for presence of *F. hepatica* cercariae, tissue was stored at -20°C. All snails were dissected and a random sample of snails (minimum 24%) from each sampling period were examined using PCR diagnostic assay for *F. hepatica.* DNA was extracted using a genomic DNA purification kit (Promega) and stored at -20 °C. PCR was performed with forward (5′-tatgttttgattttacccggg-3′) and reverse (5′atgagcaaccacaaaccatgt-3′) primers as described by Cucher *et al*. (2006). The optimal PCR consisted of final concentrations of 1 X PCR buffer, 2.5 mM $MgCl_2$, 200 µM dNTPS, 0.1% Triton X-100, 0.1 µM of each primer, 1.0 Unit polymerase and 2 µl of DNA in a final concentration of 25 µl. PCR amplification consisted of initial denaturation at 98 °C for 3.5 min, followed by 30 cycles of denaturation at 95°C for 1 min, annealing at 56°C for 1 min and extension at 72°C for 1.5 min. A final 3 min extension at 72 °C was included. Amplification products (18 µl) were electrophoretically resolved in 2 % agarose gels and stained with ethidium bromide. Monthly weather data were obtained from Claremorris, the closest weather station to the study farm. The proportion of snails infected was examined using Proc GENMOD. The model included habitat and season.

The total number of snails, size and the percentage infected with *F. hepatica* as determined *via* dissection and PCR, at each sampling period are presented in Figure 16. The PCR method was more sensitive at detecting *F. hepatica* infection in snails compared to dissection. Both habitat (P<0.01) and season (P<0.001) had significant effects on the proportion of infected snails observed. The proportion of snails infected in fields 2, 7, 9 and 10 were 14.4%, 5.9%, 20.7% and 17.1%, respectively. The highest incidence of infected snails was observed in 2007: summer (21.3 %) and autumn (27.2%). The warm dry summer of 2006 (June & July: <50 mm total monthly rainfall, average temp 15.3 ^{o}C) delayed the development of *L. truncatula* populations resulting in a peak abundance occurring later than expected (October) in all habitats. Milder wetter weather enabled snails to remain present on the soil surface throughout the winter (> 130 mm total monthly rainfall, temp. 6.6 ^{o}C). A smaller peak in snail abundance was subsequently observed in March 2007 in all habitats. Following a very wet summer in 2007 (June & July: > 100 mm total monthly rainfall, average temp 14.3 ^{o}C), peak abundance of snails was observed in late August. PCR is a more sensitive means of determining *F. hepatica* infection in *L. truncatula* populations. Contrasting seasonal weather conditions clearly influenced snail abundance and the maintenance of the *F. hepatica* life cycle. A milder winter clearly facilitates overwintered infection on pasture.

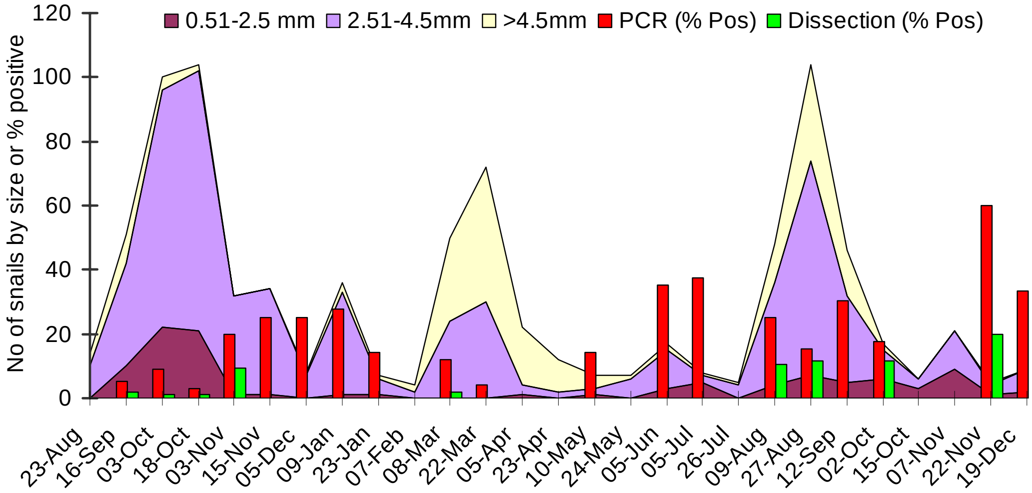

Figure 16. Snail abundance, size and percentage infected with *Fasciola hepatica* over time.

Relf, V.[1], Good, B., McCarthy, E.[1] Hanrahan, J.P. and de Waal, D.T.[1] *RMIS No.5493*
[1]UCD School of Agriculture, Food Science and Veterinary Medicine, Belfield, Dublin

Monitoring of *Fasciola hepatica* infection in sheep on the Teagasc Hill Farm

As in 2006 (Research Report 2006 p182-184) the prevalence of fasciolosis in ewes and lambs grazing the green land or upland areas was monitored from a specific cohort (randomly selected at the beginning of the sampling period) on a monthly basis. Faecal and blood samples were taken to determine fluke FEC and antibodies to *Fasciola hepatica* infection, respectively. Tracer lambs (n= 6) were also monitored over the season. At birth the tracer lambs remained indoors with their dams prior to the hill flock being put to the hill in spring as per routine husbandry practice. When the hill flock was gathered from the hill grazing area, for routine management and sampling procedures the tracer lambs and their dams were put indoors to eliminate any exposure to green land prior to their direct return to the hill. These lambs remained with their dams on the hill until the latter was moved in October for mating. They were housed in November.

Results for serology (significant level of *F. hepatica* antibodies) and liver fluke FEC in lambs grazing the hill (n=12) or green land area (n=41) are shown in Figure 17. Both grazing groups had positive FEC by September. Around this period, the hill grazing lambs were given a fasciolicide against mature fluke. FEC was not observed in this group again until December (33%, n=3). The serology results for the tracer lambs are shown in Figure 17. The first evidence for infection tracer lambs as determined by positive serology (*F. hepatica* antibodies) and FEC was observed in October (n=1) and November (n=2) respectively. These results suggest that lambs were being exposed to *F. hepatica* on the hill.

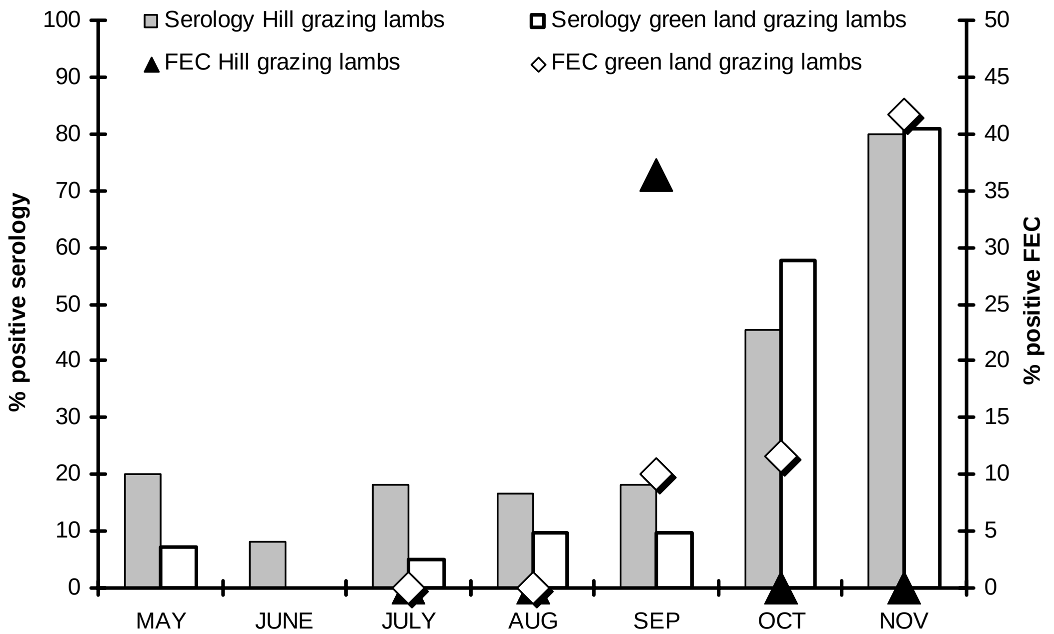

Figure 17. Serology and FEC results in lambs grazing hill or lowland during 2007.

Relf, V.[1]*, Good, B., Hanrahan, J.P. and de Waal, D.T.*[1] *RMIS No. 5493*
[1]UCD School of Agriculture, Food Science and Veterinary Medicine, Belfield, Dublin

The comparative efficacy of four fasciolicides against natural liver fluke infection in lowland ewe flock at Leenane

Fasciolosis, which is caused by the trematode *Fasciola hepatica,* is common in both sheep and cattle worldwide. Infection in sheep results in anemia and may be fatal. Treatment of sheep with flukicides is the main method of control and a number of fasciolicides are available on the Irish market. With one exception, namely triclabendazole, no other flukicides are efficacious against all stages of *Fasciola hepatica*. The aim of this study was to evaluate the efficacy of triclabendazole, closantel, oxyclozanide and nitroxynil against *F. hepatica* in naturally infected ewes in the lowland flock system at the Leenane hill sheep farm.

On the first week of January all ewes (n=138) were housed as per routine husbandry practice. Ewes were weighed, faecal and blood sampled (2 vacutainers: no anticoagulant, with anticoagulant) and randomly assigned to 1 of 4 treatment groups; namely triclabendazole (Fasinex 5%, Novartis Animal Health), closantel (Flukiver, 5 injection, Jannsen Cilag Ltd), oxyclozanide (Zanil fluke drench, Schering Plough Animal Health Ltd.), and nitroxynil treated group (Trodax 34%, Merial Animal Health Ltd.). All treatments were administered according to manufacturers' recommendations and the dosing equipment was calibrated prior to use. Faecal samples were taken again on days 7, 14, 21 and 56 post-treatment and blood samples (plain vacutainer; no anticoagulant with EDTA vacutainer) on days 14 and 56 post-treatment. Faecal samples were processed using the sedimentation method to determine the number of fluke eggs per gram of faeces (LFEC). Blood samples were processed to determine levels of Glutamate dehydrogenase (GLDH) and Gamma glutamyltransferase (GGT) in the serum (both indicators of liver damage) and packed cell volume (PCV) (indicator of anaemia). Barren ewes (n=12) were excluded from further study and were moved to the hill as per normal management practice.

Liver fluke faecal egg count data were excluded from analysis if pretreatment LFEC value was zero or missing for a particular animal (on day 0) (n=33) or if data for a particular animal was missing from all subsequent time points after day 0 (i.e. days 7, 14, 21 and 56 inclusive)(n=9). LFEC data (n=84) were analysed using mixed model procedures. The model included fixed effects for treatment, time and treatment by time interaction and animal within treatment as a random effect. Drug efficacy was determined using the following formulae: % efficacy = (LFEC Day 0 – LFEC Day X) * 100) / (LFEC Day 0) for each animal and determining the mean where X represents data from day 7, 14, 21 or 56 post treatment. The liver enzymes and haematological data (n=84) were analysed using mixed model procedures. Prior to analysis the enzyme GLDH was transformed using the log transformation to stabilise the variance. No transformation was applied to the enzyme GGT or the haematological variable, PCV. The models included fixed effects for treatment, time and treatment by time interaction for each variable with animal within treatment as a random effect. Measurements taken pretreatment (day 0) were used as a covariate.

The mean values for enzyme concentrations over time by treatment are presented in Figures 18 and 19. All enzyme measurements were within the normal reference values. Treatment and treatment-by-time had significant effects on GGT concentration. Time approached significance (P=0.07). Time had a highly significant effect on GLDH, GDLH decreasing over time in all treatment groups (P< 0.001). Treatment was also significant. The treatment-by-time interaction was not significant. The mean values for PCV over time, by treatment, are presented in Figure 20. PCV values were within the reference range throughout the period studied. PCV decreased significantly with time post-treatment. Neither treatment nor time-by-treatment interaction was significant.

The results for treatment efficacy are shown in Table 25. LFEC between treatment groups was not significant at day 0. The results for closantel, oxyclozanide and nitroxynil treatments indicate that these drugs are highly effective compounds for the treatment of fluke in sheep on this farm. In contrast, the results for triclabendazole indicated low levels of efficacy which is indicative of the presence of triclabendazole resistant *Fasciola hepatica*.

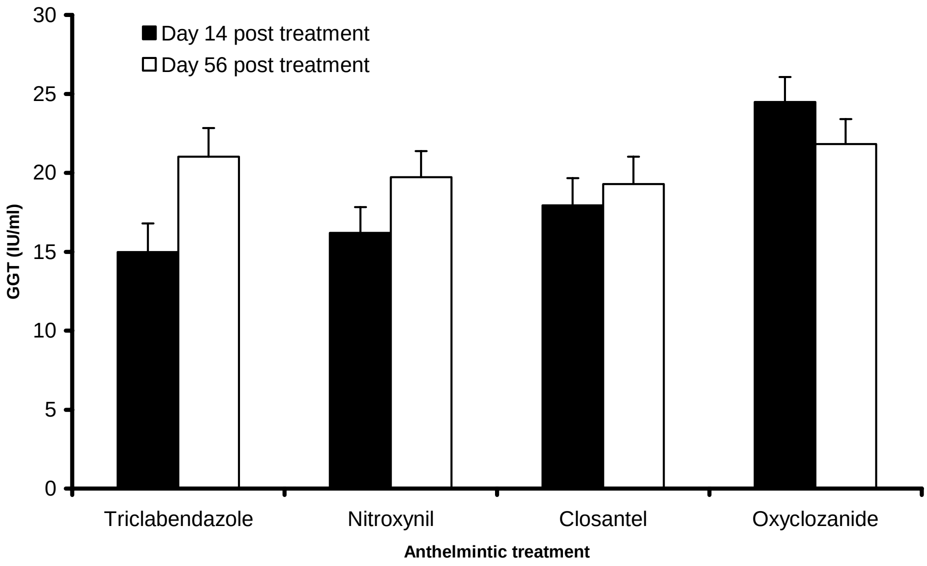

Figure 18. Least squares means for GGT per treatment group. Vertical bars on the column represent standard errors.

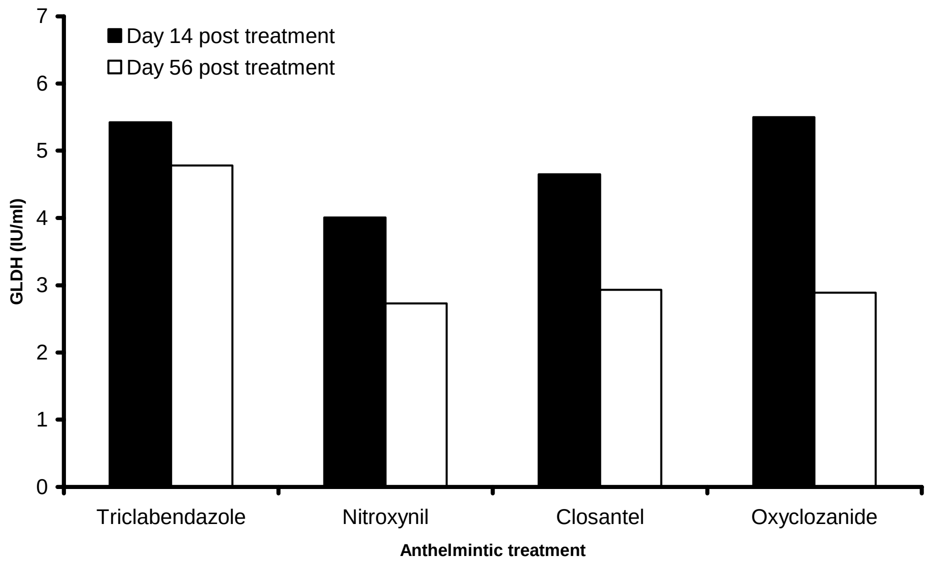

Figure 19. Least squares means (back transformed values) for GLDH per treatment group.

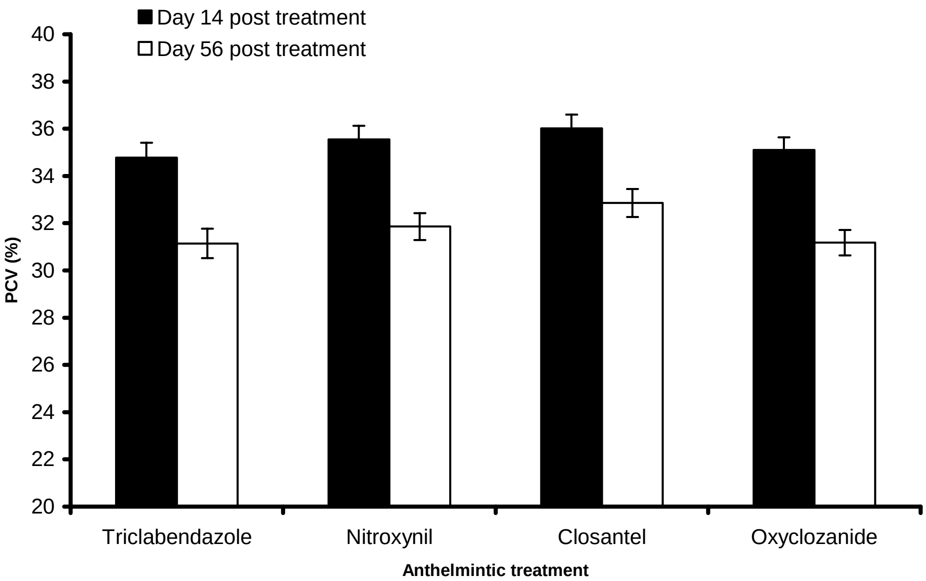

Figure 20. Least squares means for PCV per treatment group.

Table 25. Efficacy of treatment with four fasciolicides in naturally infected ewes.

		Treatment group			
Days		Triclabendazole[1]	Closantel[2]	Nitroxynil[3]	Oxyclozanide[4]
0[5]	n	18	20	22	24
	Mean epg	20.4	34.2	17.0	37.4
	Range	(0.3-67.7)	(0.3-206)	(0.3-89.0)	(0.7-450)
	Efficacy (%)	-	-	-	-
7	n	18	20	22	22
	Mean epg	10.4	0.1	0.3	0.1
	Range	(0.0-36.7)	(0.0-0.3)	(0.0-3.7)	(0.0-1.0)
	Efficacy (%)	51.8	94.8	98.2	99.9
14	n	17	20	21	20
	Mean epg	9.4	0.0	0.0	0.0
	Range	(0-36.0)	(0.0-0.0)	(0.0-0.0)	(0.0-0.0)
	Efficacy (%)	58.1	100	100	100
21	n	18	20	21	22
	Mean epg	6.4	0.0	0.0	0.0
	Range	(0-25.0)	(0.0-0.0)	(0.0-0.0)	(0.0-0.0)
	Efficacy (%)	70.9	100	100	100
56	n	17	19	20	24
	Mean epg	6.9	0.0	0.0	0.0
	Range	(0.0-28.7)	(0.0-0.0)	((0.0-0.0)	(0.0-0.0)
	Efficacy (%)	74.6	100	100	100

[1]Fasinex 5%, Novartis Animal Health; [2]Flukiver, Jannsen Cilag Ltd.; [3]Trodax 34%, Merial Animal Health Ltd.; [4]Zanil fluke drench, Schering Plough Animal Health Ltd.; [5]Day 0 represents pretreatment value.

Mooney, L.[1], Good, B., Hanrahan, J.P. and de Waal, D.T.[1] *RMIS No. 5493*
[1]UCD School of Agriculture, Food Science and Veterinary Medicine, Belfield, Dublin

Parasite levels in the organic sheep flock, Mellows

Roundworm parasite levels were monitored weekly in ewes, lambs and hoggets during the grazing season. Faecal egg counts (FEC) were determined using the FECPAK© method from pooled faecal material from at least 15 animals per group. To prevent problems due to roundworms the flock graze 'clean' pastures at turnout (i.e. not grazed by sheep in the previous two seasons). Ewes were dosed at turnout to minimise pasture contamination and hoggets dosed prior to their entry to the grazing area. The pattern of FEC values for the ewes and lambs and are shown in Figures 21 and 22, respectively. The FEC values in the replacement hoggets were negligible throughout the grazing season (data not shown). Up until the middle of June the FEC values for the lambs remained near or below 500 epg. Similar to last year (see Research report 2006 pg 158-159) FEC rose quite sharply in late June. On the basis of escalating FEC, levamisole was administered (Nilzan Drench Plus, Schering Plough Animal Health, Ireland) to all lambs on the 17 July according to manufacturer's recommendations and in accordance with organic regulations. Individual samples were taken from 15 lambs pre treatment and at 7 and 23 days post treatment to examine drug efficacy. FEC was determined for each lamb using the modified McMaster methodology. The criteria used to evaluate anthelmintic resistance were based on the World Association for the Advancement Veterinary Parasitology guidelines for detecting resistance. The arithmetic mean FEC (excluding *Nematodirus spp* and *Strongyloides papillosus*) on day 0, 7 and 23 were 1353, 88 and 27 eggs per gram of faeces respectively. Anthelmintic resistance was not evident.

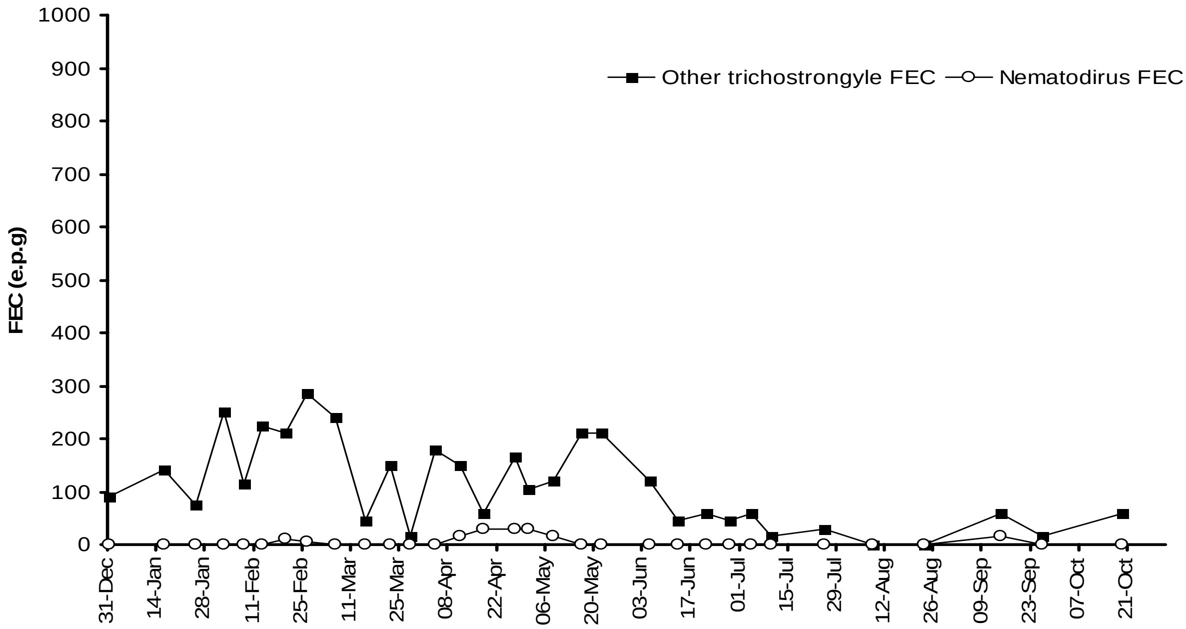

Figure 21. FEC in ewes from the organic flock in 2007.

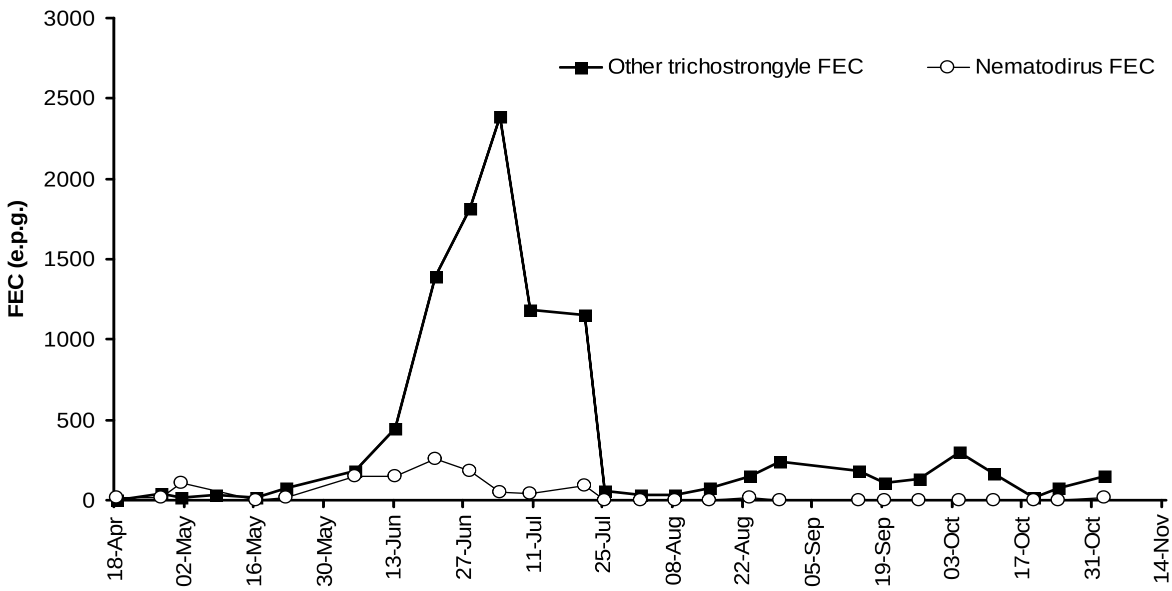

Figure 22. FEC in lambs from the organic flock in 2007.

Good, B., Hanrahan, J.P. and Nally, J. *RMIS No. 5253*

Organic sheep flock performance 2007

The flock consisted of 119 ewes put to the in autumn 2006 of whom 111 lambed. The mating plan involved use of Belclare rams on a proportion (1/3) of the flock to generate ewe replacements whilst the remainder was joined with Texel rams. The litter size averaged 2.22 and mean lambing date was 8 March. There was an unexpectedly high incidence of ewes with triplets (27 %) and higher-order multiples (5 %, including a ewe with sextuplets). Peri-natal lamb mortality was high (10 %) and the loss rate of live (tagged) lambs was also high (16 %). These loss rates are partly a reflection of the high litter size but are also likely to be a reflection of the generally low birth weight (Table 26). Birth weight was 0.5 to 0.6 kg less for singles and twins when compared with 2006 results and triplets were 0.4 kg lighter. Lamb growth rate (Table 26) up to 5 weeks of age was satisfactory but declined substantially between 5 weeks of age and weaning (21 June). Thus, 23 May and 21 June daily gain for lambs reared as twins or triplets averaged only 197 g. This was probably a consequence of the increasing parasite challenge during this period (see Figure 22). Breed of sire had no significant effect in either birth weight or growth rate.

Table 26: Least squares means for lamb growth traits-organic flock

Main effect	Birth wt (kg)	Growth rate (g/day)		Weight at
		0 to 5 weeks	0 to 14 weeks	14 weeks (kg)
Rearing type[1]				
Single	4.8 ± 0.29	340 ± 26.9	295 ± 20.3	33.7 ± 2.06
Twin	3.9 ± 0.19	273 ± 25.0	241 ± 18.8	27.7 ± 1.91
Triplet	3.0± 0.23	229 ± 28.4	223 ± 21.4	25.2 ± 2.16
F-test	**	**	**	**
Sire breed				
Belclare	3.9 ± 0.41	271 ± 37.6	251.8 ± 28.3	28.6 ± 2.84
Texel	3.9 ± 0.18	290 ± 24.3	254.3 ± 18.3	29.1 ± 1.87
F-test	n.s.	n.s.	n.s.	n.s.

[1]Birth type in the case of birth weight.

Hanrahan, J. P. *RMIS No. 5253*