A multi-species mix: Chicory, perennial ryegrass, bird's-foot trefoil, red clover, ribwort plantain, white clover, caraway und salad burnet (from right to left).

BANKING ON BIODIVERSITY

The potential of meadow herbs in permanent grassland and leys

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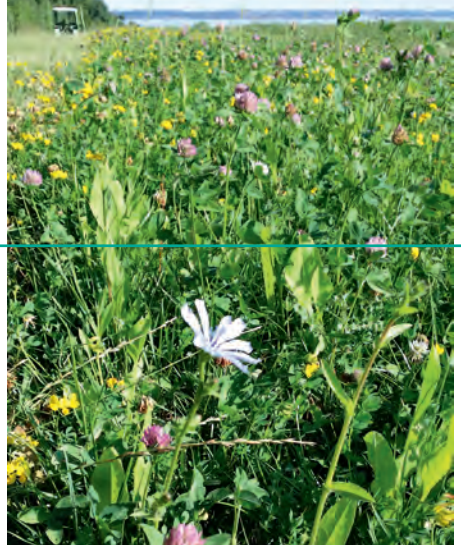
In 2018 large parts of northern Germany were gripped by drought. Normally highly productive grassland and leys stopped growing completely for months on end while deep-rooted meadow herbs such as ribwort plantain and legumes such as red clover, alfalfa and bird's-foot trefoil continued to grow seemingly unaffected. Agrometerologists are warning of the long-term negative consequences of climate change on forage production. Extreme weather conditions associated with prolonged periods without rainfall are set to become more likely in future, reducing the yield reliability of existing forage production systems. International experts advise growing a broader range of species and above all, including drought-tolerant grasses and deep-rooted legumes or even meadow herbs to reduce the risk of yield losses in the face of impending droughts.

At the Faculty of Grassland Science and Forage Research at the University of Kiel we have spent years developing adaptive strategies for forage cropping systems to mitigate the effects of climate change and trying to work out solutions to reduce potential greenhouse gas emissions arising from forage production.

We have paid particular attention to deep-rooted forage crops such as tall fescue, red clover and alfalfa since these species can access water from deeper soil horizons than shallow-rooted species such as ryegrasses and white clover. At the same time, their extensive root growth increases the soil's humus reserves, which counteracts harmful CO_2 emissions from agricultural soils. Studies from New Zealand and Australia point out the huge potential of deep-rooted herbs such as chicory and ribwort plantain to bridge the dry periods on dairy farms in these regions. In view of this high potential, both these species have been bred for yield performance and forage quality and are actively grown by antipodean farmers either as fertilised monocrops or as a component of nitrogen-fixing, self-fertilising clover-grass mixes.

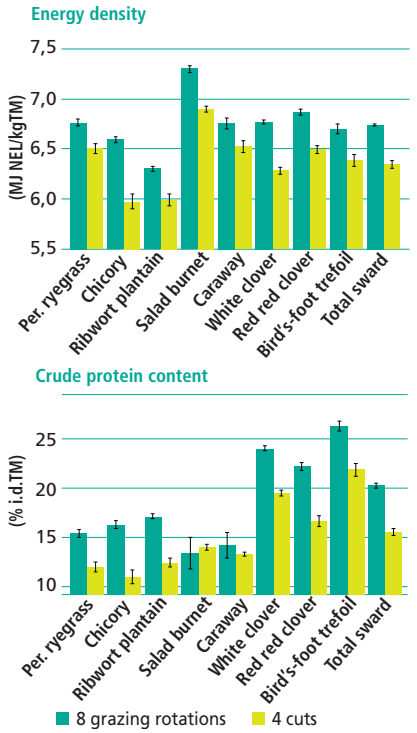
Ribwort plantain as a monocrop.

Extract from the German magazine „Innovation“



The Lindhof multi-species mix at the height of the drought in early August.

Fig. 1: Net energy and crude protein contents of different forage crops on the grazing and 4-cut regime*



*Mean regrowth and average for trial years 2015–2017 at the Lindhof Research Farm in Schleswig-Holstein.

Our interest was sparked several years ago by these improved varieties that offer a high drought tolerance and better yield and forage characteristics than ecotypes. As a result, we conducted numerous field trial series to investigate the potential of these and other meadow herbs and deep-rooted clover species by including them in grassland and ley systems.

Our interest in these alternative plant species was also fuelled by the biodiversity debate in which modern agriculture is accused of species poverty. The inclusion of flowering meadow herbs and clover in seed mixes provides an opportunity to increase biodiversity in forage production. Little was previously known about the yield potential of these species under local growing conditions. Selected results and findings from these studies are presented below.

What are the benefits of meadow herbs?

Let's take forage quality first: Ruminants find herbs such as ribwort plantain, caraway, salad burnet, and chicory and legumes like red clover and bird's-foot trefoil highly palatable, so feed intake increases. These plants are rich in natural vitamins and minerals. Many herbs also contain high levels of secondary constituents which have anti-inflammatory effects, among other things. The polyphenol oxidase contained in red clover and naturally high tannin content of bird's-foot trefoil leads to high levels of rumen-resistant protein.

Fig. 1 compares the net energy and crude protein contents of the promising alternative species from our trials in 8 grazing rotations and 4 cuts. Intensive grazing produces significantly higher energy and protein levels, irrespective of the species. Salad burnet and caraway are on a par with perennial ryegrass in terms of the NEL content regardless of the grassland management system, but the legumes match it only with the grazing regime. While intensive grazing produces only a slight decline in the energy content of chicory and ribwort plantain, more severe energy losses are observed in 4-cut regimes. The great advantage of legumes is their high crude protein content, which in the case of red clover and bird's-foot trefoil is also very rumen-resistant. Bearing this in mind, highly productive red clover should not be underestimated as a source of protein on farms producing forage for dairy cows.

Other tests conducted at the faculty showed that a single-crop sowing of red clover or red clover-grass significantly exceeds the protein production capacity of grain legumes.

Benefits of high nutrient levels

We also compared the calcium and phosphorus levels in selected meadow herbs and legumes compared with perennial ryegrass. The difference in available calcium levels was particularly noticeable. Calcium levels in all legumes and herbs were at least double those of perennial ryegrass. We found a similar trend for magnesium and potassium. Chicory, ribwort plantain, caraway and yarrow were found to contain high levels of phosphorus. Many organic farmers in Denmark have had positive experiences of using herbs in their clover-grass seed mixes, an approach which is stipulated by the dairies. They found that they could reduce mineral supplements whilst maintaining very high herd performance.

Lindhof clover-grass seed mixes

A typical Lindhof clover-grass mix which is entirely self-sufficient in nitrogen consists of 7 kg/ha each of diploid perennial ryegrass of medium maturity and high-sugar perennial ryegrass, 2 kg/ha of white clover, 4 kg/ha of red clover and 2 kg/ha each of bird's-foot trefoil, ribwort plantain and chicory.

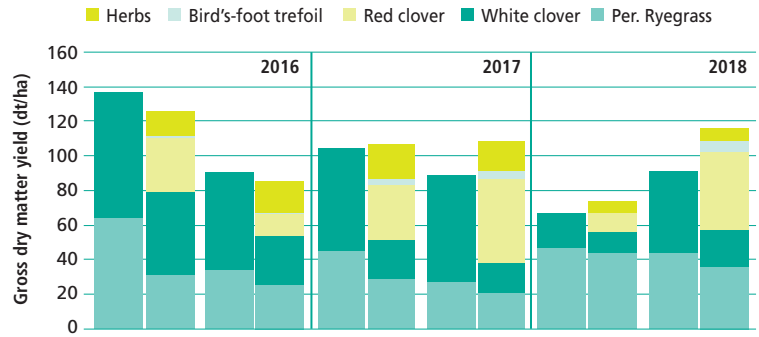
The 55 hectares of clover-grass sustain a 100-head herd of Jersey cows as well as 19 bee colonies whose honey is direct marketed – another example of how biodiversity pays off.

Good yields even in dry spells

8 grazing rotations and an 8-cut regime for fresh indoor feeding. At the start of the study we hypothesised whether herb-clover-grass can match white clover-grass as a botanically diverse alternative in very intensive management regimes. Averaged over the three study years so far, the answer is definitely ‘yes’. The studies showed that in 2017 (very wet autumn) and 2018 (severe summer drought) – two extreme years in forage production terms – the multi-species mix even outperformed the clover-grass mix. The herb-clover-grass mix does not appear to offer any benefits for grazing. However, considering the significantly smaller amount of herb-clover-grass that is left ungrazed and deducting this from the equation, we find that the herb-clover-grass yield is at least on a par with the white clover-grass which is traditionally used on intensively managed grassland in organic farming systems.

The fact that animals leave fewer areas ungrazed after meadow herbs were added to the mix underlines the high palatability of meadow herbs and provides an important basis for the high milk yields obtained from pasture-grazed dairy cows at the University’s Lindhof Research Farm.

Fig. 2: Comparison of gross dry matter yields of white-clover grass (WCG) and herb-clover-grass (HCG) in 8 grazing rotations and 8 cuts for fresh indoor feeding*



*Trial years 2016–2018 at the Lindhof Research Farm in Schleswig-Holstein
Gross dry matter yield (dt/ha)

Conclusion

Deep-rooted red clover, bird’s-foot trefoil, ribwort plantain and chicory increased both the net grazed yield and the cut yield in the dry extreme year 2018 and we believe they are of particular interest for organic farms. However, herbs such as chicory and ribwort plantain have major drawbacks in a classic 4-cut regime. These warmth-loving plants start to grow late in the season, and although they produce extreme amounts of growth in summer despite drought conditions, this is associated with rapid quality losses due to their tendency to flower. Furthermore, herbs are difficult to ensile and tend to disintegrate during wilting. Intensive strip grazing is the only way to exploit the yield potential of chicory and ribwort plantain without loss of quality. This is the dominant grassland management system in New Zealand and it is clear why single-crop sowings of both herb species that are heavily fertilised with nitrogen are key to ensuring a consistent supply of homegrown forage in the country’s arid regions. The pastures are routinely reseeded every three years or newly sown on other fields. If this becomes diseased or is damaged by poor management, the plant will die. As a result, with intensive management systems annual losses of 30% can be expected. So regular sward replacement or reseeding in permanent grassland is required with these species. Purely from a yield perspective, yield benefits obtained during dry periods alone do not justify the use of meadow herbs in high-yielding forage production, unless extreme droughts become the norm. The seeding and management effort is simply too high. However, we do recommend exploring the potential of alternative legumes and meadow herbs on trial plots initially by including them in seed mixes if other objectives come into play, for example increasing biodiversity, becoming self-sufficient in forage or switching to organic farming.

Jersey cow enjoying a mouthful of chicory from the Lindhof mix.

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