



Herbal-rich grassland as Nature-based Solution for climate resilient and circular food systems

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Introduction

This paper presents an assessment of the potential benefits and possible trade-offs of herbal-rich grasslands as Nature-based Solution, based on literature and expert knowledge. Herbal-rich grassland is a nature-based solutions since natural processes and diversity are used to cope and adapt to several challenges, like climate change and depletion of resources. We review to what extent herbal-rich grassland can contribute to climate resilient and circular food systems, compared with more mono-specie grasslands. In our study, we interpreted climate resilient as the capacity of herbal-rich grassland to cope with climate change induced shocks and stresses, like droughts and extreme precipitation. Circularity is seen in the face of total resource use and the efficient use of these resources.

Multiple definitions of Nature-based Solutions (NbS) exist. The definition from IUCN fits our frame nicely, because it explicitly addresses food related topics (Cohen-Shacham et al.,2016):

"Nature-based Solutions are actions to protect, sustainably manage, and restore natural and modified ecosystems in ways that address societal challenges effectively and adaptively, to provide both human well-being and biodiversity benefits. They are underpinned by benefits that flow from healthy ecosystems and target major challenges like climate change, disaster risk reduction, food and water security, health and are critical to economic development."

The IUCN definition clearly shows that NbS are actions that can help in facing challenges and provide multiple benefits for humans and ecosystems.

For our assessment, we compare the potential benefits of herbal-rich grasslands and performances regarding climate resilient and circularity as a NbS with the currently common English ryegrasslands in the Netherlands. The main focus is on grassland performance and production, and not on the production of milk.

Grassland in the Netherlands

Currently there is approximately 900.000 hectares of grassland in the Netherlands (CBS, 2022). Most of these grasslands do have very limited number of plant species in the sward. The productive English ryegrass (*Lolium perenne*) is abundantly present and it provides feed for milk producing cattle. This grass is productive and has good nutritional values for cows (Boerennatuur, 2022). Ryegrass serves one purpose only: feed production for cattle. However, these grasslands do not provide habitat for biodiversity (some call the English ryegrass fields 'green deserts' (Omroep Brabant, 2019), because biodiversity is low (Universiteit Utrecht 2019), can be vulnerable to climate extremes and provide a one-sided diet for cows (Landbouw met natuur, n.d.). Therefore, the interest for more specie-rich grasslands with herbs, that can provide multiple services, is growing.

Performance and management of productive herbal-rich grasslands

Specie-rich, or herbal-rich grassland can be split up in two major categories (pers. Communication Wagenaar 2022):

- Natural or extensive grassland. These are actually nature conservation fields, which are maintained by farmers. There are several restrictions in usage, like fertilization and harvest-dates, in order to oblige to nature-policies (Wagenaar et al. 2017). Farmers receive yearly subsidies for the maintenance and the harvest is approximately 3-7 ton dry matter per hectare per year (Boerennatuur, 2022). These biodiverse and herb rich grassland have approximately 15-25 plant species (herbs and grasses) per 25 m² (Boerennatuur, 2022).
- Productive herbal-rich grasslands. This type of grassland is focused on agricultural production and it includes around 3 grass-species and 5 herb-species (pers. Communication Wagenaar 2022). No subsidies are currently available and the production is around 10 ton dry matter per hectare per year (Boerennatuur, 2022).

In this paper, we will focus on productive herbal-rich grasslands, since this offers a suitable alternative for farmers that currently have intensive English ryegrasslands.

Productive herbal-rich grasslands aims to improve the functions and ecosystem services from grasslands. These grasslands have different characteristics and require a different management from farmers compared to English ryegrass fields. These differences are highlighted below:

- Diversity: In order to maintain the level of diversity, reseeding once every few years is necessary in productive herbal-rich grasslands. If this is not done, the grasses outcompete the herbs. Especially on fertile soils with sufficient water supply, grasses outcompete the herbs easily.
- Choice of herb species when seeding: several herb species can sustain in production grasslands, like white clover (*Trifolium repens*), red clover (*Trifolium pratense*), dandelion (*Taraxacum Officinale*), narrow-leaved plantain (*Plantago lanceolata*), cichory (*Cichorium intybus*) and caraway (*Carum carvi*) (Wagenaar et al., 2017). A more detailed description per herb, including its effects can be found in Wijland (2021, in Dutch).
 - See Groot (2022) for an overview of toxic plants for cattle in grassland.
- Timing of seeding and seed quantity: Herbs need a higher soil temperature to germinate compared to grassland. This requires a detailed planning when seeding herbal-rich grasslands. The seed quantity of herbs depends on the desired level of herbs. For more details, see Wagenaar et al. (2017).

Herbal-rich grassland thus requires another type of management, which is more complicated compared to English ryegrasslands. The current area of productive herbal-rich grassland is hard to estimate. Experts think that the current area is approximately several ten-thousands of hectares in the Netherlands (pers. communication Wagenaar

2022). There are several ongoing initiatives that aim to stimulate the application of herbal-rich grasslands, e.g. the initiative of Urgenda (n.d.).



Figure 1. Herbal-rich grassland in 2019 in the Netherlands. Picture: Jan-Paul Wagenaar.

Herbal-rich grassland and climate resilience and circularity

In this chapter, we compare the impact of climate change on productive herbal-rich grassland with that of English ryegrassland. In particular we compare the resilience of productive herbal-rich grassland to drought and extreme precipitation with that of ryegrassland. We also compare the contribution to circularity (input and nutrient efficiency) of both types of grassland.

Drought

A more diverse grassland is able to produce better during dry spells. This is proven during the drought in 2018 in the Netherlands, in which herbal-rich grasslands was able to maintain production (PPS Ruwvoer en Bodem, 2021). The same effect was found in field trials (pers. Communication Wagenaar 2022). Van Asseldonk et al (2021) found that regular grassland production in the Netherlands (mostly English ryegrass) dropped in 2018 to approximately 8 ton per hectare per year, compared to 10 ton average production per hectare per year. Farming for Nature (2020) used aerial photos in Ireland to show that during the 2018 dry spell, diverse grassland remained relatively green compared to non-diverse grassland (Farming for Nature, 2020). This can be explained by the deeper rooting system of the herbs, but also because of functional complementarity between species, which improve ecosystem functioning and makes the sward more resilient to drought (Lüscher et al., 2022). Furthermore, it creates a higher soil health and functioning due to an increase in soil microorganisms (Bellocchi and Picon-Cochard, 2021). Herbal-rich grasslands possibly also sequesters more carbon (Bellocchi and Picon-Cochard 2021), which increases the water holding capacity of the soil. The research program Slim Landgebruik, aiming at exploring suitable and effective measures for carbon sequestration in Dutch agricultural systems, reports

however that more research is needed to quantify the exact effect of herbal rich grassland on carbon sequestration (Verdonk et al., 2022). Currently, field trials are executed to research the exact effect of herbal-rich grassland on carbon sequestration (pers communication Wagenaar 2022).

Extreme precipitation

Due to an improved soil structure, as a result of the more diverse rooting systems of herbal-rich grasslands, infiltration during rainfall can be improved. This reduces the chance of waterlogging, preventing crop damages and leaching of nutrients and pesticides.

In years with more rainfall than average, with a nice distribution of precipitation over the year, the reference grassland (English ryegrass) produces relatively better than the herb rich grasslands (pers. Communication Wagenaar 2022).

Inputs and nutrient efficiency

In order to maintain the diversity of herbs and grasses in a sward, the fertilization quantities has to be lower compared with English ryegrasslands. If this is not done, the English ryegrass will quickly outcompete the herbs (pers. Communication JP Wagenaar 2022). Korrevaar and Geerts (2016) showed that high nutrient application levels (N) lead to lower species diversity in grasslands. The required lower amount of fertilizers lead to lower nutrient demands, especially for artificial fertilizer. Organic fertilizers are and can be still applied on herbal rich grassland (Boerennatuur 2022). So herbal-rich grassland decreases the required inputs and there for contributing to circularity. Furthermore, during dry periods, herbal rich grassland is assumed to be more efficient with the nutrients provided because the productivity is higher compared to English ryegrass, as presented in the paragraph about **Drought**, (pers. Communication Wagenaar 2022). This higher efficiency also contributes to circularity objectives.

Other effects

Biodiversity. Bellocchi and Picon-Cochard (2021) mentioned that herbal-rich grasslands can provide multiple ecosystem services, among other a habitat for pollinators and wildlife. That can help in improving natural pest control (Farming for nature 2020).

Feed quality and health of cows. Groot et al (2020) identified that there are several herbs that contribute to cow-health. Korrevaar and Geerts (2016) noted that herbs and legumes contains higher levels of minerals in the feed for cows and that the herbage provides more structure in the diets of the cattle.

Application and scaling

Although the potential benefits as presented above, herbal-rich grasslands does not offer a suitable solution for all grasslands in the Netherlands because of biophysical, financial and management barriers to scaling. These aspects are discussed below:

- On peatlands, the competition for herbs with grass species is severe, and the herbs are often outcompeted within a couple of years. This caused by high levels of nitrogen in the peat soils (Wijland, n.d.).

- If all fields of a farm would become herbal-rich grassland instead of English ryegrass, the production decreases and the farmer needs to buy more external feed for the cows. This increases the costs.
- There are currently no subsidies available for productive herbal-rich grassland. There are a couple of initiatives running from companies (for example: certification On the way to Planet Proof (n.d.) and KPI-K (Critical Performance Indicators to reach Circular and sustainable Agriculture) to provide a premium price for milk that comes from farms with herbal-rich grasslands. An increase in appreciation of consumers for herbal-rich grassland can help in scaling (Nature today, 2020).
- Management of herbal-rich grassland is more complicated and new for farmers compared to current practices. There is a need for specific knowledge and advice regarding the implementation and maintenance of herbal-rich.

Experts see a steady increase in the interest and cultivated area of herbal-rich grasslands because of the potential benefits and current challenges that the English ryegrasslands are facing (droughts, carbon sequestration, soil quality and circularity) (pers comm Wagenaar 2022).

Conclusion and outlook

This paper presented the possible impacts of climate change on productive herbal-rich grassland as Nature-based Solutions and compared it with the impacts on regular, English ryegrass in the Netherlands. Herbal-rich grassland provides benefits for the farmer and to nature, in terms of a more stable production during droughts and an increase in input and resource efficiency. Due to the positive effects regarding climate resilience and circularity, there is an increasing interest in herbal-rich grassland. This can be observed in the increasing cultivated area of herbal-rich grasslands, which can (partly) be explained by stimulation activities from several initiatives from the NGO's and private sector for further scaling. However, more research is required to identify the exact effects on grass productions under different climatic circumstances and management. Furthermore, the link has to be made between herbal-rich grassland and milk production. Finally, it is important that farmers can acquire the necessary knowledge about herbal-rich grassland management. Increasing knowledge dissemination and advice about herbal-rich grassland will be of great value.

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