SOLID | Sustainable Organic and Low Input Dairying

Use of diverse swards and 'mob grazing' for forage production

Introduction

Feeding and nutrition of the dairy cow represents the highest cost in producing a litre of milk and therefore is one of the most important factors in efficient dairy production. Nutrition is a key factor in the overall performance, health and welfare of dairy cattle. In these respects, farmers, particularly within the organic and low-input sectors, must increasingly concern themselves with optimising feed efficiency and nutrition. Given the high reliance of organic and low-input dairy cattle on forage resources and the various environments in which they are maintained, producers may inevitably have to adjust methods for forage production and adopt grazing strategies for better pasture utilisation while broadening the inclusion of alternative feed resources and diverse swards into their system (Zollitsch *et al.*, 2004).

There are an increasing number of farmers seeking ways to reduce their costs of production by using less fertiliser and by reducing the amount of purchased feed. In order to achieve this, some farmers, particularly from the organic or low-input sectors, choose to grow diverse swards with high proportions of different legumes, grasses and herbs. Whilst there are many benefits from mixing multiple species in leys, some farmers are not familiar with this practice and have reservations about their use compared to the typical grass leys or grass/white clover mixtures. In addition, innovative grazing strategies can also influence soil organic matter and performance of dairy cows in terms of energy utilisation and milk production. This technical note pinpoints some of the potential benefits of utilising diverse swards for low-input and organic dairy systems and reviews the claimed benefits of a grazing system called 'mob grazing' on soil organic matter and dairy cow productivity.

Benefits of diverse swards

Documented information about the benefits of diverse swards comes from a recently completed project in the UK (LEGLINK; Döring et al., 2012). It was evidenced that species-rich legume-based leys can maximise pasture productivity and other ecosystem services while functionally diverse plant species can be optimised and fine-tuned to farm-specific needs. Diverse swards have increased above-ground biomass and provide greater stability of biomass production compared to monocultures while productivity increases over time. In addition, they have greater resilience to adverse weather, climate and management conditions.

Legumes and herbs, compared with grasses, can provide considerably higher amounts of minerals and protein per kg DM of grazed forage, which is particularly important for the pasture-fed cow on organic or low-input dairy farms (Lindstrom et al. 2013). Micronutrient status of the soil, and variety within plant species, has some effect on the mineral content of legumes and herbs, but the pH of the soil can have an even greater effect on the mineral concentration in the herbage, particularly of manganese and molybdenum. The potential to provide adequate levels of minerals through selection of forage species is considerable. In addition to clover there is scope to include herbs, and there are indications that they will make a significant contribution to total cow needs; however some farms experience difficulties in establishment and maintenance of herbs in a diverse ley, in which case herb strips may be a solution. There is recent interest in the use of browsing shrubs and trees to supply trace minerals but there is a lack of information about species selection and mineral contribution (for more information about minerals on dairy cow nutrition refer to Technical Note no 4 of the handbook).

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Benefits of mixing species

- Diverse mixtures have greater above-ground biomass production and crop cover than simple mixtures
- Productivity increases over time
- Greater stability of biomass production
- Improved soil organic matter
- Mixing species with different properties allows better weed control
- Greater resilience to variable weather, climate and management conditions
- Improved drought tolerance and soil structure due to deeper rooting
- Better N utilisation by subsequent crops; lower costs for N fertilisation
- Diverse mixtures support more pollinators throughout the season
- Diverse mixtures provide a larger food range for other invertebrates ('bird food')
- Mixtures with higher diversity do not compromise wild plant diversity
- Slower decomposing species decrease the risk of nitrogen losses to the environment (leaching, gaseous losses) following incorporation

Commercial performance of diverse swards

In a case-study farm as part of the SOLID project, herbage yield, composition and nutritional value of diverse swards were assessed on a monthly basis from May to September 2014 and compared to those of grass-clover. The diverse sward mixture included 10 different grass species, 6 legumes and 5 herbs. Analysis showed that ME content of the diverse sward averaged about11 MJ (normal values for this type of forage are 11 to 13 MJ of ME per kg DM) CP content was high (21%) and NDF within the expected levels (about 350 g/kg).

From April to September diverse swards produced 10.5 tonnes of herbage per hectare. Of the total production clover accounted for about 46% and grass accounted for 34%; the productivity of other legumes and 'broad leaves' represented 14% of the total production and senescent material was about 6%. Preliminary data collected in 2013 indicated a similar productivity of the diverse sward.

Herbage production of the simple grass-clover ley over the same period (i.e. May to September 2014) was better than those of diverse swards and averaged 12.3 tonnes per hectare. As expected, composition was dominated by grass and clover which accounted for about 44% and 46% respectively, while the productivity of other legumes and 'broad leaves' represented just 4% of the total production (Figure 1). The grass-clover ley had an average of 17.2% DM, 10 MJ of ME and 21.5% of CP indicating a good quality forage.

This study showed that although pasture productivity of the diverse sward was lower than that in the grass-clover ley, the total productivity remained relatively high (above 10 tonnes per ha) suggesting that diverse pastures can serve as a viable alternative to conventional pastures.

Designing a diverse mixture

Mixes with high agronomic productivity should contain at least two **common legumes** (e.g. lucerne and white clover), but performance improves by including a third or fourth legume species. In the UK, multifunctional mixtures that contain lucerne, red clover and black medic (*Medicago lupulina*) were found to have the best performance and resilience, particularly as fertility building crops.

White clover (*Trifolium repens*) consistently performs well in terms of yield and persistence and its creeping habit makes it the legume best adapted to grazing.

Red clover (*Trifolium pratense*) is generally more productive than white clover, but less persistent and less tolerant to high grazing pressure. White clover and red clover have better N utilisation by subsequent crops than black medic or lucerne.

Lucerne (*Medicago sativa*) is a high yielding species that produces high quality feed, dried or ensiled. Although not commonly grazed there are some varieties more tolerant of being grazed provided this is in a rotational grazing situation.

Sainfoin (*Onobrychis viciifolia*) shows marked differences in performance depending on region and soil. It is attractive as a non-bloating, high quality legume on alkaline soils but is less persistent under hard grazing.

Some other legume species such as meadow pea (*Lathyrus pratensis*), winter vetch (*Vicia villosa*) and large birdsfoot trefoil (*Lotus corniculatus*) often show low performance in northern European climates BUT can perform better under other climatic conditions.

Grasses: Depending on the use of the ley and soil type there are a number of grass species that can be combined to complement legumes: perennial and Italian ryegrass (*Lolium perenne* or *multiflorum*) for its high yield and palatability, timothy (*Festuca arundinacea*) for yield, palatability and suitability to wetter conditions, cocksfoot (*Dactylis glomerata*) for yield, rooting and drought resistance, but is less palatable, and meadow fescue (*Phleum pratense*) for palatability and yield but is less competitive. Recently developed festulolium provides a combination of high quality forage with good winter hardiness, persistence and stress tolerance.

Herb species can also be included, such as burnet (*Sanguisorba minor*), chicory (*Cichorium intybus*), ribgrass (*Plantago lanceolata*) and sheeps parsley (*Petroselenium crispum*).

Sainfoin in diverse sward

Grazing strategies for increasing soil organic matter

Farmers are interested in increasing soil organic matter (SOM) because it is well known that it serves as a reservoir of nutrients for crops, provides soil aggregation, increases nutrient exchange, retains moisture, reduces compaction, reduces surface crusting, and increases water infiltration into soil. The potential for carbon sequestration is of increasing interest. The build-up of SOM can be influenced by the way in which the sward is managed (e.g. increasing the return of vegetation to the soil), and also by the plant species in the sward.

A grazing system relatively new to Europe called 'mob grazing' is attracting attention, especially in regards to increasing SOM. Mob grazing is a livestock management grazing strategy that is characterised by high stocking densities of livestock on relatively tall forage. Livestock are moved frequently, i.e. at least one or twice per day, with the aid of electric fences and trample forage into the ground as they graze. The pasture land is then left, ungrazed, until it has fully recovered, giving all plant species present the chance to re-establish in the sward. In this respect, mob grazing tries to simulate the grazing behaviour of the vast herds of wild herbivores found on the American plains, or in the African savannah.

Claimed benefits of 'mob grazing'

It is considered that leaving higher residuals in the paddock can be a strategy for building up SOM, through the contribution of 'liquid carbon' through plant roots (Savory & Butterfield, 1999). Plants with more above ground canopy are able to grow larger root systems than those that are grazed more severely and the long recovery time between grazing allows plants to establish a healthy root system. The roots grow deeper into the soil, bringing up nutrients and making the plant more drought-hardy. The long recovery time also leads to high volumes of above-ground forage, a mixture of leaf, seed and stem. In addition, it is claimed that the high stocking density results in more than 50% of the plant being trampled into the ground by the animals. Uneaten plant stems are trodden onto the soil surface and these stalks act both as mulch and as a food source for soil microorganisms, building new soil in the process (Chapman 2011; Richmond 2011).

It is also claimed that by turning animals out into a fully mature pasture, animal performance is improved as they can select the most nutritious parts of the plants and benefit from grazing the lush tops of the plants, seed-heads and upper leaves that are high in energy and protein.

Mob grazing: it should be noted that there is an inconsistency in the terminology found in the literature. The different perspectives on this grazing system create some confusion and in many cases make it difficult to compare and discuss its claimed benefits. In the case study presented in this leaflet we regarded 'mob grazing' as a short duration, high-density grazing (i.e. 100 t of LW per ha) followed by a recovery period of more than 50 days.

A case study of mob grazing for dairy farm productivity

The claimed benefits of mob grazing for SOM and animal performance have not been studied scientifically in robust experiments/studies and this gap in scientific knowledge is reflected in the literature. In the UK, there is a growing interest in this grazing method also among organic and low-input farmers, but there is some uncertainty about the levels of production that may be achieved, especially on dairy farms.

On the case-study farm, herbage yield and composition of diverse swards were assessed on a monthly basis in the same field which was representative of the type and the age of the swards across the farm. On average 181 milking cows grazed a diverse sward field of total area 12.5 ha for a total of 43 days in monthly rotation intervals. The resting period of the diverse sward between consecutive grazings averaged about 21 days, with 16 and 25 days the shortest and the longest, respectively. These resting periods do not fully coincide with the stated principles of 'mob grazing', where resting periods are of long duration (i.e. more than 50 days) but the stocking density was relatively high (i.e. 115 tonnes of LW per ha). The farmer stated that over the last 7 years he has applied a 40 to 50 days rotation management allowing the pastures to recover for longer.

Over the period the average daily grazed intake per cow was estimated to be 17 ± 1.9 kg DM (based on herbage cuts taken before and after grazing) but it fluctuated from as little

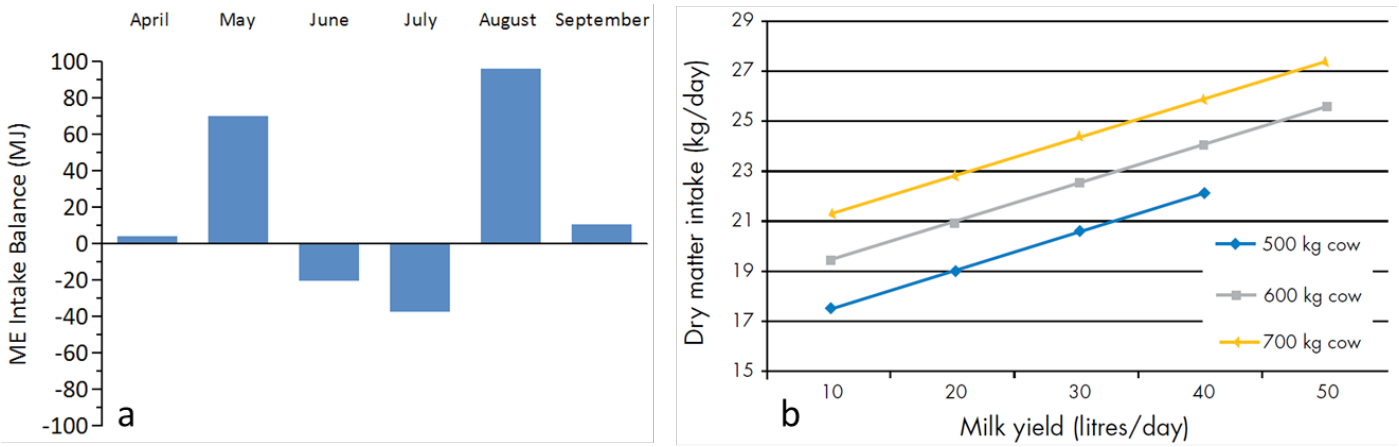

Figure 1. Monthly estimated ME intake balance of the cows from April to September 2014 (Panel a); relationship between dry matter intake and daily milk yield (Panel b; Source: AHDB Dairy 2012)

as 10.9 kg DM in July up to 23.8 kg DM in August. The average daily concentrate supplementation per cow was 2.9 ± 0.29 kg DM, ranging from 4.3 kg DM in April to 2.2 kg DM in September.

Nutritional shortfalls in ME intake during the grazing periods in June and July (Figure 1) may occur because of the relatively low forage DM intake, which is attributed to the low forage availability. Nevertheless milk yield may not be compromised if subsequent grazing in the next field in the rotation allows for better DM intakes. In the case-study farm, over the monitoring period the daily total DM intake per cow averaged 19.6 kg DM while the daily milk yield averaged 22.3 kg. These intake and productivity data are consistent with each other and are in accordance with the predictions postulated by the literature and illustrated in Figure 1.

This case-study illustrated that soil improvement through rotational high stocking grazing of biodiverse pastures can have a positive impact on SOM. The farmer reported SOM increases on fields managed with this strategy: more than doubling in one field (from 4.4 to 9.8% between 2007 and 2015) and increases of more than 40% in two other fields (from 5.3% to 7.8 and from 5.7 to 8% respectively, between 2012 and 2015) (Zaralis 2015). However, further research on the benefits of diverse pasture and different grazing strategies on the performance and productivity of dairy farms is needed to confirm these findings.

Conclusions and recommendations

- Multi-species diverse pastures are sufficiently productive to serve as a viable alternative to conventional pastures (i.e. grass/clover pastures) as they can maintain animal productivity at high levels.
- A period of less than 30 days between two consecutive grazings is rather short over the summer months to allow for an adequate recovery of the pasture and can result in low intakes.
- Under the principles of 'mob grazing', grazing rotation should be long enough to allow for full recovery of the pasture while the residual ungrazed forage should be left relatively tall.
- The monitored farm operating high stocking density and 30 – 50 day rotational grazing of multi-species diverse pastures has experienced a significant build-up of soil organic matter.
- Further research on the benefits of diverse pasture and different grazing strategies on the performance and productivity of dairy farms is needed.

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