The role of clover in organic milk production

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Introduction

Grazed pasture makes up between 60 and 75% of the diet of dairy cows on conventional farms in Ireland. This reliance on grazed pasture results in lower milk production costs compared with other countries in Europe. On organic dairy farms, the very high cost of concentrates, relatively high cost of making silage and relatively low stocking densities create a strong incentive to maximise the proportion of grazed pasture in the diet of cows. White clover is a key component of organic pastures because swards that contain white clover have twice the productivity of swards that don't (Figure 1). The reason for this is that clover forms a symbiotic relationship with N-fixing *Rhizobium* bacteria that can supply up to 150 kg N per ha per year under Irish conditions.

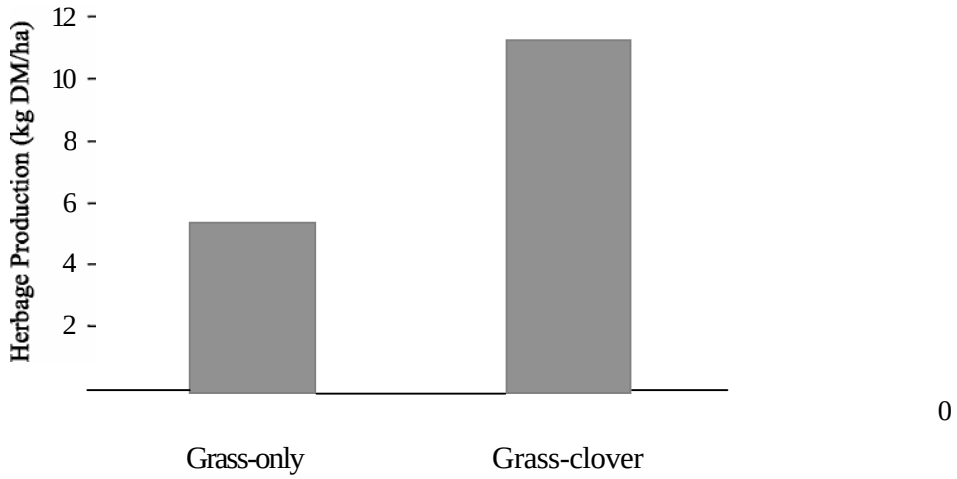

Figure 1. Herbage dry matter (DM) production of grass-only and grass-clover swards receiving no inputs of synthetic fertilizer N

An important difference between grass-clover swards on conventional and organic farms is that, on conventional farms, fertilizer N can be used to increase pasture production in spring. On organic farms, the growing season is curtailed in spring unless slurry or farmyard manure (FYM) is used to increase spring growth, although the availability of FYM is unlikely be sufficient to entirely meet this requirement on

organic farms. Slower pasture production in spring raises the question of calving date. Should calving date be delayed in spring to better match pasture supply? Another important question influencing calving date is milk price. There is a price premium for organic milk when 55% of annual production is supplied between 1 September and 1 March. Hence, milk production during the winter is important and this has an important bearing on calving dates on organic dairy farms.

Pasture supply during the year

The pattern of pasture supply from grass-white clover swards receiving no inputs of fertilizer N is shown in Figure 2. Growth rates are quite low until late March and this is associated with a low clover content of swards. In general clover likes warm temperatures and does not begin to grow and fix N until soil temperatures reach around 9°C in April. However, the grass component of the sward will start growing from early March onwards and where early spring growth is required FYM should be applied during February to meet this requirement. The clover makes a small direct contribution to pasture production in spring accounting for 5% or 15% of sward DM during February and March. Clover makes and increasing contribution to pasture production during April and May. There is usually a peak in grass production during late May followed by a sharp reduction due to the death of reproductive grass tillers during this time of year. During this mid-summer depression of grass growth clover becomes prominent in the sward because (i) high soil temperatures during this time of the year favours clover growth and (ii) the dip in grass growth rates means that it is less competitive with the clover. From mid-summer onwards, approximately 50% of the sward is composed of clover and it is during this time of the year that most N fixation takes place. Some of this fixed N becomes directly available for pasture production and the remainder is tied up in the clover stolons at the base of the sward. During the summer and early autumn there can be a four-fold increase in the amount of clover stolon per ha. During the winter much of this clover stolon dies back releasing the N for pasture production when soil temperatures rise during the following spring and early summer. Hence, some N fixed in one year is carried over the winter and released for growth during the early part of the following year.

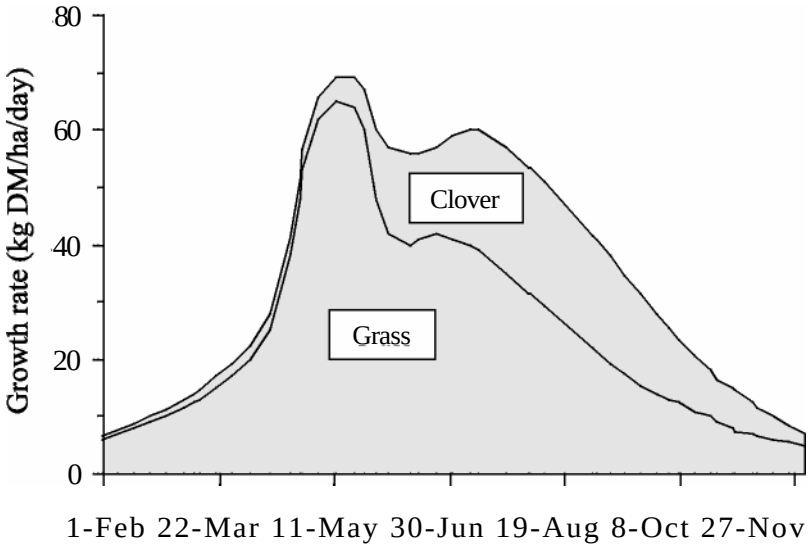

Figure 2. Changes in the grass and white clover content of swards during the year

While the rate of pasture accumulation of grass-clover swards is relatively low in spring, high soil temperatures and a high clover content of the sward means that rates of pasture production from grass-clover swards can be very high during the summer and autumn, matching the production of perennial ryegrass swards receiving high inputs of fertilizer N. These grass-clover swards also have high nutritive value because white clover has the highest nutritive value of any grassland species, having a high crude protein content and high digestibility. Furthermore, research has shown that a grass-clover sward being grazed on a 42-day rotation had similar nutritive value to a grass-only sward on a 28-day rotation during the autumn. The clover content of the sward is at its highest during the autumn and this contributes to maintaining sward nutritive value under long rotations. Progressively increasing rotation lengths in a planned way during the late summer and autumn facilitates extending the grazing season into the winter. Hence, while growth of organic grass-clover swards during the spring is relatively low, there is substantial potential to extend the grazing season into the winter by extending out rotation lengths from the late summer onwards. This combined with intermediate stocking densities (1.6 LU per ha) on organic dairy farms means that long grazing seasons can be achieved on grass-clover swards despite relatively low growth rates on spring.

Experimental systems at Solohead

At Solohead we are examining the potential of grass-clover swards receiving no inputs of fertilizer N (NFN) to meet the feed requirements of dairy cows during the year. A description of these systems is shown in Table 1.

Table 1. Comparison of the levels of production on the average dairy farm from the National Farm Survey and clover-based systems at Solohead (i) early spring calving receiving no inputs of fertilizer N (ii) late spring calving receiving no inputs of fertilizer N and (iii) Standard clover system receiving 90 kg per ha of fertilizer N in spring

	Average Dairy Farm	Early-calving Solohead NFN	Late calving Solohead NFN	Standard Solohead system
Stocking density (cows per ha)	1.9	1.6	1.6	2.15
Fertilizer N (kg per ha)	170	0	0	90
Mean calving date	mid-March	15 February	15 April	15 February
Milk yield (litres per cow)	4,700	6,400	6,400	6,400
Milk Fat (%)	3.75	4.15	4.15	4.15
Milkprotein(%)	3.30	3.55	3.55	3.55
Milk solids (kg per cow)	342	493	493	493
Milk solids (kg per ha)	650	788	788	1,060
Concentrate (kg per cow)	715	400	750	400

The stocking density on two systems being examined is 1.6 LU per ha. The mean calving date of the early-NFN system is 15 February and cows were turned out to grass from late January onwards as they calved. On this system pasture supply was

tight until the end of April. Concentrate supplementation during the spring was 250 kg per cow. Compared with the standard Solohead grass-clover system receiving fertilizer N in spring, first-cut silage production was greatly curtailed on the early-NFN system because the entire area was needed for grazing until late April, even at the lower stocking density, and no silage ground was closed off until late April. The late-NFN system had a mean calving date of 15 April. Cows started calving in March and went straight to pasture and received no concentrate supplementation during the spring and summer. The plan was to keep grass in the diet of these cows through to drying off in late February. This was facilitated by housing replacement heifers and calves in late September and making the entire area of the system available for grazing by the cows during the late-autumn and winter, hence, the stocking density of dairy cows during the winter was 1.2 cows per ha.

By extending the rotation length from mid-July onwards 1,200 kg DM per ha was accumulated on the late-NFN system on 1 November. Experience at Solohead has shown that grass-clover swards receiving no fertilizer N during the summer, autumn and winter grow at an average daily rate of 10 kg DM per ha during the winter. From 1 November to drying off on 28 February is 120 days. Hence growth during the late autumn and winter supplies a further 1,200 kg DM per ha. Accumulated pasture and winter growth gives total pasture availability of 2,400 kg DM per ha or 2,000 kg DM per cow (at a winter stocking density of 1.2 cows per ha). This equates to a pasture allowance of 16.7 kg DM per cow per day. Along with this daily allowance of pasture, the cows receive 4 kg concentrate per day from mid-September through to drying off in late February. Assuming the cows consume 14 kg pasture DM per day and a daily allowance of 4 kg concentrate gives total intake of 18 kg DM per cow per day, which is sufficient to meet the requirements of the cows. Silage is only fed when grazing conditions are very difficult and during these days, concentrate supplementation is increased to 5 kg DM per cow. Total concentrate input to this system is 750 kg per cow compared with 400 kg per cow on the system with a mean calving date of 15 February. The cost of this additional concentrate is compensated by the higher milk price on the later calving herd that produces 55% of the milk between 1 September and 1 March each year. The cows in the late-NFN system are dried off during February and housed until the commencement of calving in late-March.

It can also be seen in Table 1 that the levels of milk production per ha, in terms of milk solids per ha, is higher on the clover-based swards receiving no fertilizer N. This demonstrates that clover- based swards place no limitation on milk output per cow from cows with potential for high milk output and also can also support moderately high output per ha.

Maintaining the clover content and productivity of swards

Maintaining the clover content of swards is a key component of maintaining productivity from year to year. Experience at Solohead has shown that there are two key components in achieving this objective:

(i) Tight grazing during the year and particularly during the autumn and winter;

(ii) Regular renovation of the clover plants in the sward

Tight grazing during the year

Clover does not compete as aggressively and can be shaded out by the grass component of the sward. Clover is most vulnerable to shading during the winter and early spring because, as pointed out above, it needs higher soil temperatures for growth than grass. At Solohead, cows graze down to a post-grazing height (PGH) of 4 cm from turnout in spring. It is important that cows start grazing to 4 cm and that this is maintained to ensure that the cows are presented with a leafy highly nutritive sward throughout the grazing season. Lax grazing in spring followed by tighter grazing later in the growing season will depress milk yield and constituents. Tight grazing during the late autumn and winter allows light down to the clover stolons at the base of the sward. The amount of light penetrating to the base of the sward directly influences the survival of stolon over the winter and the more stolon that survives the winter the higher will be the clover content of the sward during the following growing season. In the late-NFN system described above, tight grazing throughout the winter should promote very high clover contents in the following year. This is an issue that we are investigating in the experiment described above.

Regular renovation of the clover plants in the sward

White clover has a reputation for inconsistent production from year to year. Part of the reason for this is differences in weather conditions from year to year. Fixation of

N is a biological process dependent on conditions such as soil temperature and moisture availability. Cold soil conditions and too little or an excess of water can impede N fixation and these are factors that vary from year to year. Nevertheless, the main reason for inconsistent production is the interaction between grass and clover. In newly established re-seeded swards receiving no fertilizer N the clover usually has an advantage because it can fix its own independent supply of N. However, over time the N content of the soil builds up as clover stolon increases and dies back from year to year. Greater availability of N in the soil favours the grass, which increasingly shades out the clover. The clover goes into decline and the rate of N fixation drops off. This is often seen happening after a period of four or five years. In the next year the productivity of the sward can be relatively high although the clover content of the sward is quite low because grass growth is fuelled by the residual N in the soil. However, in the following year pasture production can be very low because the residual N has been used up and there is little clover remaining in the sward. Freed from competition from the grass due to declining grass growth the clover content of the sward will again increase during the following year or two and remain productive for another couple of years before competition from the grass again drives the clover into decline and the cycle is repeated. Often it is adverse weather conditions in a particular year that can trigger the decline in the clover content of the sward across the farm and this has consequences for maintaining pasture supply. Hoof damage by grazing cows is another factor that can lead to the sudden loss of clover from a sward. Hooves penetrating down thought the soil surface can bury and break up stolons and this is detrimental to clover survival. This inconsistency of pasture production can make it very difficult to operate an efficient dairy production system maintaining consistent milk output from year to year.

At Solohead we have been investigating methods of maintaining consistent supply of clover from year to year. Tight grazing is important as pointed out above. Over-sowing 20% of the farm each year is also an important component. On organic farms clover seed can be over-sown using a slug pellet applicator, or mixed with lime or granulated rock-phosphate. 20% of the farm is over-sown each year on a five-year rotation to ensure that there are swards of different ages distributed across the farm. Each sward is in a different stage of development which acts as a hedge against swards with declining clover contents. Swards with low clover contents due to

competition from grass or due to hoof damage are identified and then over-sown in the following year. Hence, these swards are brought quickly back into production. When managing clover swards it is necessary to accept that not all parts of the farm will be fully productive all the time; some will have declining clover contents whereas others will be recently over-sown and these swards generally take around a year to become fully productive again. On the other hand, using a planned approach to maintaining the clover content of swards avoids the boom and bust cycles usually associated with clover swards.

Although 20% of the farm is over-sown each year it is not always the same paddocks that are over-sown every five years. This is because the clover content of some swards can go into decline after three years whereas it can be as long as seven years in other paddocks, with an average of five years across all paddocks. Therefore, the clover content of swards are examined and recorded each year and paddocks with declining clover contents are identified for over-sowing in the following year.

Summary and Conclusions

Relatively high levels of milk output are possible from organic clover-based grassland compared with average production on conventional dairy farms in Ireland. Although clover-based swards receiving no fertilizer have relatively low growth in spring, a long grazing season can be achieved by extending the grazing season during the autumn and winter. High growth rates during the summer and autumn and relatively low stocking densities on organic dairy farms facilitate this. Maintaining the clover content of swards is important to maintain productivity. Tight grazing to 4 cm throughout the year and particularly during the late autumn and winter is important. Identifying swards with declining clover contents due to competition from the grass component of the sward or due to hoof damage is also important. These swards need to be over- sown the following year with the target of over-sowing or re-seeding no less than 20% of the farm each year.