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The Development of Feeding and Management Strategies for Milk Production Systems with Very Contrasting Milk Supply Patterns

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Contents

Summary

In Experiment 1, three systems of milk production with contrasting calving patterns, namely 100% autumn (A); 100% spring (S) and 50% autumn: 50% spring (AS), were compared over a two year period. The average milk yield was 6,532, 6,358 and 6,142 kg/cow for systems A, AS and S respectively. The difference in yield was not statistically significant. Fat yield, fat content and protein yield for system S was significantly lower than those with the other two systems. The autumn-calving cows (A) had reduced reproductive performance.

Experiment 2 compared grazed grass with grass silage as a forage source for autumn-calving cows in early lactation; it showed that the cows on grazed grass had significantly higher milk protein yield and milk protein content. The cows on the grass silage had significantly lower dry matter intake and a significantly higher bodyweight loss post-calving.

The aim of this project was to develop low-cost systems of milk production which lead to an improved milk supply pattern of quality milk for the food industry. In particular, the objective was to research the role which grazed grass can contribute to the feed requirements of cows calving at different times during the year.

Experiment 1. A comparison of three systems of milk production based on very contrasting calving patterns

Introduction

Predominantly spring - calving herds are a feature of the Irish dairy industry at present. More than 85% of manufacturing milk is produced from March to October, inclusive, and the remaining 15% is produced from November to February. This results from the milk pricing structure and from the fact that the lactation period in Ireland is synchronised to the availability of (low cost) grazed grass. Spring-calving systems of milk production result in a highly seasonal milk supply pattern which presents problems in terms of the product mix which can be manufactured from the milk. It also makes inefficient use of milk assembly and milk processing facilities.

The costs associated with winter milk production are higher than those for summer milk production. Winter milk production systems are generally perceived as 'high silage input' systems. It is important to determine the additional feed requirement, especially concentrates for autumn-calving cows. Grazed grass may be able to make a major contribution to reducing costs in these systems. The two objectives of the two experiments were to define the inputs and outputs including milk characteristics for processing for systems of milk production with contrasting calving patterns to quantify and compare grazing management strategies for dairy cows with contrasting calving patterns.

Materials and Methods

Location and site characteristics

This study was carried out at the Solohead Research Farm, Co. Tipperary, which is part of the Teagasc Dairy Production Research Centre. The experiment commenced in September 1995 and ended in January 1998. The experimental area was totally reseeded over the previous two years.

Experimental design and treatments

Three very contrasting calving patterns were compared in this experiment. A total of 78 Holstein Friesian cows blocked for lactation number and milk yield were allocated to three treatment groups. There were 26 animals per treatment for Year 1 and Year 2 of the experiment. The three experimental treatments are outlined in Table 1.

Table 1. Details of the three experimental treatments

		Stocking rate (cows/ha)		Calving date	
System	**Description**	**Year 1**	**Year 2**	**Year 1**	**Year 2**
A	**100% autumn-calving**	**2.56**	**2.48**	**28/9**	**25/10**
AS	**50% autumn and 50% spring-calving**	**2.56**	**2.48**	**29/9 : 22/2**	**10/10: 22/2**
S	**100% spring-calving**	**2.56**	**2.48**	**22/2**	**16/2**

The experimental animals had an average breeding index (RBI95) of 113 in year 1 and an average breeding index (RBI95) of 116 in Year 2 of the experiment. In Year 1, 8 first lactation animals were randomly assigned to each of the three treatments, while in Year 2 there were six first lactation animals per treatment.

Farmlet design and grassland management

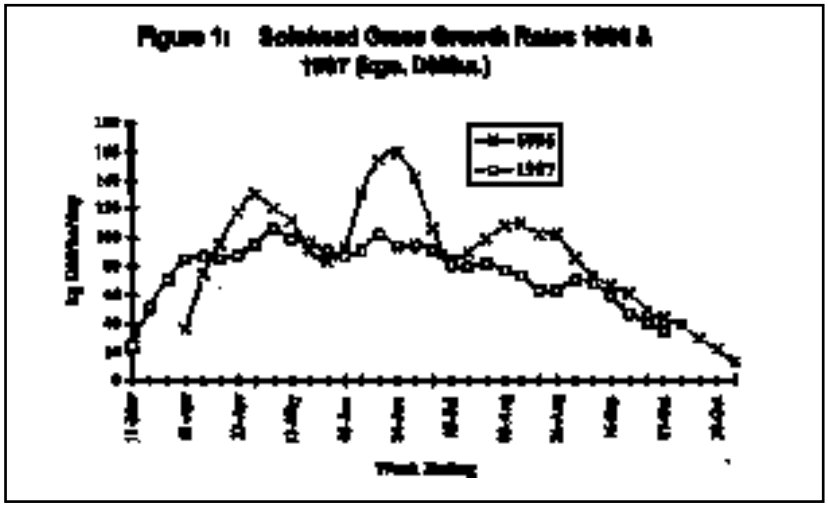
The site was reseeded in the previous two years and was almost 100% perennial ryegrass (Lolium perenne) at the start of the experiment. The seed mixture per hectare was Condessa (16.85 kg), Magella (5.61 kg), Tyrone (5.61 kg), Susi (1.11 kg) and Aran (1.11

kg). Each treatment had it's own farmlet comprising of 19 paddocks in Year 2 and 18 paddocks in Year 2. Paddock areas ranged from 0.49 ha. to 0.73 ha. The paddocks were grouped into blocks of 3 paddocks. The treatments were randomly assigned to the paddocks within each block. A rotational paddock grazing system was employed. For grazing, each paddock was subdivided to give a daily allowance of grass to the cows. Temporary electric fences were used to achieve greater control over the grazing area. Two 'entrances/exits' to each paddock were used to avoid 'poaching' in wet weather.

Results

Grass production

Grass production was measured (in a separate experiment using 650 kg N fertiliser per ha at the Solohead Research Farm) using the method of Corrall and Fenlon (1978). The grass production for 1996 and 1997 are shown in Figure 1. Total grass production averaged 19.8 tonnes DM per hectare in 1996 and 16.7 tonnes DM per hectare in 1997. Therefore, total grass production was very high in 1996 and was especially so in June and August. Peak growth yields of 160 kg DM/ha/day in the week of 25th June 1996, was the highest ever recorded in this type of experiment in Ireland. In 1997, grass growth was above normal in March and early April and was below normal in May.



Grazing Management

Table 2 shows the grazing pattern for the two years of the experiment. Turnout date depended on ground conditions and not on grass supply. The turnout date in 1996 is the 'normal' turnout date for the Solohead Farm. Turnout was particularly early in 1997 due to good ground conditions in February and March. Grazing ceased in both years because of poor ground conditions and not because of restricted grass supply. When the ground score rises above 4.5 the soil surface becomes susceptible to damage by poaching. All animals were removed and housed when the ground score rose above this critical level.

Table 2. The dates on which grazing was commenced and ended in 1996 and 1997.

	Year 1 - 1996	Year 2 - 1997
Start of grazing season		
Out by day	**April 1**	**March 10**
Out by day and night	**April 16**	**March 14**
End of grazing season:		
Housed by night	**October 25**	**—**
Housed by day and night	**November 19**	**November 4**
Housed by day and night*		**November 17**

***Treatment A**

Concentrate supplementation

Table 3 gives the concentrate input to the three treatments for the two years. In Year 1, the autumn-calving cows in Treatments A and AS were fed at a level of 8 kg concentrates/cow/day during the indoor period; this was gradually reduced after turnout to pasture and all cows were off concentrates by early May. The spring-calving cows in Treatments AS and S were fed at a level of 8 kg concentrates/cow/day from calving until turnout to pasture, this was gradually reduced and all cows were off concentrates by early May. The spring-calving cows in Treatments AS and S were given 2 kg concentrate/cow/day from October 11 onwards until drying off.

In Year 2, the autumn-calving cows in Treatments AS and S were given 6 kg concentrates/cow/day during the indoor period, this level was then gradually reduced and all cows were off concentrates by early April. The spring-calving cows in Treatments AS and S were fed at a level of 6 kg concentrates/cow/day from calving until turnout to pasture, this level of feeding was then gradually reduced and all cows were off concentrates by early April. Due to poor grass growing conditions in Year 2, the cows in Treatment A were supplemented with 3 kg concentrates/cow/day, while Treatment AS and S were supplemented with 5 kg of concentrate per cow per day from May 8th to May 30th. The spring-calving cows in Treatments AS and S were offered 2 kg concentrate/cow/day from September 12 onwards until drying off.

Table 3. The quantity (kg/cow) of the concentrate supplement offered to each of the three treatments for the two years.

	Year	
	Year 1	***Year 2***
Treatment A	***1,524***	***949***
Treatment AS	***1,095***	***719***
Treatment S	***666***	***560***

Milk yield and composition

The milk yields, milk composition and lactation lengths for 1996 and 1997 are shown in Table 4.

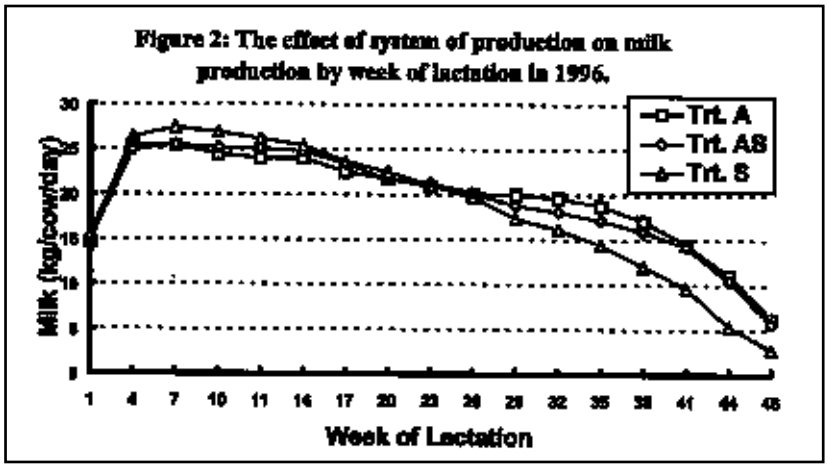
Table 4. The effect of system of production on milk yield and milk composition

		Treatment				
	Year	**A**	**AS**	**S**	**SEM**	**Sig.**
Total milk yield (kg/cow)	**1996**	6,638	6,513	6,179	196	NS
	1997	6,435	6,200	6,101	179	NS
	Combined	6,532	6,358	6,142	133	NS
305-day milk yield (kg/cow)	**1996**	6,322	6,235	6,038	169	NS
	1997	6,219	6,103	6,011	167	NS
	Combined	6,267	6,170	6,026	119	NS
Milk fat (kg/cow)	**1996**	269	270	250	9.0	NS
	1997	265	261	242	8.1	NS
	Combined	266	266	246	6.0	*
Milk protein (kg/cow)	**1996**	232	229	215	6.6	NS
	1997	213	221	213	6.3	NS
	Combined	229	225	214	4.6	*
Milk lactose (kg/cow)	**1996**	309	306	287	9.9	NS
	1997	295	290	281	8.6	NS
	Combined	302	298	284	6.6	NS
Fat (g/kg)	**1996**	40.8	41.5	40.6	0.8	NS
	1997	41.4	42.2	39.6	0.7	*
	Combined	41.1	41.9	40.1	0.5	*
Protein (g/kg)	**1996**	35.1	35.2	35.0	0.4	NS
	1997	35.2	35.7	35.1	0.3	NS
	Combined	35.2	35.4	35.0	0.3	NS
Lactose (g/kg)	**1996**	46.4	47.0	46.6	0.3	NS
	1997	45.9	46.8	46.1	0.2	*
	Combined	46.2	46.9	46.3	0.2	*
Lactation length (days)	**1996**	322	318	304	5.07	*
	1997	309	292	298	6.88	NS
	Combined	316	305	301	5.09	NS

SEM = standard error of mean; NS, not significant (P<0.05); *P<0.05;

There were no statistically differences between treatments in milk yield in either year of the trial but there was a non-significant tendency towards higher milk production in Treatment A. Treatment A had a significantly longer lactation length in 1996. This longer lactation length accounts for some of the difference in milk yield but when all treatments had their lactations adjusted to a 305-day lactation, there was still a tendency towards higher milk yield with Treatment A. There were no significant differences in milk fat, protein and lactose yield in either year. Milk fat concentration was significantly lower ($p<0.05$) for Treatment S in Year 2, but not in year 1. When the two years results were combined Treatment S had a significantly lower ($p<0.05$) fat and protein yield and a significantly lower milk fat concentration ($p<0.05$). Differences between treatments in milk protein concentration in the two years combined were not statistically significant.

The effect of system of production on milk production by week of lactation is shown in Figure 2 . The graph for 1997 is very similar to that for 1996. In early lactation in year 1 there was a higher peak milk production with Treatment S. Treatment A had higher milk production levels in the latter half of lactation and yields were more persistent until the end of lactation. There was an increase in milk production which coincided with turnout to pasture in Treatment A. Treatment S had the lowest milk production levels at the end of lactation in both years.



Treatment A and S had a highly seasonal milk supply pattern. Treatment S reached peak milk production at Week 35 of the experiment. Treatment AS had a more even or uniform supply pattern though it declined steadily after Week 50 of the experiment.

Grazing management in the early Spring period

Spring grass has a higher feeding value than grass at any other part of the season. Autumn-calving cows are in mid-lactation at this time and are still producing high milk yields. The provision of early spring grass is an important consideration on farms with autumn-calving cows. The primary objectives are to give autumn-calving cows access to grazed grass as early as possible and to budget that grass until grass supply equals demand. Recent work by Maher *et al*.(1998) showed that 20 kg DM/cow/day was capable of supporting a high level of milk production and maintain optimum pasture utilisation. Higher levels of daily herbage allowances may result in only a small increase in milk production and under utilisation of pasture.

Grazing management in the mid-summer period

The supply of grass for grazing exceeds the demands of autumn-calving herds from mid-July onwards; this is because of the low herd demand for feed of the non-lactating cow. Grass growth rates are still relatively good at this time of year. The supply of grass on the farm should be monitored so as to avoid large surpluses (increase in farm cover) occurring. A larger area (16.4 ha) was conserved as surplus for Treatment A than for Treatment AS (13.1 ha) or Treatment S (12.6 ha) in both years of the study.

Autumn-calving cows generally have a higher body condition score at the end of lactation. It is important that they should not gain excess body condition during the dry period and that they calve down at a body condition score of 3.0 - 3.5. The strategy followed to restrict grass during the systems study was to graze the milking cows ahead of the dry cows. The pre- and post-grazing heights for the dry cows for both years are given in Table 5. The dry cows entered paddocks with varying pre-grazing heights and grazed these paddocks to a pre determined target height of 6 cm. A post-grazing height of 6 cm resulted in dry cows being maintained at an optimum body condition score; and pasture quality was also improved for the remainder of the grazing season.

Table 5. Dry cow grazing measurements for 1996 and 1997.

Date	1996	1997
Pre-grazing height	**8.97**	**8.13**
Post-grazing height	**5.77**	**6.46**

The grazing management for lactating autumn-calving cows in the late autumn/early winter period is described in Experiment 2.

Reproductive performance

The data in Table 6 show the reproductive performance of all Spring and Autumn - calving cows. The effect of calving season on reproductive performance is also shown.

Table 6. The effect of calving season on reproductive performance combined for the two years of the experiment.

	Calving Period			
	Autumn	**Spring**	**SEM**	**Sig.**
Calving to Service Interval (days)	**83**	**77**	**2.51**	**NS**
Services per Conception	**1.68**	**1.87**	**0.10**	**NS**
Calving to conception interval (days)	**102**	**96**	**4.05**	**NS**
Cows served in the first 3 weeks (%)	**59**	**87**		***
Pregnancy Rate to the first Service (%)	**45**	**51**		**NS**
Pregnancy Rate in the second Service (%)	**42**	**35**		**NS**
Infertile Rate (%)	**23**	**10**		*

SEM = standard error of mean; NS, not significant (P<0.05); *P<0.05; ***P<0.001;

Differences in the calving to service interval and calving to conception interval between autumn and spring-calving cows were not significant but both followed the same trend, i.e., it were longest for autumn-calving cows. The number of animals submitted for service in the first three weeks of the breeding season was significantly lower ($p<0.001$) for the autumn-calving cows (59%) than for the spring-calving cows (87%). Differences in pregnancy rate to first and second service were not significant. The infertile rate was significantly higher ($p<0.05$) with autumn-calving cows (23%) than with spring-calving cows (10%).

Experiment 2. A comparison of grazed grass versus grass silage as a forage source for autumn-calving cows in early lactation

Materials and Methods

The experiment was carried out between September 29 and November 17, 1997. The experimental treatments were as follows:
Treatment A: 20kg grass DM/cow/day and 6kg concentrate.
Treatment B: Ad-libitum grass silage + 6kg concentrate.
There were 12 cows per treatment including 6 first lactation animals. The RBI 95 of the cows was 118. The cows were on experiment for an average of 43 days. Carry-over effects were measured for a subsequent 5 week period on a standard diet of silage plus concentrates.

Results

The effects of treatment on milk yield and composition and liveweight changes are shown in Table 7. Treatment differences in milk yield in the experimental period were not statistically significant. The milk yield tended to fall for Treatments A and B in the carry over period (Weeks 8 to 12) but the difference was not significant. There was significant difference in fat and lactose yield or fat and lactose concentration. Milk protein yield was significantly higher ($p<0.01$) for Treatment A in Weeks 1 to 7, but there was not a difference in milk protein yield in the carry-over period (Weeks 8 to 12). The milk protein concentration was also significantly higher ($p<0.01$) for Treatment A in Weeks 1 to 7 and Weeks 8 to 12. Cows in Treatment B had a significantly higher ($p<0.05$) bodyweight loss in Weeks 1 to 7. The cows on Treatment A had significantly higher ($p<0.001$) dry matter intakes (17.3 kg DM) than the cows on Treatment B (11.3 kg DM).

Table 7. The effect of treatment on milk yield and composition

	Week No.	Treat. A	Treat. B	SE	Sig.
Milk yield (kg/cow/day)	1 to 7	23.27	22.48	1.018	NS
	8 to 12	21.48	22.34	1.090	NS
Fat yield (kg/cow/day)	1 to 7	0.99	0.96	0.057	NS
	8 to 12	0.84	0.87	0.050	NS
Protein yield (kg/cow/day)	1 to 7	0.83	0.68	0.042	**
	8 to 12	0.77	0.70	0.040	NS
Lactose yield (kg/cow/day)	1 to 7	0.94	0.85	0.071	
	8 to 12	1.02	1.04	0.06	NS
Milk Fat Content (g/kg)	1 to 7	42.95	42.85	1.768	NS
	8 to 12	39.25	39.08	2.362	NS
Milk Protein Content (g/kg)	1 to 7	35.48	30.41	1.330	**
	8 to 12	35.82	31.58	1.189	**
Milk Lactose Content (g/kg)	1 to7	47.24	44.15	1.966	NS
	8 to 12	47.55	46.35	0.806	NS
Average bodyweight change (kg/cow /day)	1 to 7	-0.39	-0.75	0.184	*

Conclusions

• Treatment A (100% autumn-calving) produced 400 kg more milk than the cows on Treatment S (100% spring-calving).

• The cows on Treatment S had the highest peak milk yield but the yields were less persistent in late lactation than those on Treatment A. The cows on Treatment A had a 'secondary peak' in mid-lactation; this coincided with the cows being turned out to pasture.

• Reproductive performance was poorer in the autumn-calving cows. The autumn-calving cows had a higher infertile rate as well as a lower submission rate in the first three weeks of the breeding season. It was more difficult to detect oestrus in autumn-calving cows.

• Herd management was more difficult with Treatment AS than with Treatments A or S since there were cows at different stages of lactation and this makes management more difficult. In System A or System S the

workload is concentrated around a few main periods. Management decisions within Systems A and S are made on a herd basis; this simplifies the milk production system. Split calving patterns leads to four groups of replacement heifers; this makes management more difficult.

• Autumn-calving cows should be allowed access to grazed grass as early as possible in the spring. Turnout to pasture results in a 'secondary peak' in milk yield, a rise in protein yield and lower milk production costs. The optimum allowance for autumn in the spring time is 20 kg DM/cow/day resulting in high levels of milk production and optimum utilisation of pasture. Higher allowances may be necessary with cows of higher genetic merit.

• Autumn-calving cows are non-lactating in the mid summer period and therefore have a low herd demand for feed. It is important to monitor farm grass cover during this period to avoid surpluses. Surplus grass should be conserved as high dry matter, high digestibility silage.

• Graze the dry cows behind the milking cows; in this way the milking cows are offered herbage of higher energy content. The dry cows should graze to a pre-determined height in order to improve pasture quality and to insure that dry cows are in optimum body condition at calving.

• The optimum calving pattern for winter milk production will vary depending on the winter milk scheme available. Cows calving in September and October may be calved outdoors in favourable weather conditions thereby reducing the workload and minimising the risk of disease. September and October calving also allows for the inclusion of some grazed grass post-calving. Improved milk protein yield and concentration were obtained from autumn-calving cows on grazed grass in early lactation. The cows on grass silage lost more bodyweight than the cows on grazed grass. Autumn-calving systems of milk production should aim to maximise grazed grass in the cows diet in order to improve animal performance, and animal intakes, and to reduce the requirement for silage. This strategy reduces the cost of milk production in the late autumn/early winter period.

• Autumn-calving cow's diet post - calving consists of grass, concentrates and silage until they are indoors full time. The optimum level of supplementation in the autumn period depends on the quantity and quality of grass available.

• The utilisation of grass in the autumn period is one of the most important factors influencing animal performance. The pre-grazing yield for autumn-calving cows in early lactation should not exceed 2,000 kg DM/ha..

• Autumn-calving cows should remain outdoors full-time until ground conditions or grass supply necessitate them being housed.

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