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NBSOIL
Nature-Based Solutions for Soil Management

Practice abstracts – initial version

Deliverable 2.7

17.11.2023

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[1] **R**=Document, report; **DEM**=Demonstrator, pilot, prototype; **DEC**=website, patent fillings, videos, etc.; **OTHER**=other

[2] **PU**=Public, **CO**=Confidential, only for members of the consortium (including the Commission Services), **CI**=Classified

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1 Practice abstracts

NBSoil will compile a Handbook of soil health enhancing practices for the different ecosystems investigated in the project. The Handbook contains a series of practice abstracts that provide an overview of nature-base solutions to next generation soil advisers on currently available management approaches to soil health improvement.

- In particular the practice abstract aim to provide the following information:
- Short overview of soil-health related objectives of the practice.
- Main elements to consider for implementing the practice.
- Estimation of effectiveness in terms of the IUCN-NBS standard.
- Further information and NBS demo sites (if available) where the measures are put into practice.

The handbook will also serve as a written material for the online and other course formats implemented within NBSoil.

Subsequently, an initial version of abstracts within ecosystems investigated in NBS is presented as deliverable for M12 and as a basis for further construction of a comprehensive handbook of nature-based soil solutions. Besides completing the target number of 100 abstracts for all ecosystems of NBSoil, subsequent versions of the handbook building on the initial version presented here will update and extend (i) the contacts to NBS demo sites, (ii) the link to the respective courses, (iii) the sources of information, and (iv) the assessment according to IUCN standards by assessment of a larger number of experts.

1.1 Agriculture

1.1.1 Regenerative farming

Regenerative farming is an approach that mainly aims to restore and improve soil fertility as a key lever for sustainable agricultural production. In particular, regenerative farming systems focus on combining a set of measures oriented to strengthen the soil (micro)biology. The key principles of regenerative farming are:

1) Minimize soil disturbance to enhance the activity of soil organisms, in particular earthworms and soil fungi.
2) Keep the soil surface covered by (living) mulch in order to protect the soil against erosion as well as direct heating by solar radiation.
3) Keep the soil intensively rooted with a diverse range of crops (diverse main crops, inter and cover crops) that access the different soil layers and thereby input dissolved organic carbon via root exudates into the soil ("liquid carbon pathway") and provide a dense rhizosphere with high microbial activity.
4) Diversify the crop rotations via planting different main crops, integration of cover crops between main crops as well as using inter crops together with cover crops.
5) Integrate grazing animals into your farm, thereby including pasture crops into the rotation which facilitates soil rest, strengthens soil health and closes nutrient cycles via organic manures from

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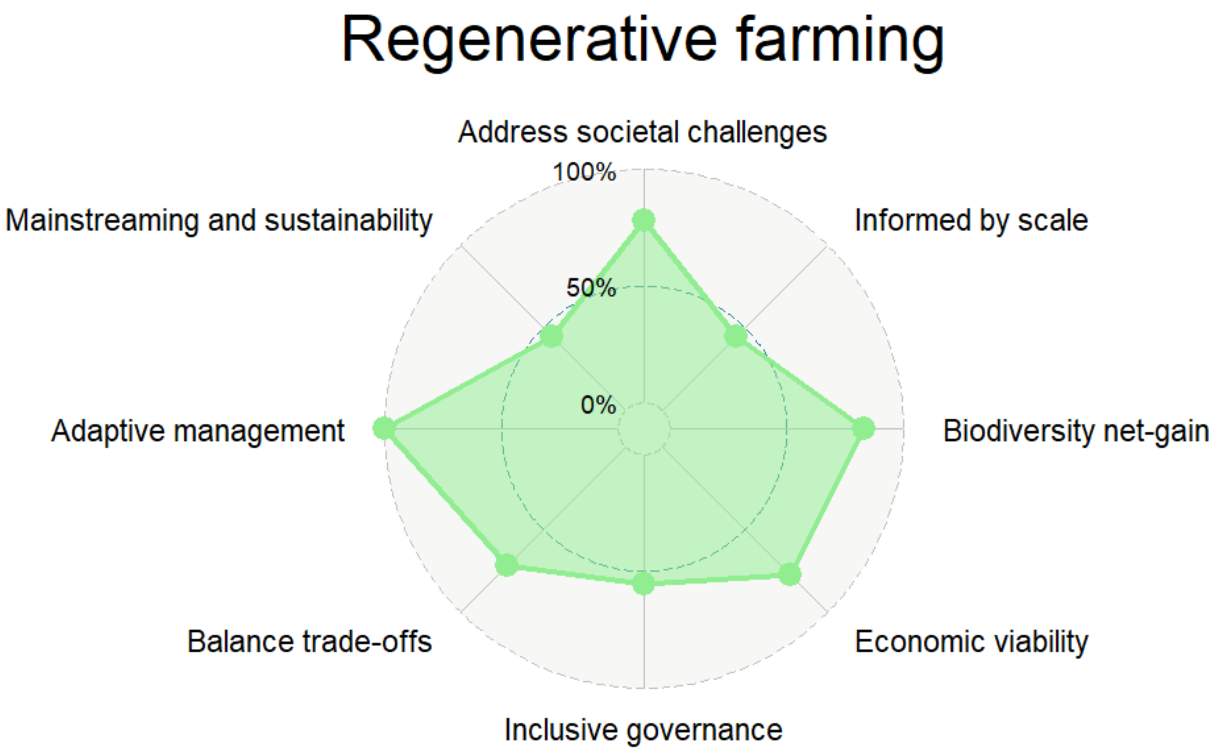
animal husbandry (this principal however does not exclude that regenerative farming can be also applied in arable cropping without animals.)

The principal aims of regenerative farming are a restauration of soil health, enhancement of biodiversity, better adaptation to climate change, contribution to climate change mitigation via carbon sequestration in soils and more efficient resource-use. Overall regenerative farming is expected to improve the resilience of the farming system against biotic and abiotic stresses and minimize the dependence on external inputs.

Assessment according to IUCN NBS Standard



1. *Address societal challenges:* Main challenges addressed are climate change mitigation and adaptation, environmental degradation and biodiversity loss, human health, food security, water security and disaster risk reduction.
2. *Informed by scale:* Direct interaction with consumers from non-farm sectors, including urban areas, as well as the consideration of interaction of the single farm with companion ecosystems integrates relevant information beyond the scale of the single farm.
3. *Biodiversity net gain:* Within agricultural land-use, biodiversity gains are a main focus via high levels of soil protection, reduced tillage or diversification of crop rotations.
4. *Economic viability:* Outcome (e.g., yield) is stabilized (climate change adaptation) not maximized, income is diversified and consumer/customer demands (e.g., environmental friendliness) are more

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directly addressed, providing potential benefits.

5. *Inclusive governance:* Mostly individual farming solution, partially enhanced interaction with consumers and their expectations.
6. *Balance trade-offs:* Holistic approach to farming and therefore consideration of effects beyond the individual farm in designing the single management measures.
7. *Adaptive management:* Highly dynamic farming systems with adaptation to the farmer's experience, feedback from within the RA community via different sources of (digital) information and integration of novel technologies (e.g., machinery, cultivars, biostimulants, analytical methods).
8. *Mainstreaming and sustainability:* Currently there are so far no common regulatory standards for regenerative farming. However, there are commonly agreed principles that are adapted to the individual farming settings.

Sources of information: https://rodaleinstitute.org/, https://regenerationinternational.org/

NBS-demo sites: *to be updated in subsequent version*

Courses on NBS-Academy: *to be updated in subsequent version*

1.1.2 Organic farming

According to IFOAM (2008), "Organic Agriculture is a production system that sustains the health of soils, ecosystems, and people. It relies on ecological processes, biodiversity and cycles adapted to local conditions, rather than the use of inputs with adverse effects. Organic Agriculture combines tradition, innovation, and science to benefit the shared environment and promote fair relationships and good quality of life for all involved." Organic farming systems are based on the four principles health, ecology, fairness and care:

1) Health: Organic farming should help to preserve and improve the health of soil, plants, animals and humans.
2) Ecology: Organic agriculture should be based on living ecological systems and cycles. Trying to sustain and close nutrient cycles within the farming system is key.
3) Fairness: Organic farming should build on fair relationships.
4) Care: Organic agricultural systems should take over responsibility for the environment as well as for current and future generations.

Organic farming considers long-term impacts of agricultural practices on the environment and relies on natural processes and inputs to maintain soil fertility, control pests and diseases, and promote overall ecosystem health. The key practices associated with organic farming are diverse crop rotations, avoidance of synthetic chemicals (pesticides and fertilizers) and GMOs, biological pest control and high animal welfare standards. Organic farming strongly focuses on maintaining and improving soil health. For this reason, high organic matter inputs through the use of compost, cover crops, and crop rotation are commonly used to enhance soil fertility, structure, and microbial activity.

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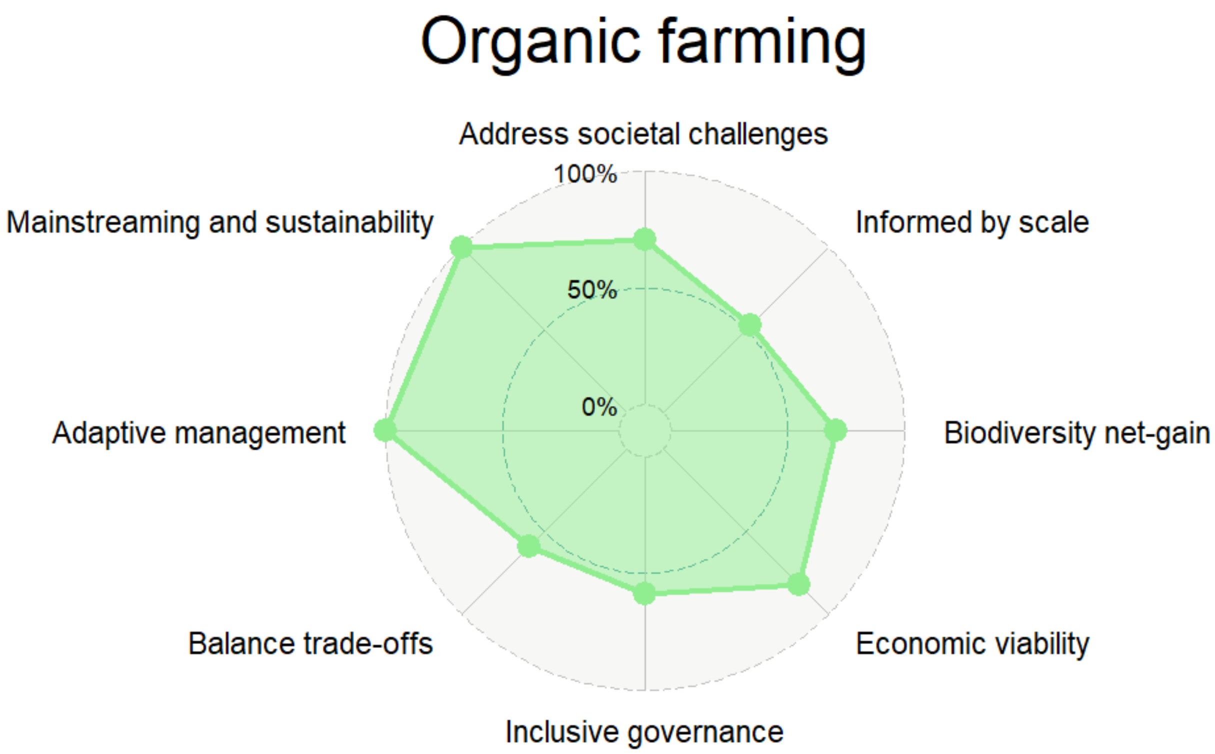

1. *Address societal challenges:* Main challenges addressed are climate change mitigation and adaption, disaster risk reduction, human health, food and water security and environmental degradation and biodiversity loss.
2. *Informed by scale:* Direct interaction with consumers from both urban and rural environments. Also interaction of the single farm with companion ecosystems integrates relevant information beyond the scale of the single farm.
3. *Biodiversity net gain:* Within agricultural land-use, biodiversity gains are a main focus of farming systems based on natural processes that aim at high levels of soil protection, diverse cropping systems and the reduction of external inputs.
4. *Economic viability:* Outcome (e.g., yield) is stabilized (climate change adaptation) not maximized, income is diversified and consumer/customer demands (e.g., environmental friendliness) are more directly addressed, providing potential benefits. Higher prices can be achieved by organically certified goods compared to conventional goods.
5. *Inclusive governance:* Mostly individual farming solution, partially enhanced interaction with consumers and their expectations.
6. *Balance trade-offs:* Holistic farming approach relying on natural processes and therefore consideration of effects beyond the individual farm in designing the single management measures.
7. *Adaptive management:* Highly dynamic farming systems on regional and individual scale. Adaptation happen according to the farmer's experience, feedback from other farmers or consumers and integration of novel technologies (e.g., machinery, cultivars, biostimulants).
8. *Mainstreaming and sustainability:* Standards for organic farming exist on a European level. The system

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is well established and adapted in governance. Farmer associations can specify the standards according to their values and intentions.

Sources of information: https://www.oekolandbau.de/, https://sarep.ucdavis.edu/sustainable-ag/organic-farming, https://www.ifoam.bio/

NBS-demo sites: *to be updated in subsequent version*

Courses on NBS-Academy: *to be updated in subsequent version*

1.1.3 Agroforestry

Agroforestry is a land-use systems that combines the cultivation of woody perennials with arable or grassland farming. Agroforestry systems are very heterogenous and include all types of silvo-arable or silvo-pastoral practices like alley cropping of any fruit, nut timber or fuel trees as well as hedgerows, riparian buffer strips and grazed forests.

The implementation of agroforestry system can offer multiple ecosystem services and environmental benefits, such as enhanced biodiversity, less evapotranspiration and thus water loss from soil, reduced soil erosion and increased soil health through higher aggregate stability and nutrient mobilization. The higher leaf area and deeper rooting systems can also increase carbon sequestration rates and reduce greenhouse gas emissions. Improved drought resilience of crops in agroforestry systems is another potential benefit, caused by deep-rooting trees. Trees also diversify root exudates, which in turn enhances soil microbial biodiversity and overall microbial activity in soils. Agroforestry also offers economic opportunities, as farmers can diversify their production through additional food, feed, fuel, or fiber products. These offer additional sources of income and make them more resilient against price fluctuations.

As agroforestry system can be very heterogenous, they require profound planning to meet the farmers´ objectives before implementation. Thus, the cultivation practices and tree species, site conditions (climate, soil type, slope,..), prevalent farming system and marketing opportunities have to be selected accordingly. In practice, choosing the appropriate system can be challenging, which is why training courses and demonstration farms would be an important measure in the frame of nature-based solutions for soil health.

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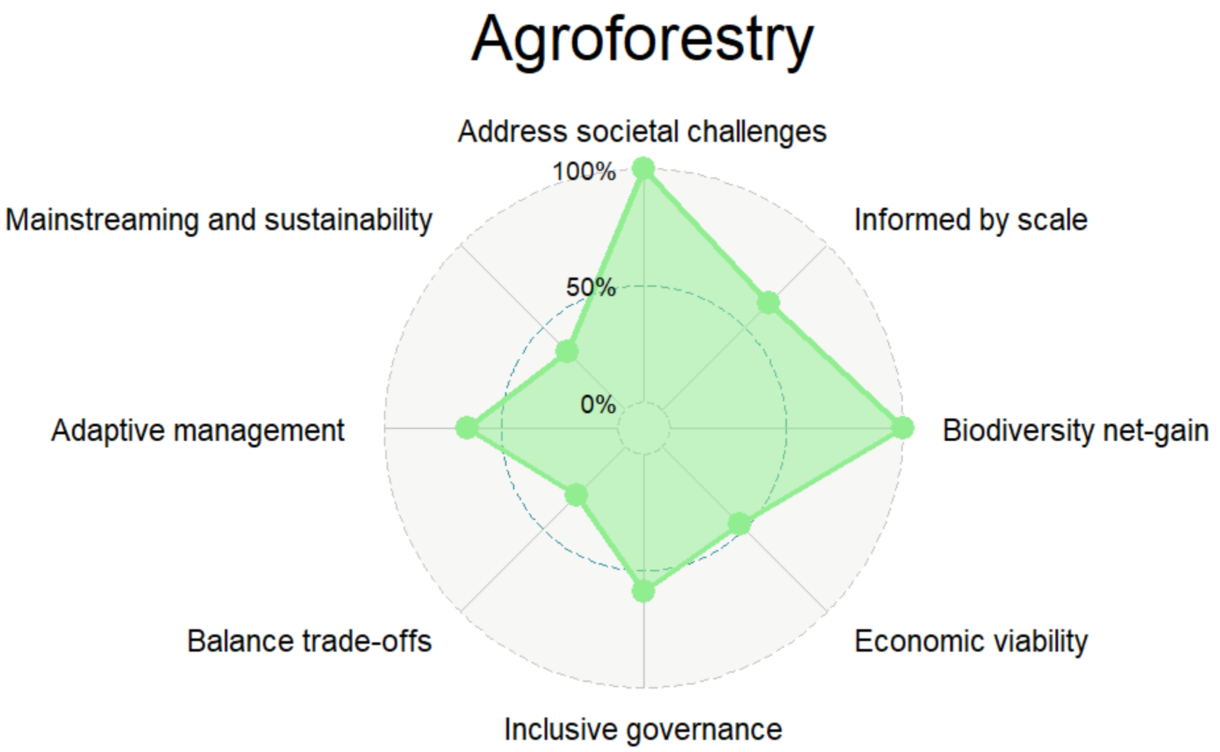

1. *Address societal challenges:* Main challenges addressed are loss of biodiversity, climate change mitigation (carbon seqeuestration, and reduction of GHG), increased water retention, reduced erosion,

   farmers economic resilience and possible reduction of rural abandonment through additional employment opportunities in rural areas.
2. *Informed by scale:* Directed to single fields, as well as whole farm where they provide additional income for farmers. Scale effects are also found for agro-ecosystems in immediate vicinity. Larger-scale effects depend on governmental policies fostering wide implementation via agro-environmental programs.
3. *Biodiversity net gain:* Important measure to increase biodiversity of soil (micro)organisms, insects, birds and mammals in agro-ecosystems.
4. *Economic viability:* Implementing agroforestry systems can be associated with higher initial investments for farmers. In the longer run, they can offer economic benefits through diversified production and higher resilience.
5. *Inclusive governance:* Solution for field and farm level. Non-farm stakeholders profit from a diversification of agricultural landscapes, enhanced biodiversity and carbon sequestration.
6. *Balance trade-offs:* Negative trade-offs include costs for implementation and maintenance, and increased workload; however, this might be counter-balanced by higher income and improved soil fertility in the long-term.
7. *Adaptive management:* As agroforestry systems are very heterogenous, the can be adapted to

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different soil types, climatic site conditions and agricultural systems. However, in most European countries, it's no common practice, which mean know-how, tools and resources required for the implementation are of utmost importance.

8. *Mainstreaming and sustainability:* There is no comprehensive legal framework or subsidy system for agroforestry on the EU level. This can be a burden for farmers who apply for subsidies as agroforestry farm.

Sources of information: https://www.usda.gov/topics/forestry/agroforestry, https://www.oekolandbau.de/landwirtschaft/pflanze/grundlagen-pflanzenbau/regenerative-landwirtschaft/agroforstsysteme/

NBS-demo sites: *to be updated in subsequent version*

Courses on NBS-Academy: *to be updated in subsequent version*

1.1.4 Mob grazing

Mob grazing is a grazing management strategy used in livestock farming, mostly cattle, to optimize the health of pastures and soils and to improve overall land productivity. The basic idea behind mob grazing is to concentrate a large number of animals in a relatively small area for a short period of time before moving them to a new pasture section. The goal is to mimic the natural behavior of large herds that move quickly across landscapes. This short duration of grazing helps to prevent overgrazing and selective grazing, as animals are moved frequently to new paddocks and have limited time to consume the available forage in a specific area. After the animals have been moved, the land is given a significant rest period before being grazed again, which allows forage plants to recover, regrow, and build root reserves, contributing to healthier and more resilient pasture ecosystems.

Mob grazing can have positive effects on soil health. The periodic trampling and incorporation of plant material into the soil by grazing animals can enhance soil organic matter content, improving soil structure and water retention. The movement of animals across pastures in a mob grazing system facilitates more even distribution of manure, enhancing microbial activity and nutrient cycling in the ecosystem. Mob grazing, with its emphasis on rotation and rest, can also contribute to increased plant biodiversity in pastures, as well as improved forage quality.

Compared to other grazing systems, mob grazing tends to be more time consuming, as livestock has to be moved, in most cases, daily. Handling of herds with higher density is usually also more difficult. Before implementing mob grazing, an adequate design of pasture, paddocks and water sources, is crucial.

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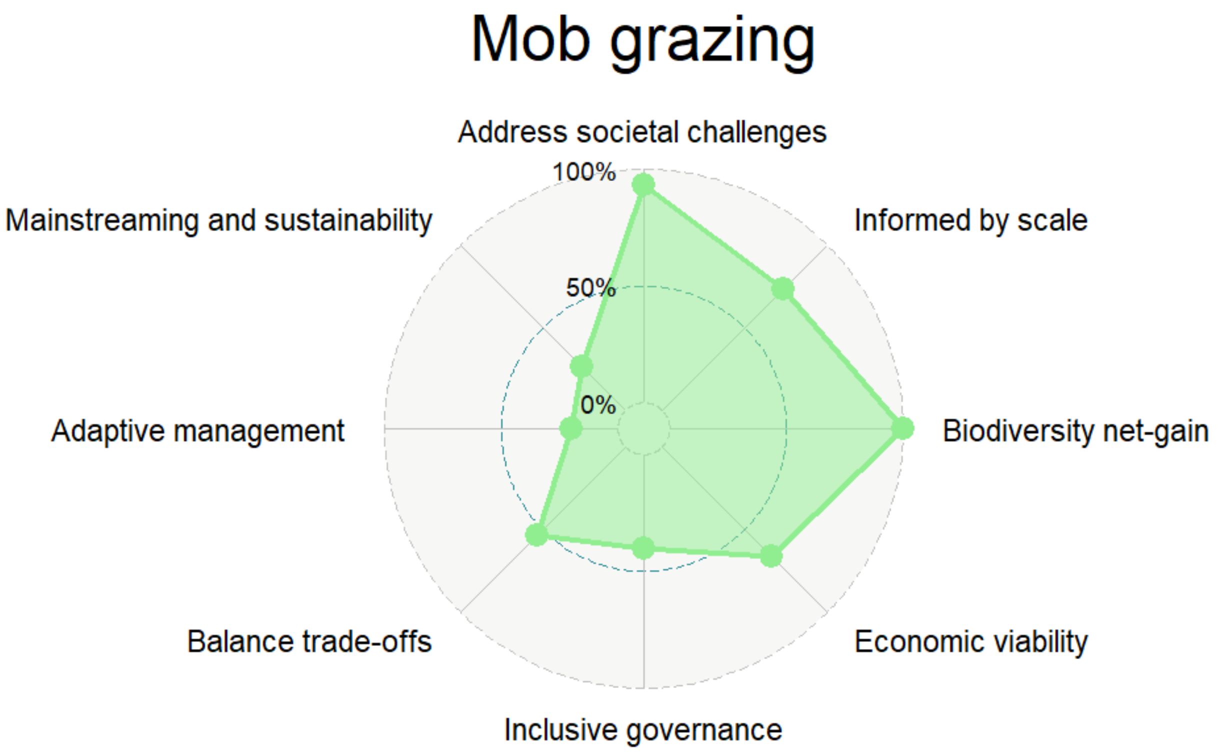

1. *Address societal challenges:* Main challenges addressed are increased soil health, biodiversity, reduced erosion and optimized use of resources (pastures) which leads to higher economic resilience.
2. *Informed by scale:* Usually implemented as whole farm strategy leading to optimized use of pastures and more productive farms. It also improves health of soils and plants, as well as biodiversity.
3. *Biodiversity net gain:* Can increase biodiversity of soil (micro)organisms, insects and plant communities in pastures.
4. *Economic viability:* Usually requires higher workload but can offer benefits through more efficient use of resources.
5. *Inclusive governance:* Mostly solution for individual farms. Non-farm stakeholders profit from enhanced biodiversity.
6. *Balance trade-offs:* Higher workload is balanced by more productive and healthier pastures.
7. *Adaptive management:* Is most effective in productive soils with higher plant growth rates, may not be implemented efficiently to all pedo-climatic regions.
8. *Mainstreaming and sustainability:* No subsidy system directed directly at mob grazing, and little experience with mob grazing in Europe.

Sources of information: https://www.mob-grazing.de/definition-mob-grazing, https://noe.lko.at/wie-mit-mob-grazing-%C3%A4cker-ganzj%C3%A4hrig-bedeckt-sind+2400+3617250

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Courses on NBS-Academy: *to be updated in subsequent version*

1.1.5 Cover cropping

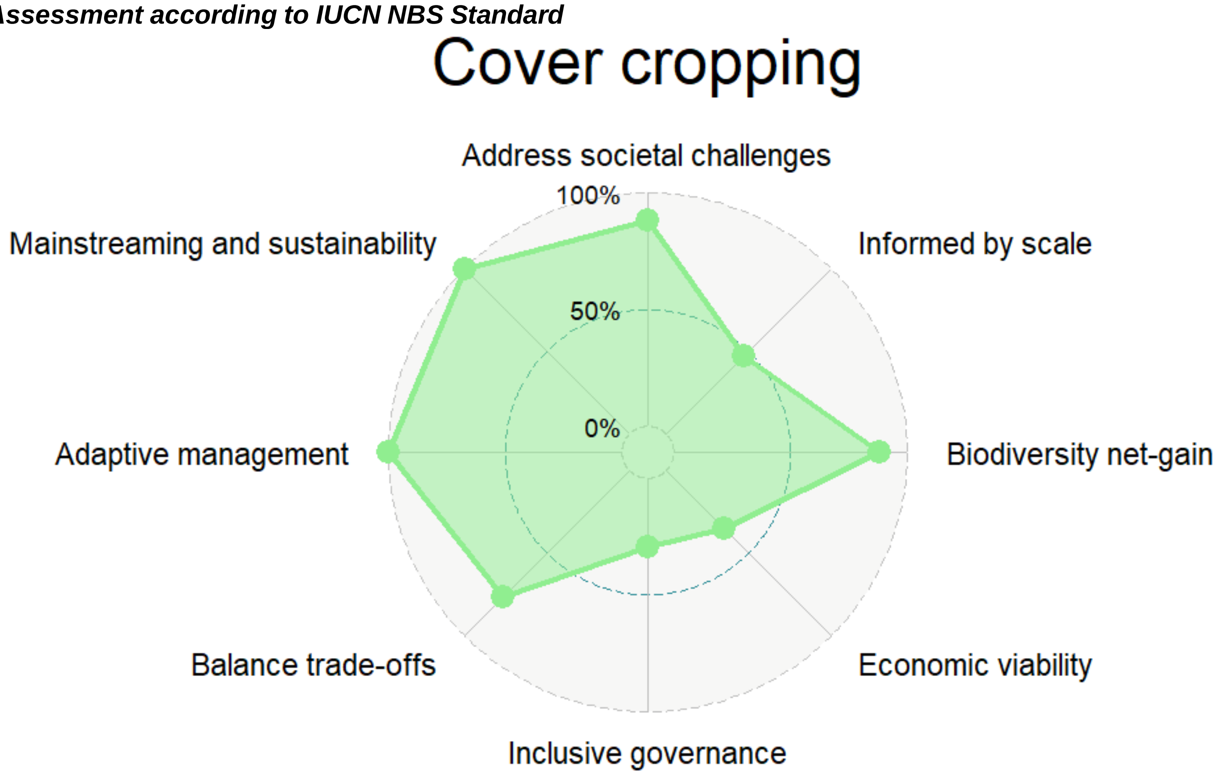
Cover cropping aims to reduce the time of bare fallow between main crops in arable farming. Cover crops are primarily cultivated to enhance soil health; thus, their biomass (roots and shoots) is mainly dedicated to soil organic matter reproduction. However, in specific cases, aboveground cover crop biomass can also be used as feed for animals. Cover crops can be used as single species; however, within the frame of nature-based solutions, high-biodiversity cover cropping mixtures are recommended to maximize their impact on soil health and the environment.

Cover crops are seeded after harvest of the main crop. While stubble tillage is possible, still it is recommended to keep the distance between main crop harvest and cover crop seeding short to maximize growing time and optimize weed suppression. Opportunities for seeding cover crops before harvest (e.g., drone seeding) and with harvest (e.g., seeding machine on harvester, seeds covered by straw) are available.

Cover crops are available from a range of plant species and have to be selected according to common crop rotation principles (i.e., avoiding the same species in sequence). Diversifying cover crop mixtures can combine the specific effects of single species (e.g., N-uptake efficiency, weed suppression, P-mobilization, N-fixation, quick soil coverage, soil structure improvement, or biopore formation) and ensure a high biomass potential with variable weather conditions.

The main goals of cover cropping are reduction of nitrate losses to the groundwater, mitigation of soil erosion, improvement of soil structure, soil organic matter accrual, fostering biodiversity (soil microbes, insects), mobilization of soil nutrients, suppression of weeds and diversifying agricultural landscapes.

Assessment according to IUCN NBS Standard



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1. *Address societal challenges:* Main challenges addressed are environmental degradation and biodiversity loss, climate change mitigation (carbon sequestration) and adaptation (buffering extreme rainfall events), water security (runoff, evaporation losses) and disaster risk reduction (erosion).
2. *Informed by scale:* Mostly directed to single fields where implemented. Scale effects can still be found for companion ecosystems (groundwater, adjacent fields). Larger-scale effects depend on governmental policies fostering wide implementation via agro-environmental programs.
3. *Biodiversity net gain:* Provides a measure to diversify common crop rotations which can be readily implemented in most farming systems. Main biodiversity gains for soil (micro)organisms and insects.
4. *Economic viability:* Cover cropping implies additional costs for farmers (seeds, labor). Yield effects are variable and might be positive, neutral or negative. Particularly legacy effects in water and nitrogen cycling have to be considered site-specifically. Thus, the implementation potential may vary with pedo-climatic characteristics.
5. *Inclusive governance:* Mostly solution for individual fields and within a single farm. Non-farm stakeholders profit mostly from a diversification of agricultural landscapes (aesthetic value).
6. *Balance trade-offs:* Single management measures with few negative trade-offs beyond the immediate costs for implementation (economic trade-off) that, however, on a longer run might be counter-balanced by soil fertility gains.
7. *Adaptive management:* Cover crop mixtures can be readily adapted to pedo-climatic site conditions and specific crop rotations. Adapted mixtures are available on the market and can be created by the farmer based on own experience.
8. *Mainstreaming and sustainability:* Cover cropping is regulated in many European Countries according to the CAP via agro-environmental schemes as well as by single member states and regions as an effective measure to mitigate environmental risks from arable cropping (mostly groundwater protection and erosion control).

Sources of information: https://sarep.ucdavis.edu/covercrop, https://plants.usda.gov/home/covercropplants, https://humusbewegung.at/zwischenfruche/

NBS-demo sites: *to be updated in subsequent version*

Courses on NBS-Academy: *to be updated in subsequent version*

1.1.6 Inter cropping

Mixed cropping is a soil-friendly cultivation method that can simultaneously stabilize and increase yields. Mixed crops enhance water use and promote infiltration by intercepting raindrops before they touch the soil surface, minimizing soil erosion. Additionally, they improve soil quality and fertility by boosting enzymatic activities in the soil, increasing cation exchange capacity, and enhancing humus content. Through efficient utilization of resources such as water, soil nutrients, light, and reduced cultivation risk, mixed crops achieve higher yields compared to monocultures.

The success of mixed crops depends on factors such as closely aligned harvest timings of the mixed partners, good stand stability of the mixture, and effective weed suppression.

In particular, the mixed cultivation of grain legumes with cereals has the potential to improve yield security in the cultivation of grain legumes in Europe. This approach also has the potential to reduce the negative ecological impacts of soybean imports while simultaneously promoting soil health in Europe.

Proven mixed crop partners include, for example, grain field peas and barley or field beans and oats.

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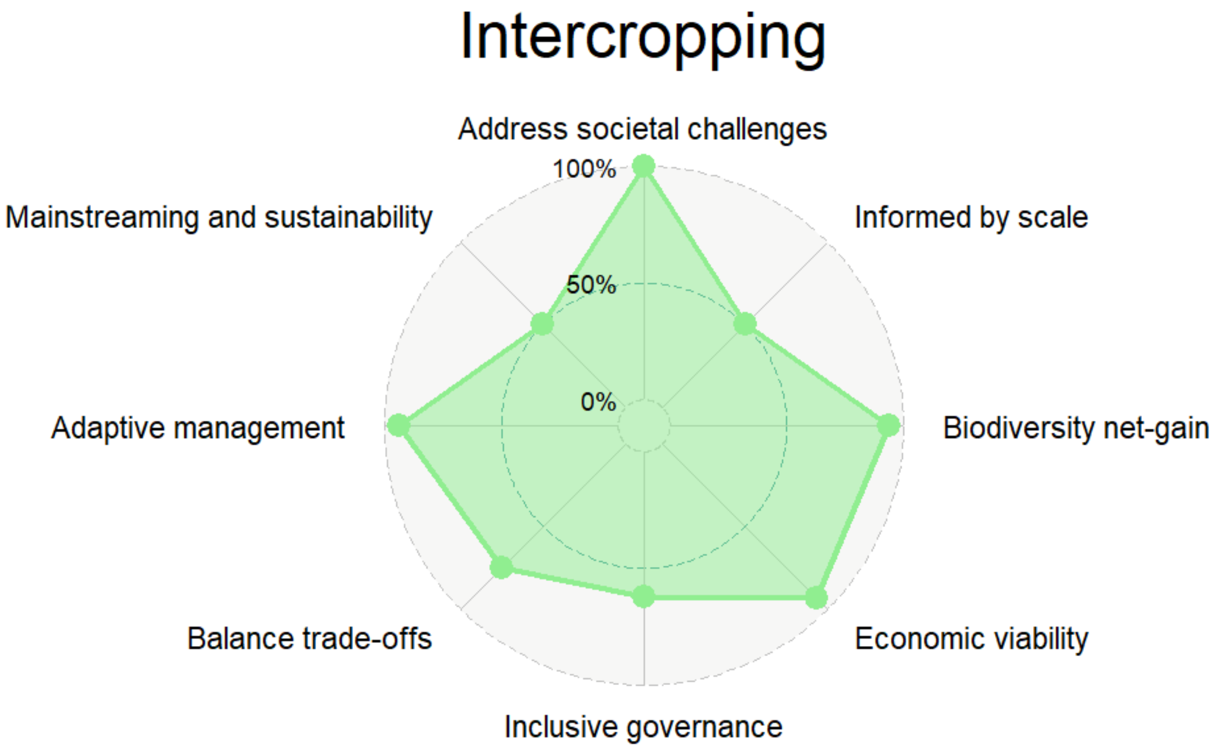
Assessment according to IUCN NBS Standard



1. *Address societal challenges:* Intercropping contributes to reducing biodiversity loss. By increasing yields and improving protein supply in Europe, it can alleviate pressure on deforestation of rainforests. Simultaneously, it plays a role in mitigating soil degradation in Europe. Through more efficient nutrient utilization, intercropping can also reduce the threat of nitrate pollution in Europe.
2. *Informed by scale:* The decision to cultivate intercrops primarily affects the farm level and has limited implications for other farmers in the vicinity. An improved protein supply in Europe might reduce demand from South America and weaken agriculture there. However, this is unlikely due to the globally increasing demand for protein-rich animal feed.
3. *Biodiversity net gain:* When farmland is planted with a variety of crops, more diverse animals, especially arthropods, thrive there.
4. *Economic viability:* Intercropping is particularly worthwhile as it reduces cultivation risks and, at the same time, yields higher returns than the two individual crops grown separately. However, the harvested produce cannot usually be marketed mixed, leading to additional costs for separation.
5. *Inclusive governance:* Intercropping is a farm-level decision and has little impact on other stakeholders. However, the quality of the harvested produce may change (e.g., hectoliter weight, breakage). Therefore, it should be agreed upon with the buyer beforehand to what extent this could pose a problem during acceptance. Additionally, crop rotations may narrow, leading to the emergence of crop rotation diseases.
6. *Balance trade-offs:* The benefits are experienced by the farmers (higher yields, reduced cultivation risks, improved soil health) and by society (increased biodiversity, possibly less deforestation of rainforests). The costs (potentially lower quality and separation costs) are borne solely by the farmers.
7. *Adaptive management:* Intercropping can be cultivated in various contexts, as there are many possible

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companion crops that are adapted to different climates.

8. *Mainstreaming and sustainability:* Since in monoculture, higher levels of fertilization under ideal conditions and the choice of financially more lucrative crops may lead to higher financial returns, some farmers are skeptical, even though intercropping can be more productive and financially attractive over several years on average. In conventional agriculture, both pest control and fertilization are precisely optimized for a single crop, which may make very intensive conventional production unsuitable for intercropping. However, in more extensive intercropping, significant savings in pest control and fertilization can be achieved.

Sources of information: https://www.fibl.org/de/shop/1670-koernerleguminosen-mischkulturen
https://intercropvalues.eu/

NBS-demo sites: *to be updated in subsequent version*

Courses on NBS-Academy: *to be updated in subsequent version*

1.1.7 No tillage

No-till farming is also known as zero tillage or direct seeding and involves planting crops without mechanically disturbing the soil. As opposed to traditional farming practices that often involve plowing or tilling the soil, no-till agriculture works without disturbing the soil through tillage. Key features of no-till farming include:

1) Minimal disturbance: No-till farming avoids traditional tillage operations like plowing, harrowing or discing. Instead, the soil is left undisturbed or minimally disturbed.
2) Cover with crop residues: After harvest, crop residues are left on the field. These residues cover the soil and provide various benefits such as moisture retention, weed suppression and erosion control.
3) Conservation of soil moisture: The crop residue cover helps reduce evaporation and retain soil moisture.
4) Improved soil structure: The absence of intensive tillage promotes the development and maintenance of a stable soil structure.
5) Weed control: In no-till systems, the constant crop residue cover contributes to weed management. However, alternative weed management strategies, such as cover crops or the use of herbicides might be required.
6) Saving energy: No-till farming can reduce fuel and energy consumption associated with traditional tillage practices.

No-till farming has gained popularity for its potential environmental and economic benefits. This nature based approach to soil management can help conserve soil, improve water efficiency, and reduce the environmental impact of agriculture. However, successful implementation requires careful management practices, and the effectiveness of no-till methods can vary depending on factors such as climate, soil type, and the specific crops being cultivated.

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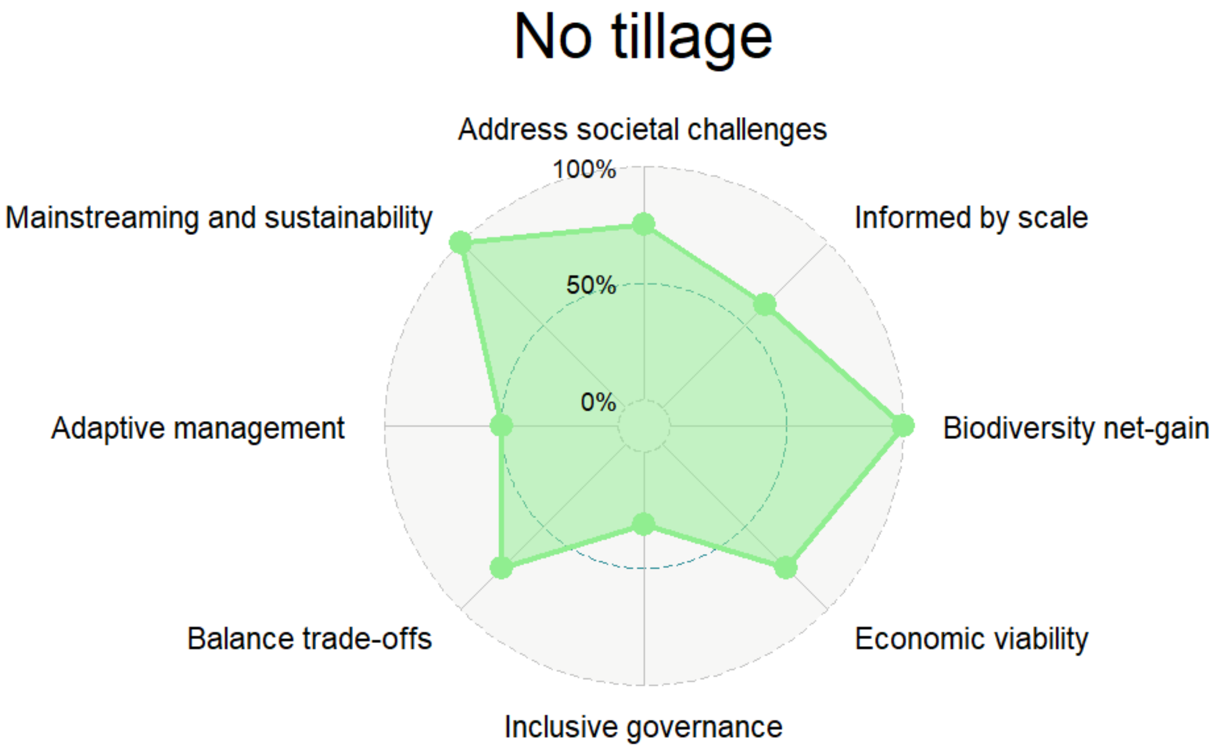

1. *Address societal challenges:* Main challenges addressed are climate change mitigation and adaption, disaster risk reduction, economic development, environmental degradation and biodiversity loss.
2. *Informed by scale:* Mostly carried out at farm level. Scale effects can still be found for companion ecosystems (groundwater, adjacent fields). Larger-scale effects depend on governmental policies fostering wide implementation via agro-environmental programs.
3. *Biodiversity net gain:* Biodiversity net gain is achieved by not constantly disturbing the system with different tillage operations.
4. *Economic viability:* No tillage systems allow to safe costs for energy and labor related to soil tillage.
5. *Inclusive governance:* Mostly implemented on farm level for individual fields. Non-farm stakeholders profit mostly from a diversification of agricultural landscapes (aesthetic value).
6. *Balance trade-offs:* Single management measure with mostly benefits when the whole farming system is adapted to these management practices.
7. *Adaptive management:* The only restriction in no tillage is to avoid soil tillage. The choice of the crops in the crop rotation and the way how they are cultivated is not specified.
8. *Mainstreaming and sustainability:* No tillage is regulated in many European Countries according to the CAP via agro-environmental schemes as well as by single member states and regions as an effective measure to mitigate environmental risks from arable cropping.

Sources of information: https://regenerationinternational.org/2018/06/24/no-till-farming/

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NBS-demo sites: *to be updated in subsequent version*

Courses on NBS-Academy: *to be updated in subsequent version*

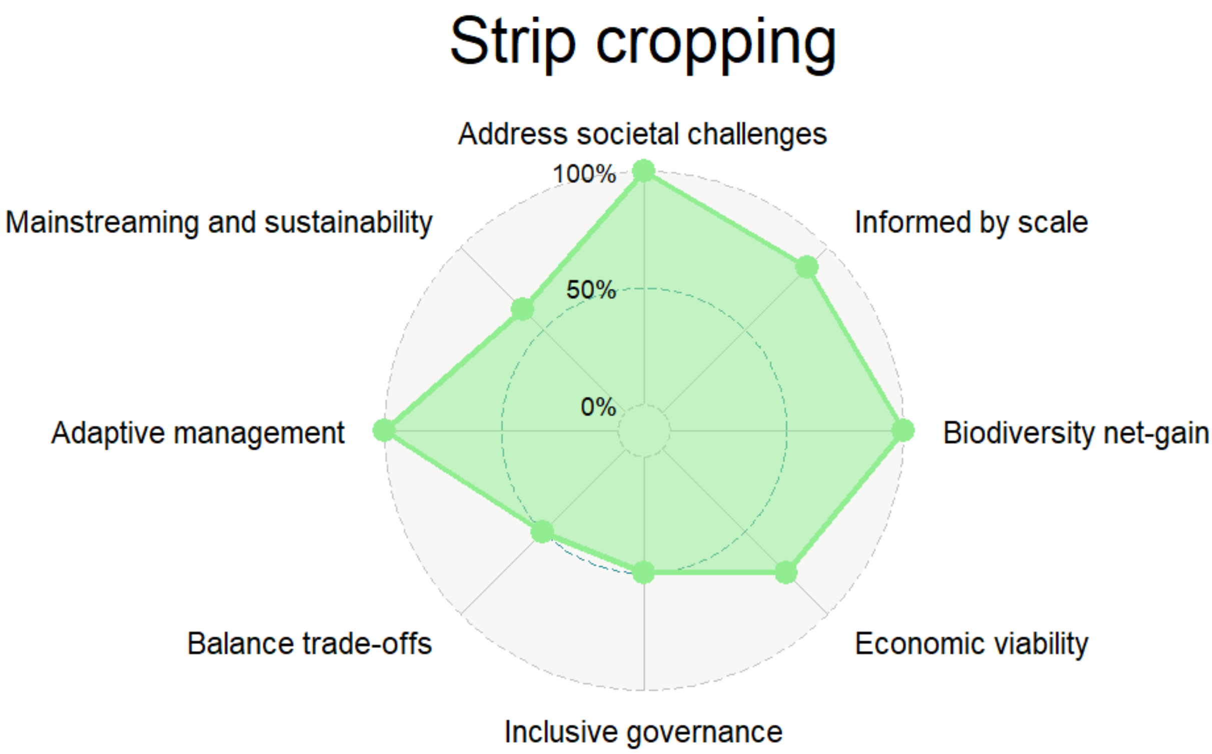
1.1.8 Strip cropping

In strip cropping, crops are grown as pure seed in strips next to each other. Due to the different vegetation periods of the selected crops, the period in which at least part of the field is covered is extended.

Strip cropping also reduces wind erosion, especially if the strips are planted at right angles to the main wind direction, and water erosion, especially if the strips are planted at right angles to the slope gradient. The barrier effect and small-scale diversity reduce the infestation pressure of pests and diseases, which is why pesticides can be saved and their negative effects on soil health are reduced, while beneficial organisms and biodiversity are promoted.

An automatic steering system with RTK correction is required for practical implementation in a European context. The strip widths should be as small as possible in order to maximise the positive effects on biodiversity, but they must be adapted to the tillage, sowing, maintenance and harvesting technology of the respective farms. The use of a mouldboard plough is not possible in this system. The system can be used with any number of crops, but this complicates crop rotation planning, which is why it makes sense to start with only two crops with different vegetation periods if possible.

Assessment according to IUCN NBS Standard



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1. *Address societal challenges:* Main challenges addressed are biodiversity loss (biodiversity gain due to habitat and less plant protection) soil degradation (erosion), climate change adaptation (buffering extreme rainfall events), water security (runoff, evaporation losses).
2. *Informed by scale:* by protecting existing agricultural soils, there is less land use change for agricultural purposes globally, mostly directed to single fields where implemented. Scale effects can still be found for companion ecosystems (groundwater, adjacent forests). Larger-scale effects depend on governmental policies fostering wide implementation via agro-environmental programs.
3. *Biodiversity net gain:* The different sowing and harvesting times of the various crops provide a habitat over a longer period of time, especially for insects and birds. In addition, insects can retreat to the neighbouring strips when the first crop is harvested.
4. *Economic viability:* The fact that different crops are grown on one field means that there is a loss of efficiency in cultivation. On the other hand, pesticides can be saved and, especially in organically farmed fields, natural pest and disease control can lead to higher yields.
5. *Inclusive governance:* The requirements for crop rotation and technology can be better managed through inter-farm collaboration. The risk, planning, decision-making, and any additional costs lie with the farmers. They can potentially benefit from reduced pesticide use and higher yields. However, the main benefit through increased biodiversity is experienced by society as a whole. Non-farm stakeholders mostly profit from the diversification of agricultural landscapes (aesthetic value).
6. *Balance trade-offs:* costs on farm level through lower efficiency in cultivation might be balanced through higher yields, preserved soil fertility and lower pesticide use. Nevertheless, the main risk is on farmer level and the main benefit is on society level.
7. *Adaptive management:* strip cropping can be done in various arable cropping regions with different crops. The higher the diversity of crops that are grown on the farm level, the more possibilities exist for strip cropping. The system can be implemented in small (very low mechanization) and large scale farming (with RTK

8. *Mainstreaming and sustainability:* Only a few European countries financially support strip cropping. However, the practice may become more attractive due to increasingly stringent regulations regarding plant protection, making ecological alternatives more appealing. Additionally, as more agricultural enterprises are equipped with RTK (Real-Time Kinematic) systems, the practice is likely to gain popularity.

Sources of information: : More nature in fields through strip cropping - Spotlight (wur.eu) https://groenkennisnet.nl/dossier/strokenteelt-dossier

Nbs-demo sites: Biohof Wolfgrube, Wolfgrubenstrasse 58, 5742 Kölliken

Courses on NBS-Academy: *to be updated in subsequent version*

1.1.9 Crop rotation diversification

A diverse crop rotation is a key practice in sustainable soil management in an agricultural context and plays a crucial role in maintaining soil health and controlling pests and diseases. By growing various crops in a spatial and temporal framework, several benefits can be achieved:

1) Nutrient cycling: Through different crop requirements, the nutrient management can be optimized and imbalances or losses can be minimized.
2) Weed, pest and disease control: Pest and disease control is supported because life cycles of pests and diseases are interrupted what prevents them from facilitation. The same applies to weed control

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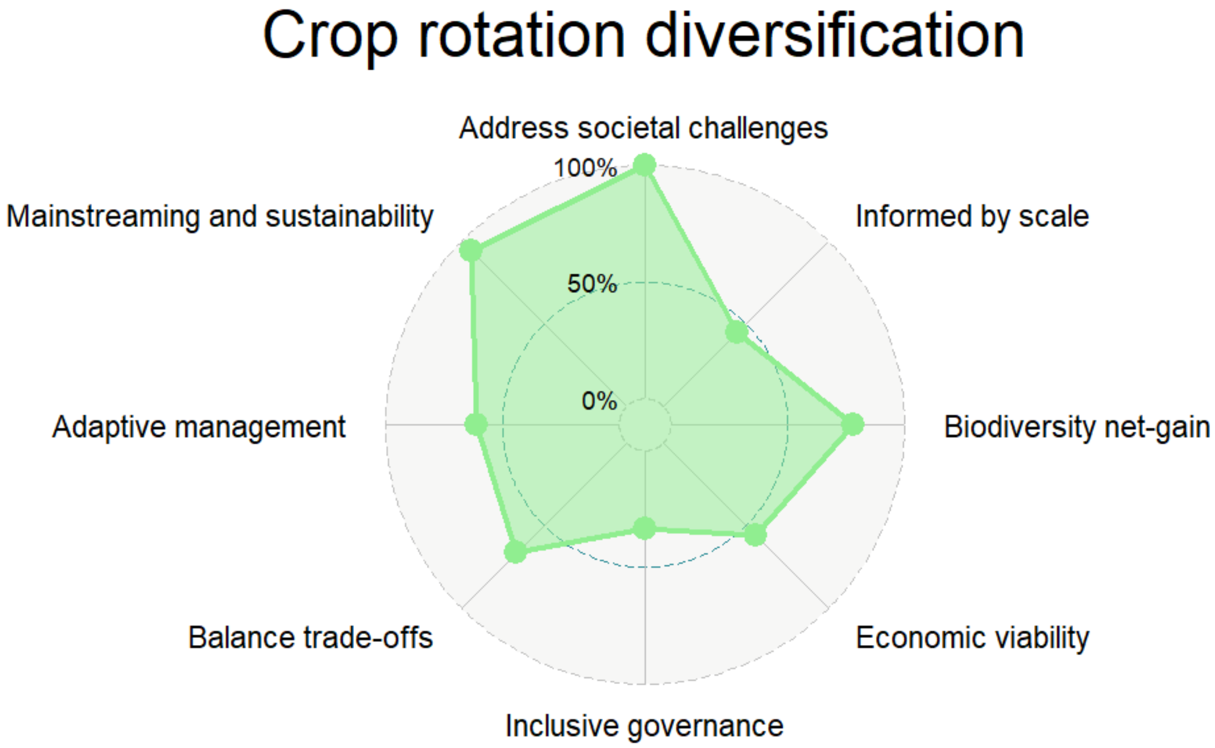
as different crops have different growth habits and can suppress specific weed species. This results in a lower use of pesticides and herbicides.

3) Water use efficiency: Water resources can be used more efficiently, especially in regions with limited water availability, by altering between crops with different rooting systems.
4) Soil health: A miscellaneous crop rotation enhances soil structure and soil health. Crop rotation has a strong influence on the organic carbon content in the soil. For an increasing SOC content, either the input of organic matter has to be increased, or the share of humus-consuming crops like silage maize, potatoes or sugar beet has to be reduced.

For a properly working crop rotation the consideration of cultivation breaks between the different crops is important. With a well-structured, diverse crop rotation, the current main crop can benefit from the previous crop. Within crop rotation practices, measures like perennial crops, cover crops and undersown crops should also be included.

Overall diverse crop rotations contribute to a more resilient cropping system since soil health is enhanced and the risk of yield losses is spread to a variety of crops while the productivity is increased through an improved use of nutrients and water.

Assessment according to IUCN NBS Standard



1. *Address societal challenges:* Main challenges addressed are climate change mitigation and adaption, disaster risk reduction, economic and social development, human health, food and water

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security, environmental degradation and biodiversity loss.

2. *Informed by scale:* Mostly implemented on farm scale. All fields of a farm are included in crop rotation in a spatial and temporal framework. Scale effects can still be found for companion ecosystems. Larger-scale effects depend on governmental policies fostering wide implementation via agro-environmental programs.
3. *Biodiversity net gain:* Crop rotations diversify cropping systems for a longer period of time. Most biodiversity gains for soil (micro)organisms and insects.
4. *Economic viability:* Crop rotation diversification contributes to spreading the risk of yield losses and increases the productivity of the system.
5. *Inclusive governance:* Mostly implemented on farm level. Non-farm stakeholders profit mostly from a diversification of agricultural landscapes (aesthetic value).
6. *Balance trade-offs:* trade-offs are well balanced in diverse crop rotations over time. Yield losses of some crops are compensated with higher productivity of others. Water and nutrients are used and cycled in an optimized way.
7. *Adaptive management:* Crop rotations can be quite flexible. Besides following some general rules, there often is a selection of possibilities for structuring a crop rotation that fits the given site factors and situation.
8. *Mainstreaming and sustainability:* Crop rotation is regulated in many European Countries according to the CAP via agro-environmental schemes as well as by single member states and regions as an effective measure to mitigate environmental risks from arable cropping.

Sources of information: https://humus-klima-netz.de/massnahmen-im-ueberblick/, https://www.oekolandbau.de/landwirtschaft/oekologischer-pflanzenbau/fruchtfolge/, https://www.fibl.org/fileadmin/documents/shop/1432-bodenschutz.pdf

NBS-demo sites: *to be updated in subsequent version*

Courses on NBS-Academy: *to be updated in subsequent version*

1.1.10 Perennial crops

Integrating perennial crops into a farming system offers several benefits compared to annual crops. These include erosion control, improved soil health with a higher carbon content in the soil, improved water and nutrient cycling and promotion of biodiversity.

Perennial crops occupy the field not only for one season, but at least for two or more years. They include fodder crops (clover grass/mixtures) and fuel crops.

Erosion control is achieved by a constant soil cover and an intensive rooting. The deep rooting systems also enhance water and nutrient cycling and enable the plants to access resources from deeper soil layers. At the same time, nutrient losses by leaching and runoff are reduced. SOC accrual is possible in perennial crops because it allows the accumulation of organic matter over time what positively influences soil stricture and soil (micro)biology. Furthermore, perennial crops serve as a habitat for various species and therefore promote biodiversity. Another benefit in this context is the attraction of beneficial organisms that help with pest and disease control.

Due to the longer period of cultivation, perennial crops need lower inputs (fertilizer, labor, water) as compared

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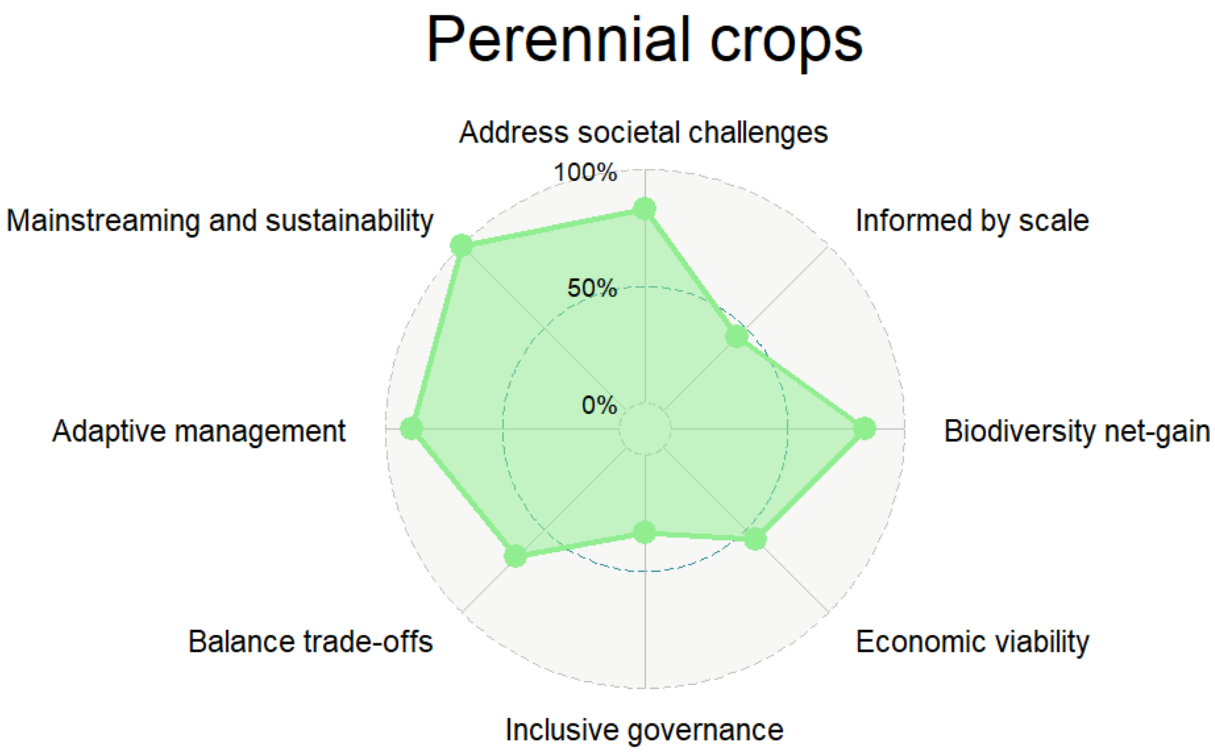
to annual crops. Additionally, they provide longer harvest periods what extends the production window and mitigates peaks of work. However, perennial crops need some special knowledge and management and the period for being established is much longer compared to annual crops. Also the initial investment costs are generally higher.

One important factor is the useful utilization of perennial crops like clover grass. Possible solutions are using the crops on farm as livestock fodder or selling it to other farms in the region. In some cases the use of perennial crops may be difficult or not feasible.

Assessment according to IUCN NBS Standard



1. *Address societal challenges:* Main challenges addressed are climate change mitigation and adaption, disaster risk reduction, economic development, human health, water security, environmental degradation and biodiversity loss.
2. *Informed by scale:* Mostly directed to single fields where implemented. Scale effects can still be found for companion ecosystems (groundwater, adjacent fields). Larger-scale effects depend on governmental policies fostering wide implementation via agro-environmental programs.
3. *Biodiversity net gain:* Provides a measure to diversify common crop rotations which can be readily implemented in most farming systems. Main biodiversity gains for soil (micro)organisms and insects.
4. *Economic viability:* Perennial crops cause higher costs in the year of sowing. However, these costs can be saved in another year since they don't need to be established every year.

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5. *Inclusive governance:* Mostly solution for individual fields and within a single farm. Non-farm stakeholders profit mostly from a diversification of agricultural landscapes (aesthetic value).
6. *Balance trade-offs:* Single management measures with few negative trade-offs beyond the immediate costs for implementation (economic trade-off) that, however, on a longer run might be counter-balanced by soil fertility gains.
7. *Adaptive management:* Perennial crops can be adapted to site conditions and crop rotations. Once established, perennial crops should stay on the field for the planned period of time.
8. *Mainstreaming and sustainability:* Perennial crops are regulated in many European Countries according to the CAP via agro-environmental schemes as well as by single member states and regions as an effective measure to mitigate environmental risks from arable cropping.

Sources of information: https://landinstitute.org/our-work/perennial-crops/, https://humus-klima-netz.de/massnahmen-im-ueberblick/

NBS-demo sites: *to be updated in subsequent version*

Courses on NBS-Academy: *to be updated in subsequent version*

1.1.11 Multi-purpose hedges

In multi-purpose hedges, shrubs, woody species as well as grasses and herbs can be found. The implementation of multi-purpose hedges into the agricultural landscape benefits not only farmers but also the society by offering several ecosystem services.

1) Soil conservation: Hedges contribute to soil conservation by reducing wind and water erosion. In open landscapes, they act as windbreaks and reduce windspeed. Water infiltration is further improved by an extensive and deep rooting system which reduces surface runoff of water.
2) Biodiversity: Furthermore hedges help to sustain and increase biodiversity by offering a diverse habitat and shelter for various plant and animal species. Many flowering plants found in hedges attract pollinators and other beneficial organisms which are beneficial for various agricultural crops, potentially leading to increased yields. Furthermore hedges improve the landscape connectivity as they act as wildlife corridors, allowing animals to move between different habitats.
3) Microclimate: Hedges influence the microclimate in their vicinity. They provide shade in their close surrounding and buffer temperature extremes.
4) High organic matter inputs: Within the hedge, a lot of organic matter is added to the soil, what enhances nutrient cycling and increases the SOC content in this area.
5) Recreational value: Finally, hedges elevate the aesthetic and recreational value of the landscape and therefore contribute to the well-being of the society.

It has to be noted that competition for water, nutrients and light between the hedge and the agricultural site might occur in the closer surrounding. To that, the organic matter input is limited to the area of the hedge itself and thus marginally benefits the agricultural site. Also, after a certain time, the area can no longer be used for agricultural purposes and the hedge must remain in place.

Hedges are particularly effective in rather open agricultural landscapes, since they actively shape the appearance and the multifunctionality of a landscape. Hedges offer a holistic approach to nature based practices, addressing ecological, agricultural, and aesthetic considerations.

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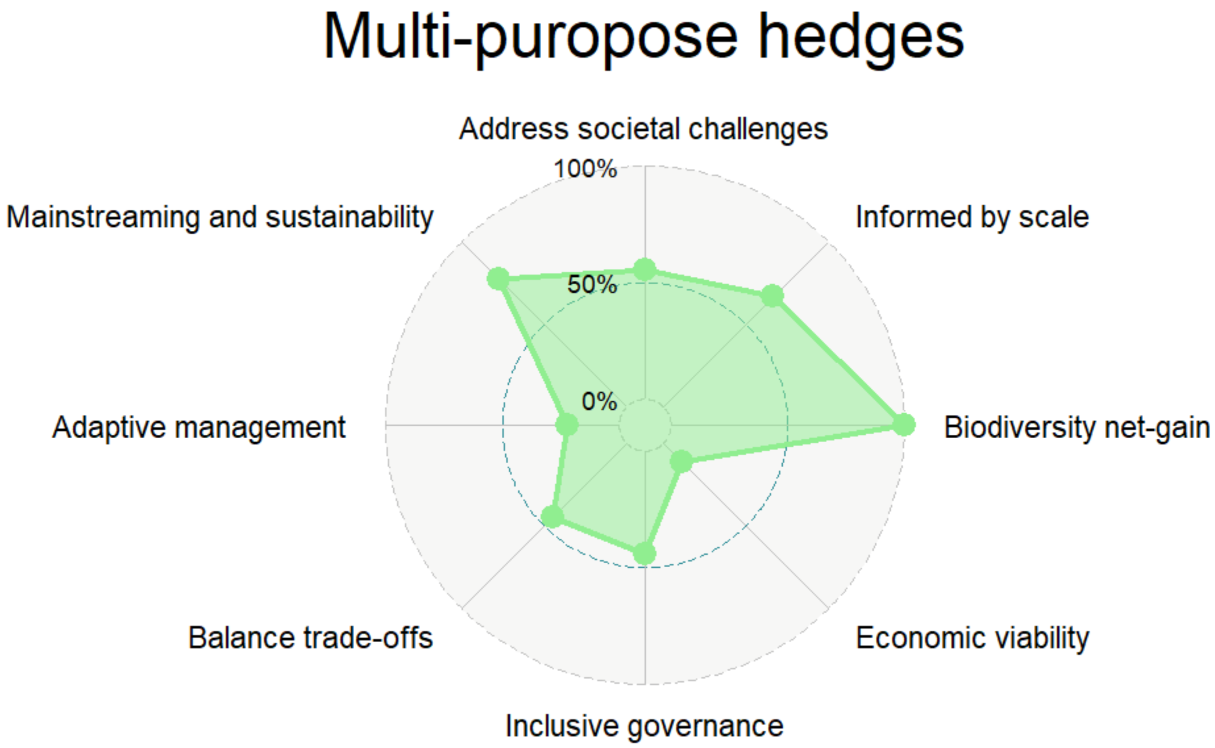

1. *Address societal challenges:* Main challenges addressed are climate change mitigation and adaption, disaster risk reduction, human health, environmental degradation and biodiversity loss.
2. *Informed by scale:* Mostly directed to specific areas along agricultural sites. Scale effects can be found for companion ecosystems (arable fields, groundwater).
3. *Biodiversity net gain:* Provides a measure to diversify and connect the landscape. Also agricultural fields benefit from higher biodiversity by the attraction of beneficial organisms and pollinators.
4. *Economic viability:* Establishing and maintaining hedges requires some investments and labor. In return, the farmer doesn't get any direct monetary benefits from the hedge. It mainly contributes to the prevention of soil erosion and adds to the recreational value of the landscape and the society's wellbeing.
5. *Inclusive governance:* Non-farm stakeholders profit from a diversification of agricultural landscapes (aesthetic value).
6. *Balance trade-offs:* Hedges cause additional costs and labor for farmers. However the recreational value of the landscape increases and benefits the whole society.
7. *Adaptive management:* Multi-purpose hedges do not offer a lot of flexibility. After the establishment it is not allowed to remove them anymore and maintenance is necessary for the whole time.
8. *Mainstreaming and sustainability:* Integrating multi-purpose hedges in the agricultural landscape is regulated in many European Countries according to the CAP via agro-environmental schemes as well as by single member states and regions.

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Sources of information: https://www.lfl.bayern.de/iab/kulturlandschaft/027061/index.php, https://humus-klima-netz.de/massnahmen-im-ueberblick/

NBS-demo sites: *to be updated in subsequent version*

Courses on NBS-Academy: *to be updated in subsequent version*

1.1.12 Biodiversity strips

Biodiversity strips are linearly planted strips covered with natural vegetation like grasses, flowers, herbs and shrubs, within or around agricultural fields. These strips are intentionally designed to enhance biodiversity and landscape connectivity what increases the value of agricultural landscapes in many ways.

Biodiversity is enhanced by diversifying the agricultural system with various native plant species. This provides habitat and shelter for a variety of insects, birds, and other wildlife. Also pollinators and beneficial organisms are attracted and contribute to a higher productivity of the cropping system. Additionally, the need for chemical inputs like pesticides and fertilizer is reduced, what again supports biodiversity. Other beneficial aspects for high biodiversity are the balanced microclimate offered by biodiversity strips as well as the function as wildlife corridors.

Besides increasing biodiversity, biodiversity strips reduce the risk of erosion by preventing surface runoff. Biodiversity strips produce a high amount of above- and belowground biomass. This leads to an accumulation of organic matter in the soil within and around the biodiversity strips. However, it has to be mentioned that only biodiversity strips that are established on additional farmland can show a climatic effect. Even though biodiversity strips should be cultivated for more than one year, they will be ploughed at some point. For this reason, it is important to constantly establish new biodiversity strips. Native flowering plants should be integrated to promote biodiversity by offering a natural habitat.

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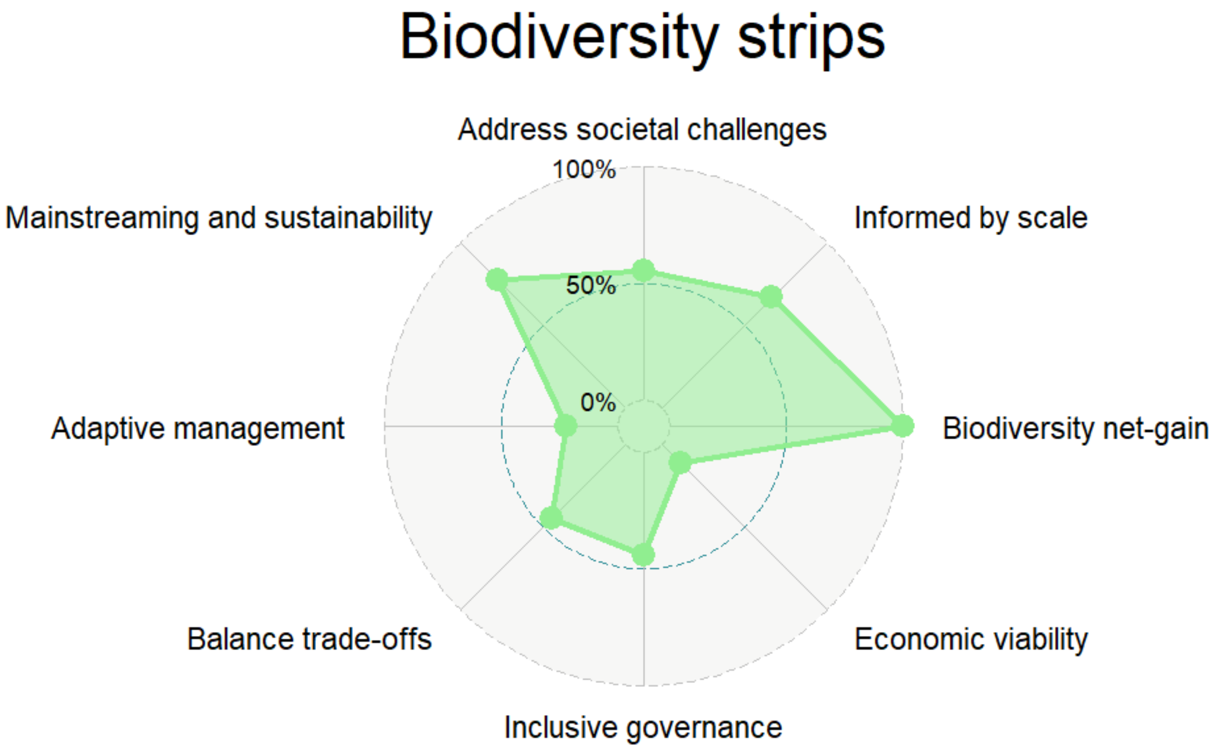
Assessment according to IUCN NBS Standard



1. *Address societal challenges:* Main challenges addressed are climate change mitigation and adaption, disaster risk reduction, human health, water security, environmental degradation and biodiversity loss.
2. *Informed by scale:* Mostly directed to single fields and their surroundings. Scale effects occur for companion ecosystems because biodiversity strips enhance the landscape connectivity. Larger-scale effects depend on governmental policies fostering wide implementation via agro-environmental programs.
3. *Biodiversity net gain:* Overall positive biodiversity net gain for soil (micro)biology, insects, birds, and other wildlife as well as plants.
4. *Economic viability:* Biodiversity strips cause additional costs in the year of seeding and they have to be maintained all the time. There is no direct monetary outcome for the farmer, but rather socio-economic benefits for the society.
5. *Inclusive governance:* Measure for designing specific arable fields as well as the entire landscape. Non-farm stakeholders profit mostly from a diversification of agricultural landscapes (aesthetic value).
6. *Balance trade-offs:* Biodiversity strips initially cause additional costs and labor for farmers. However the socio-economic value of the landscape and the fields increases and benefits the whole society.
7. *Adaptive management:* Biodiversity strips should be maintained for a longer period of time to maximize the positive effects
8. *Mainstreaming and sustainability:* Biodiversity strips are regulated in many European Countries

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according to the CAP via agro-environmental schemes as well as by single member states and regions.

Sources of information: https://www.oekolandbau.de/landwirtschaft/umwelt/biodiversitaet/mehrjaehrige-bluehflaechen-starker-hebel-fuer-mehr-biodiversitaet/, https://humus-klima-netz.de/massnahmen-im-ueberblick/

NBS-demo sites: *to be updated in subsequent version*

Courses on NBS-Academy: *to be updated in subsequent version*

1.1.13 Market gardening

Vegetable cultivation for direct marketing places a strong emphasis on both crop diversity and the efficient yet intensive use of land resources. One distinctive aspect is the manual cultivation on smaller plots, relying on manual labor rather than extensive machinery. The market garden aspires to be particularly resource-efficient with a primary objective of facilitating direct marketing.

Ecosystem services and benefits result from diversified production, involving smaller planting distances to strategically optimize the spatial and temporal utilization of the land and its inherent natural resources. This practice also extends the harvest season through the cultivation of winter vegetables. Central to the market garden is a focus on soil fertility conservation and improvement. This includes planned, diverse crop rotations, the integration of compost or mulch, and a preference for minimal disturbance of the soil through avoiding deep mixing. Characteristic tools and equipment used in market gardening include living mulch or mulch films, fleeces, plastic tunnels, and smaller hand tools for soil cultivation and weed control. Without the use of pesticides and large-scale machinery, weed control is managed manually.

Beyond ecological considerations, the economic viability of market gardening hinges on a direct marketing model. Bypassing intermediaries, produce is brought directly to consumers, reducing transportation emissions, minimizing packaging, and contributing to regional food security. Frequently, market gardeners offer

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vegetables through subscription services or in reusable vegetable crates, providing both economic stability and a direct connection between farmers and consumers. Overall, market gardening contributes to the conservation and promotion of ecological diversity, not only safeguarding the environment but also encouraging long-term sustainable agricultural practices.

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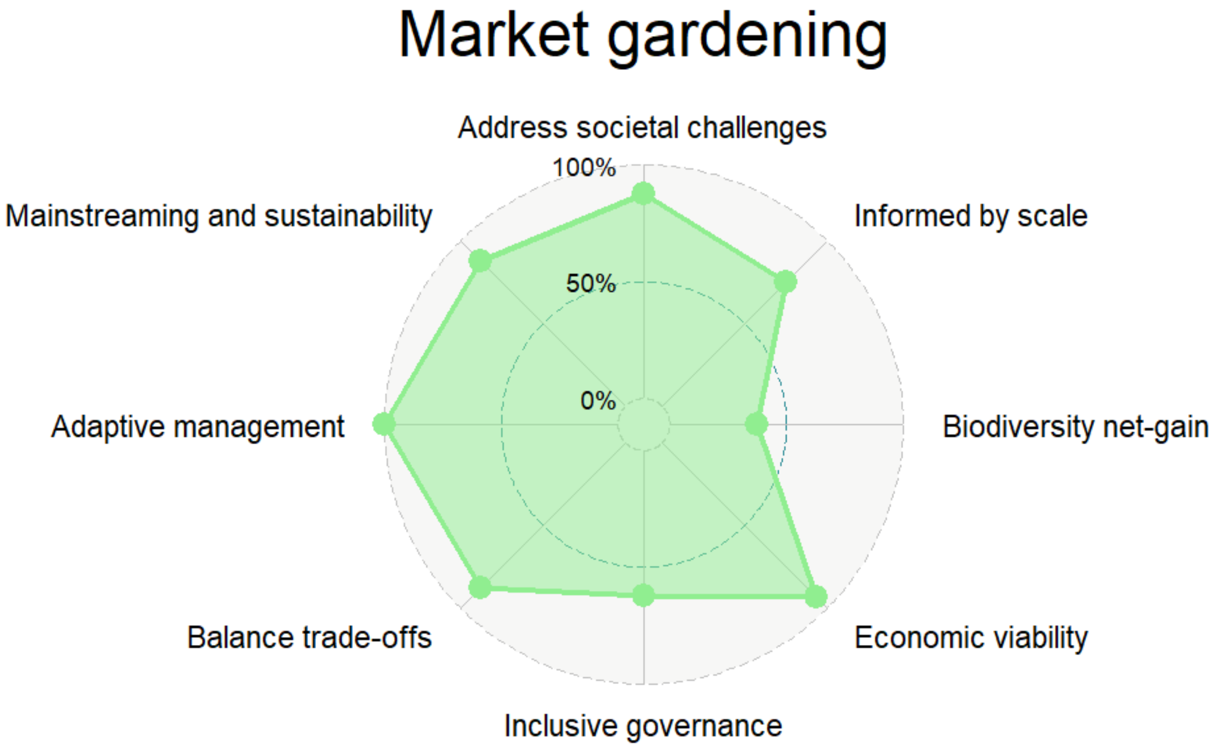

1. *Address societal challenges:* Main challenges addressed are environmental conservation, food security, the facilitation of rare species, employment opportunities, climate resilience, cultural preservation and urban green spaces
2. *Informed by scale:* Mostly directed to single fields, their surroundings and the regional impact of .the food supply. Scale effects occur on the field site due to soil conservation practices. Larger-scale effects are based on the scope of regional impact such as provisioning jobs, education and crops.
3. *Biodiversity net gain:* Market gardening, through practices such as crop diversity, agroecological methods, and habitat creation, positively contributes to biodiversity by fostering a variety of plant and animal species in the local environment.
4. *Economic viability:* Economically viable market gardening practices show consistent profitability, efficient resource management, and adaptability to market trends. Sustainable practices and effective financial management contribute to the long-term success and resilience of market gardening ventures.

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5. *Inclusive governance:* Measure for designing specific arable fields as well as the entire landscape. Non-farm stakeholders profit from local and seasonal food supply, community involvement and a direct connection between consumer and producer.
6. *Balance trade-offs:* Market gardening, like any agricultural practice, involves trade-offs and considerations. If implemented correctly, trade-offs can be reduced through sustainable, efficient cultivation. Economic and educational success can be improved by strategic marketing and long-term connections to consumers.

7. *Adaptive management:* Market gardening provides flexibility in cultivation, allowing for experimentation with various techniques and the cultivation of annual vegetables. This diverse planting not only offers opportunities to explore new management practices but also encourages adaptability in response to changing conditions.
8. *Mainstreaming and sustainability:* The specific inclusion of market gardening within CAP depends on the national implementation of CAP measures and policies. Market gardening has the potential to be scaled out geographically and make a valuable contribution to various social and sustainability targets.

Sources of information: https://ec.europa.eu/eip/agriculture/sites/default/files/field_core_attachments/market_gardening_intor_english.pdf, https://www.fibl.org/fileadmin/documents/de/news/2020/biogemuesefibel_2020_web.pdf

NBS-demo sites: *to be updated in subsequent version*

Courses on NBS-Academy: *to be updated in subsequent version*

1.1.14 Living Soil Market Gardening

Living soil market gardening is a sustainable production method based on principles that are common to soil conservation agriculture in field crops, both helping to respond to the changes facing agriculture today: becoming resilient to climatic hazards and producing healthy food in quantity while protecting natural environments and increasing ecosystem services.

Living soil market gardening involves putting the soil back at the heart of the growing system, providing 'shelter and food' for the soil's macro- and micro-fauna, and mimicking the way natural ecosystems function by using ecological processes and natural cycles. The main agroecological practices used in living soil market gardening are:

- Permanent soil cover (plant cover crops including green manures, mulch, use of blackout tarpaulins), which is essential for protecting the soil and developing intense biological activity, based on the model of a forest or meadow.
- Substantial input of organic matter (crop and cover crops residues, mulch, organic amendments, etc.) to regenerate the soil.
- No tillage or reduced tillage (without overturning) to respect soil biodiversity and biological activity.
- Preventive management of weeds and crop health, encouraged by the biodiversity of the cropping system.

These methods help to protect and regenerate soil health by increasing plant and soil biodiversity, maintaining their biological functioning, and promoting nutrient recycling.

As well as producing food, living soil market gardening provides ecosystem services - i.e., the services

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provided by ecosystems to human societies - such as soil protection, water conservation (quantitative and qualitative aspects), biodiversity protection, carbon sequestration, pollination, etc.

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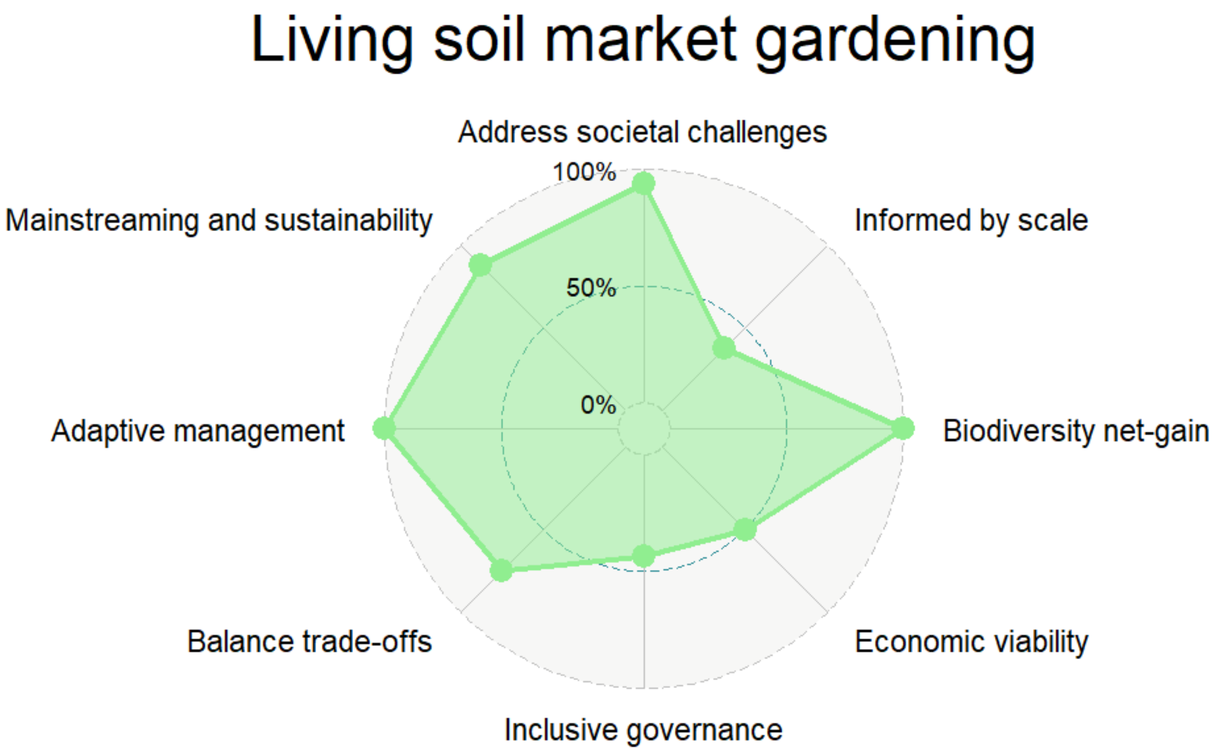

1. *Address societal challenges:* reduction of fossil energy consumption and use of inputs (mineral fertilisers, pesticides), increased sustainable crop production, climate change adaptation and mitigation, decreased erosion, enhancing biodiversity.
2. *Informed by scale:* interactions with all stakeholders from the food chain-value, up to the consumer, especially in the case of direct farm sales or short distribution channels.
3. *Biodiversity net gain:* enhanced biodiversity in crops and fauna/flora in agricultural land (crop diversification, soil protection, reduced use of phytosanitary inputs).
4. *Economic viability:* if properly managed, living soil market gardening leads to saving inputs (fuel, pesticides, fertilisers) while maintaining good yields, resulting in an improvement in income.
5. *Inclusive governance:* governance concerns mainly farmers, but their action is facilitated if other stakeholders encourage products from living soil (distribution channels, consumers), especially on small-scale value-chains.
6. *Balance trade-offs:* it could be improved if environmental services were paid to the farmers using agroecological practices.
7. *Adaptive management:* managing crop systems in living soil market gardening means constantly adapting to changing and living conditions. Sharing knowledge with other farmers is a way to improve the farm & marketing management.
8. *Mainstreaming and sustainability:* living soil market gardening, as conservation agriculture, provides long term benefits. Better recognition of its practices in regulations and financial support would be

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welcome, in particular payment for environmental services.

Sources of information:

- https://normandie.maraichagesolvivant.fr/ressources/
- La Ferme de Cagnolle, 2021. Une ferme sur sol vivant – le film
- Levavasseur V., 2021. Vidéo Ver de Terre Production Mon potager en sol vivant !

NBS-demo sites: *to be updated in subsequent version*

Courses on NBS-Academy: *to be updated in subsequent version*

1.1.15 Composting

The application of compost can raise or stabilize soil pH, increase cation exchange capacity, improve aggregate stability, as well as enhance water-holding capacity and erosion stability of soils. Some of these improvements can be observed in a short period.

For the use of compost in agriculture, it must not contain plant-harming substances or pathogens. Additionally, weed seeds should have been sterilized. A successful composting process is necessary for this, and it depends on the quality of the starting material, appropriate moisture during the composting process, and turning. Suitable starting material includes manure, which can be supplemented with other materials. For a good composting process, the C:N ratio should be between 20:1 and 30:1. Adding straw and woody plant parts can raise the ratio, while adding green plant parts and manure can lower it. Moisture levels can be checked using the hand-squeeze test. A handful of compost material is compressed in the hand; only a small amount of water should be released, and the material should stay clumped when the hand is opened. Otherwise, the material is either too dry or too wet. Using covers can protect compost from rain and drying out.

Before use, composts should be tested for phytotoxicity. This can be done by conducting a germination test with cress in a transparent, closed container using a normal planting substrate and the tested compost for comparison.

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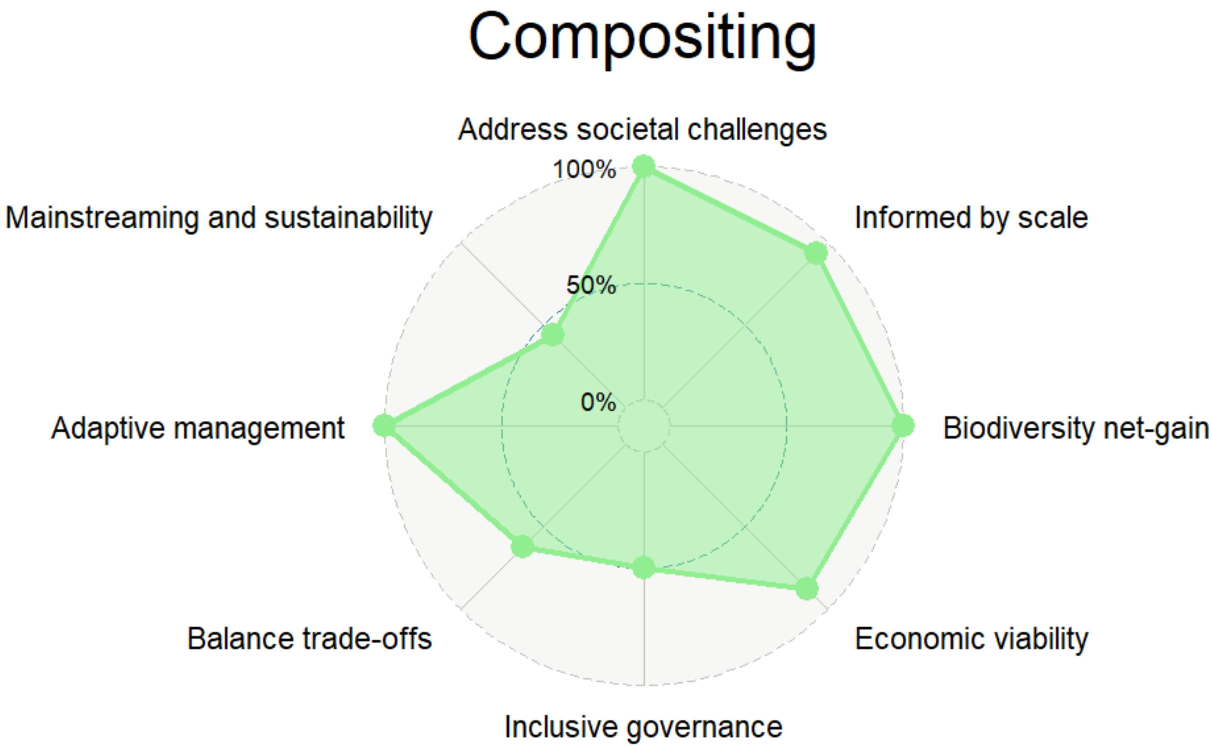

1. *Address societal challenges:* Main challenges addressed are soil health (pH, erosion, soil structure), climate change mitigation: (composting produces more stable forms of organic matter, acting as a carbon sink) and adaptation: (compost improves water retention and water infiltration in soils) and food security through better soil health.
2. *Informed by scale:* When green waste from municipalities is added, it is often contaminated with plastic. However, for municipalities, composting organic waste in agriculture represents a cost-effective and sustainable disposal method. Therefore, they should invest in the cleaning of the raw material to ensure its quality.
3. *Biodiversity net gain:* compost enhances soil microbial diversity and activity and help to sustain soil food web functions. The specific effects of compost on biodiversity can vary depending on factors such as the composition of the compost, the application rate, and the local environmental conditions.
4. *Economic viability:* Composting is labor-intensive and requires suitable machinery for turning the compost. The resulting costs reduce the financial benefits from increased yields. In certain cases, money can be earned by selling compost or composting organic waste from the community.
5. *Inclusive governance:* Whether manure is composted is a decision primarily made by farmers. No negative impacts on other stakeholders are anticipated as long as certain guidelines are followed: No compost piles in groundwater and nature conservation zones, over drains, and on ecological compensation areas.
   Maintain a minimum distance of three meters from forest edges, hedges, field groves, and water bodies.
   Construct piles on flat and vegetated sites, covering them with a compost fleece.

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Compost at the same location no more than once every three years.

6. *Balance trade-offs:* The costs incurred through composting may potentially be offset by increased yields. The risks to groundwater are negligible with proper management and are justified by improved soil health.
7. *Adaptive management:* As composting is a recurring process initiated with new material, the process can be continually evaluated and optimized. Where possible, machines should not be purchased initially but rather rented.
8. *Mainstreaming and sustainability:* Composting is currently scarcely subsidized by the government. Nevertheless, the practice is gaining popularity as farmers benefit from improved soil health.

Sources of information:
https://www.bioaktuell.ch/fileadmin/documents/ba/Pflanzenbau/Mistaufbereitung_2009-Liebegg-FiBL.pdf,
https://www.fibl.org/de/shop/1336-kompost ,

NBS-demo sites: *DOK-trial*

Courses on NBS-Academy: *to be updated in subsequent version*

1.1.16 Reduced tillage

Reduced tillage refers to farming practices that minimize ploughing depth and intensity and therefore the amount of soil disturbance compared to conventional tillage methods such as regular ploughing. The goal is to maintain or improve soil health, conserve moisture, reduce erosion, and increase the organic matter in the soil. Unlike conventional ploughing practices, which constitute a strong disturbance of the soil organisms, reduced tillage is usually not turning the soil, thus leading to less disturbance. This has a strong impact on the soil life, particularly soil microorganisms, who are key drivers of soil nutrient cycling. With reduced tillage operations, crop residues are often left on the field or rather in the topsoil. Reduced tillage aims at:

1) Soil Conservation: Protecting soil structure by reducing compaction and erosion, as the soil is not frequently disturbed and turned over. Reduced compaction also supports microbial activity.
2) Water Retention: Reduced tillage improves water infiltration and retention by keeping more plant residues on the soil surface.
3) Organic Matter: Leaving crop residues on the field increases SOC over time, which benefits soil fertility and soil structure.
4) Reduced Fuel and Labor Costs: Reduced use of machinery saves fuel and labour, making reduced tillage more energy-efficient and economical. This may be particularly the case for coarse-textured soils.
5) Environmental Impact: Reduced tillage might reduce greenhouse gas emissions by lowering fuel consumption and storing more carbon in the soil, contributing to climate change mitigation.

Reduced tillage is considered a nature-based solution for soil management because it works in harmony with natural processes, minimizing soil disturbance and enhancing the soil's natural ability to regenerate and function effectively. This practice is closely aligned with the principles of ecological balance, promoting healthy soil ecosystems, sustaining ecosystem functioning, conserving resources, and assuring resilience in arable farming systems.

1. Address societal challenges: Main challenges addressed are climate change mitigation and adaption, disaster risk reduction, economic development, environmental degradation and biodiversity loss.
2. Informed by scale: Mostly carried out at farm level. Scale effects can still be found for companion ecosystems (groundwater, adjacent fields). Larger-scale effects depend on governmental policies fostering wide implementation via agro-environmental programs.
3. Biodiversity net gain: Biodiversity net gain is achieved by less disturbance of the soil system with different tillage operations. This was shown to increase the overall diversity of soil micro-, meso- and macrofauna.
4. Economic viability: Reduced tillage systems allow to safe costs for energy and labour as compared to

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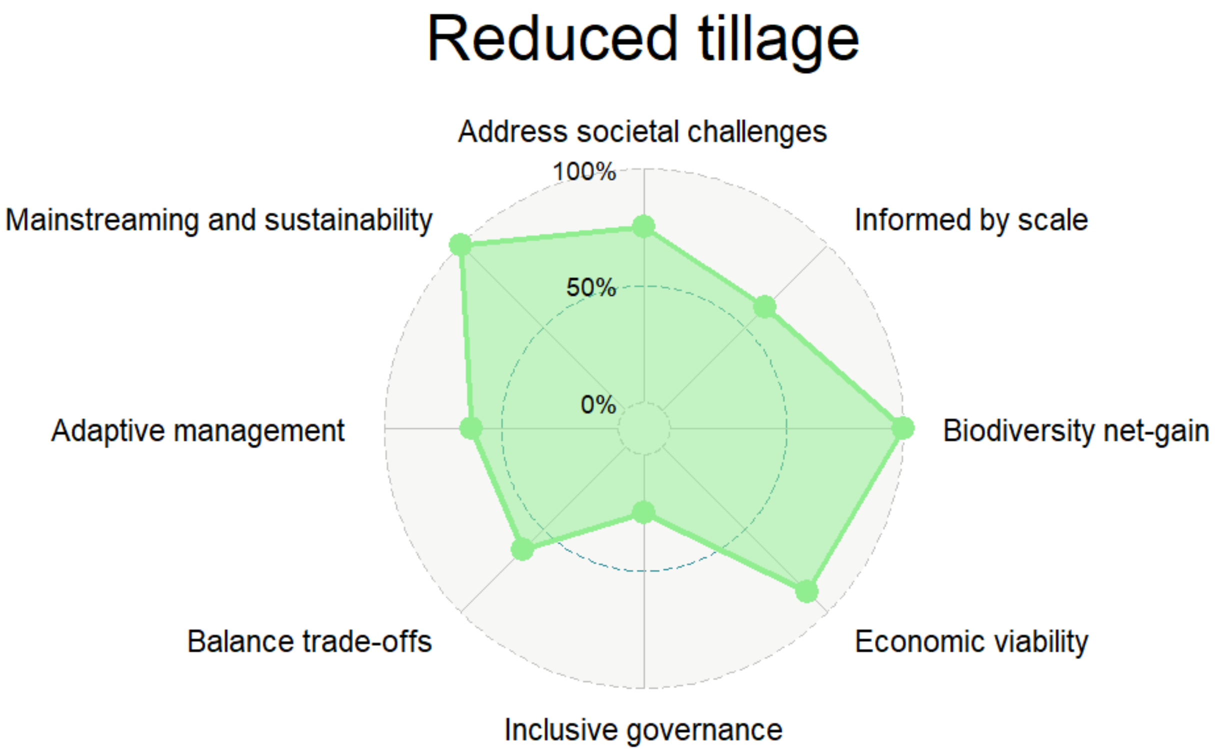
conventional soil tillage such as ploughing.

5. Inclusive governance: Mostly implemented on farm level. Non-farm stakeholders profit mostly from a diversification of agricultural landscapes (aesthetic value).
6. Balance trade-offs: Single management measure with mostly benefits when the whole farming system is adapted to these management practices.
7. Adaptive management: The only restriction is to reduce soil tillage operations to a minimum. The choice of the crops in the crop rotation and the way how they are cultivated is not specified.
8. Mainstreaming and sustainability: Reduced tillage is regulated in many European Countries according to the CAP via agro-environmental schemes as well as by single member states and regions as an effective measure to mitigate environmental risks from arable cropping.

Assessment according to IUCN NBS Standard



1.1.17 Cattle manure application

Cattle manure application is an effective way to enhance soil fertility. It contains many essential macronutrients like nitrogen, phosphorus, and potassium, cattle manure serves as an organic fertilizer that boosts microbial activity, improves soil structure, promotes healthy plant growth and also guarantees a sustainable crop production for the farmer.
When applied to fields, cattle manure adds organic substances of varying availability (although a majority nutrients has a good availability within the first year of application) to the soil, which helps improve its structure; this has further effects on aeration and water retention capabilities. This is especially beneficial in preventing soil compaction and erosion. Opposite to slow-release mineral fertilizer, the gradual release of nutrients from manure ensures that plants receive a steady supply of essential elements, enhancing crop yields without the

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risk of nutrient leaching, which is a common phenomenon with synthetic fertilizers.
To maximize the benefits and minimize environmental impacts, cattle manure should be applied at the right time – preferably before the growing season – and in appropriate amounts. Over-application can lead to nutrient runoff or leaching, subsequently contaminating nearby water bodies and contributing to issues like eutrophication. Incorporating the manure into the soil shortly after spreading helps to reduce nitrogen loss through ammonia volatilization and prevents unpleasant odors. In combination with straw application, readily available nutrients in the cattle manure can be bound and are thus released slower, further reducing the risk of nutrient leaching and eutrophication.
Good cattle manure management not only recycles valuable nutrients but also contributes to soil health, improves water retention, and enhances overall sustainability of the farming system. By enriching the soil with organic material, it promotes long-term fertility and reduces the need for chemical inputs.

1. Address societal challenges: Cattle manure helps closing nutrient cycles by bringing nutrients taken from the field back into the soil, improving fertility and reducing a strong reliance on synthetic fertilizers. It also enhances soil health, contributing to climate adaptation, food security, and biodiversity.
2. Informed by scale: Cattle manure can improve soil health on both small and large-scale farms, and its application influences neighboring ecosystems through nutrient cycling. It can also benefit non-farm sectors by enhancing organic waste management and promoting soil fertility in urban green spaces.
3. Biodiversity net gain: Increases soil organic matter and fosters microbial activity. This indirectly supports sustainable land use by improving soil structure and nutrient levels.
4. Economic viability: Manure sustains or rather improves crop yields and reduces the need for chemical fertilization, which has a positive effect on farm income.
5. Inclusive governance: Manure use is typically farm-driven, but it can be part of broader sustainable farming systems that align with consumer expectations for environmentally friendly products. It supports local nutrient cycling and can promote community engagement in sustainability practices linked to animal husbandry.
6. Balance trade-offs: While enhancing soil fertility and organic matter, proper manure management is required to prevent nutrient runoff and water contamination.
7. Adaptive management: Farmers can adjust manure application based on soil health, crop needs, and feedback from environmental conditions. Modern technologies, such as nutrient monitoring and precision application, improve the effectiveness and sustainability of manure use.
8. Mainstreaming and sustainability: While there are no uniform global regulations, best practices for manure application focus on reducing environmental impacts like nutrient leaching or volatilization.

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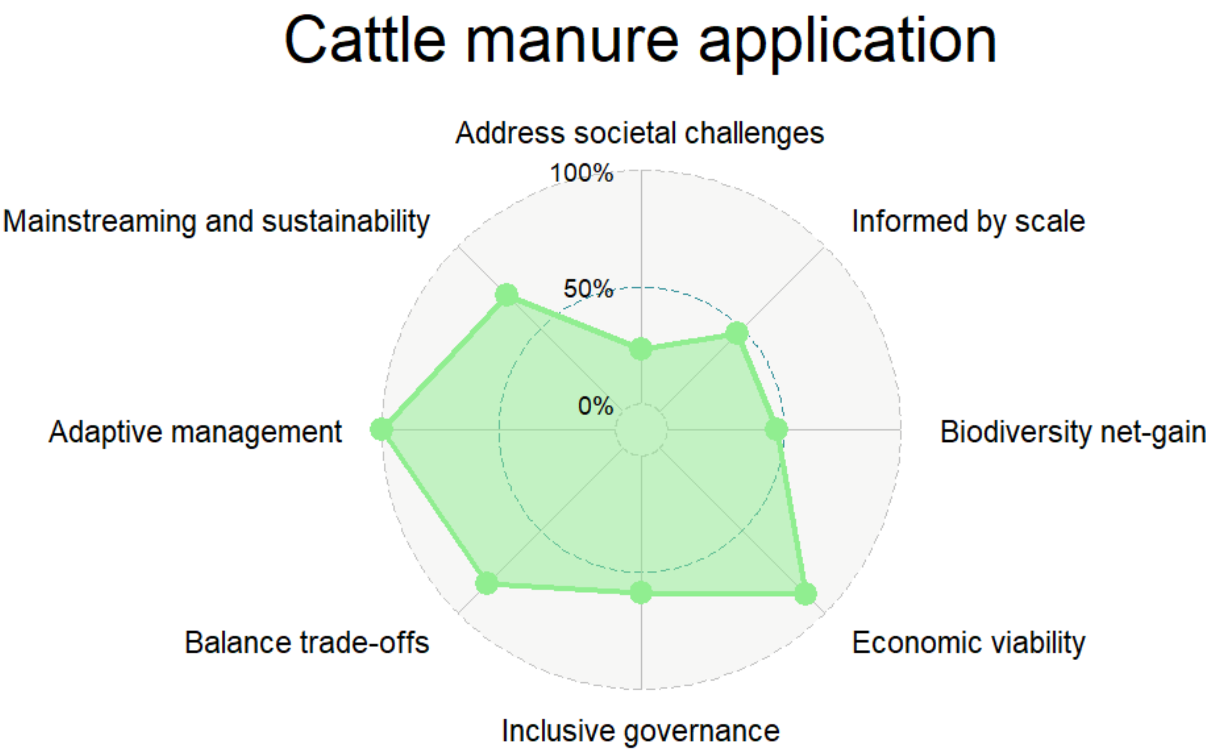

1.1.18 Biochar application

Biochar application refers to the input of inorganic carbon compounds into the soil. This practice can significantly enhance soil health on arable farms by improving its structure, nutrient retention, and water-holding capacity. Produced from the pyrolysis of organic material, biochar serves as a stable form of carbon in the soil, thus promoting carbon sequestration over decades. Since mainly organic waste or by products are used to produce the biochar, it is an effective mean to use organic material otherwise unused or wasted.
When applied to the soil, biochar increases its porosity and aeration, creating an ideal environment for soil microorganisms and enhancing microbial activity; this is particularly true for fine-textured soils. Its high surface area allows it to retain nutrients like nitrogen and phosphorus, subsequently preventing leaching and making them more accessible to plants over time. This helps improve nutrient cycling and availability, leading to better crop productivity. Due to their molecular structure, they also release nutrients over longer time periods, which also reduces the risk of nutrient leaching and eutrophication.
Biochar also plays a vital role in water management. Its ability to hold water helps soils in drought-prone regions to retain moisture, reducing irrigation needs and improving drought resilience. This is particularly important in coarse-textured soils, which may be prone to intense water losses. Additionally, biochar's impact on soil pH and organic matter content helps to support plant growth and resilience to environmental stresses. Incorporating biochar into farming practices is a long-term investment in soil fertility and sustainability, aligning with the broader goals of building long-term ecological resilience.

1. Address societal challenges: Main challenges addressed are climate change mitigation and adaptation. This may further contribute to food security at the regional and national level.
2. Informed by scale: The benefits of biochar extend beyond individual farms, improving soil quality in urban areas and enhancing ecosystems through its use in organic waste management. It also fosters

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beneficial interactions between farms and companion ecosystems.

3. Biodiversity net gain: A better pore structure in the soil – particularly in fine-textured soils – could potentially lead to better aeration and nutrient availability, which has positive effects on ecosystem biodiversity.
4. Economic viability: Biochar is still not produced on a large scale, therefore costs are still relatively high. Due to its low turnover, amortization times of biochar application are expected to be very large, subsequently reducing recurring costs.
5. Inclusive governance: Biochar is mainly implemented at the individual farm level, but it can enhance engagement with consumers by aligning with sustainability expectations. Inclusion may also appear across sectors, for example when biochar is made from forestry by-products. Its application can promote environmentally responsible farming, meeting growing demand for sustainable products.
6. Balance trade-offs: As biochar application improves soil health and carbon sequestration, positive effects are expected on crop production, which fosters environmental sustainability. Its benefits extend beyond the individual farm, enhancing ecosystem services like water filtration and habitat improvement for soil micro-, meso- and macrofauna.
7. Adaptive management: Biochar can be integrated into diverse farming systems at various application rates, allowing for adjustments based on farmer experience and environmental feedback. Its use can be combined with innovative technologies such as biostimulants and soil analytics to optimize soil health.
8. Mainstreaming and sustainability: While regulatory standards for biochar are still emerging, it aligns with widely accepted sustainable farming principles. Its adoption can be adapted to individual farm settings, supporting long-term agricultural sustainability. The origin and potential trade-offs with other means of use (e.g. leaving organic material on the field or in the forest instead of pyrolysis to biochar) has to be considered to ensure a sustainable use of this resource.

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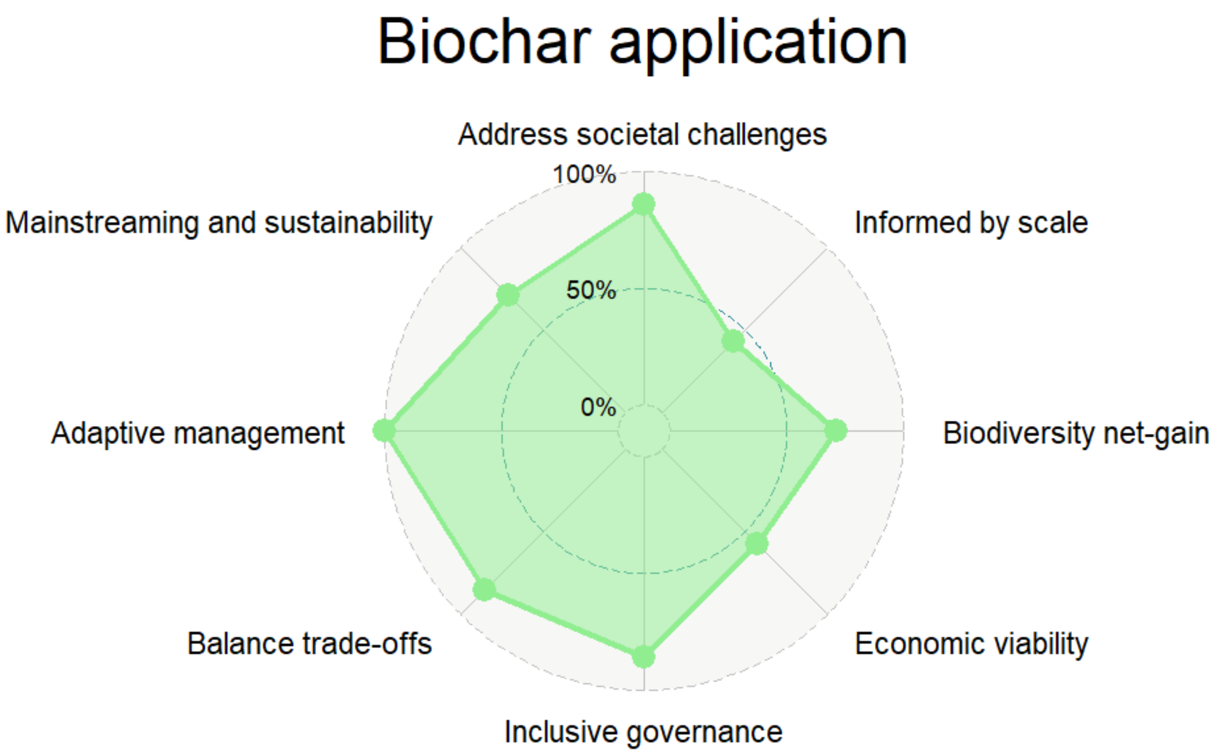

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1.1.19 Slurry application

Slurry management is a key in farming systems with animal husbandry. Slurry, a mixture of manure and water, is a valuable source of nutrients, especially nitrogen, phosphorus, and potassium, which are essential for healthy crop growth. However, improper handling can lead to nutrient losses, soil degradation, and environmental pollution. To maximize its benefits, slurry should be applied at the right time and in the correct amounts to match crop needs. Slurry has a good mixture of nutrients with different availabilities, meaning that nutrients are released over time and not instantly. This prevents nutrient runoff into water bodies, causing eutrophication. Incorporating slurry into the soil soon after application helps to reduce ammonia emissions, improving air quality and ensuring that more nitrogen remains available for plant uptake. Since it is a liquid, nutrients can distribute better throughout the soil profile. A combined use with straw further helps to bind easily-available nutrients for a certain period of time, which reduces the risk of nutrient leaching and potential eutrophication of nearby water bodies.

In addition, technologies such as slurry injectors or low-emission spreaders are recommended for efficient slurry distribution (with the advantages raised above). These methods minimize nutrient losses and reduce the risk of soil compaction, which can occur if heavy machinery is used improperly. Proper storage of slurry in sealed tanks or lagoons is also critical to avoid nutrient loss through volatilizaiton and prevent contamination of surrounding water sources. Overall, well-managed slurry application enhances soil health, boosts crop yields and ecosystem productivity, and supports the long-term sustainability of farming ecosystems by recycling organic nutrients efficiently.

1. Address societal challenges: Slurry application recycles nutrients, reducing the need for synthetic fertilizers and mitigating environmental impacts like soil degradation. It also supports climate adaptation, improves soil health, and contributes to food security by enabling a sustainable crop production.
2. Informed by scale: The benefit of nutrient provision with slurry applies across different farm sizes and affect broader ecosystems. Its use in non-farm sectors, such as urban agriculture or waste management, extends its positive environmental impacts, although this use may be quite limited.
3. Biodiversity net gain: Slurry enhances soil biodiversity by providing easily available nutrients and increasing organic matter and promoting microbial activity. It supports sustainable land management, especially when combined with conservation practices like reduced tillage and diverse crop rotations.
4. Economic viability: Slurry helps to sustain crop yields by improving soil fertility and water retention, which reduces costs for chemical fertilizers. It also aligns with consumer demands for eco-friendly practices (i.e., no input of mineral fertilizer) and can improve farm profitability.
5. Inclusive governance: While primarily used by individual farms, slurry can meet broader consumer expectations for sustainable practices. Its application aligns with environmentally friendly farming systems.
6. Balance trade-offs: Slurry improves nutrient recycling and soil fertility but must be managed carefully to prevent issues like nutrient runoff and water contamination. Effective slurry management balances productivity with environmental protection.
7. Adaptive management: Slurry use can be adapted to specific farm needs, with adjustments made based on crop requirements and environmental conditions. Precision technologies and nutrient monitoring systems enhance the sustainability and effectiveness of slurry applications.
8. Mainstreaming and sustainability: While not uniformly regulated globally, best practices for slurry application focus on minimizing environmental risks, such as runoff and emissions. It is an integral part of sustainable farming systems, adaptable to various animal husbandry-based farming contexts for long-term soil health.

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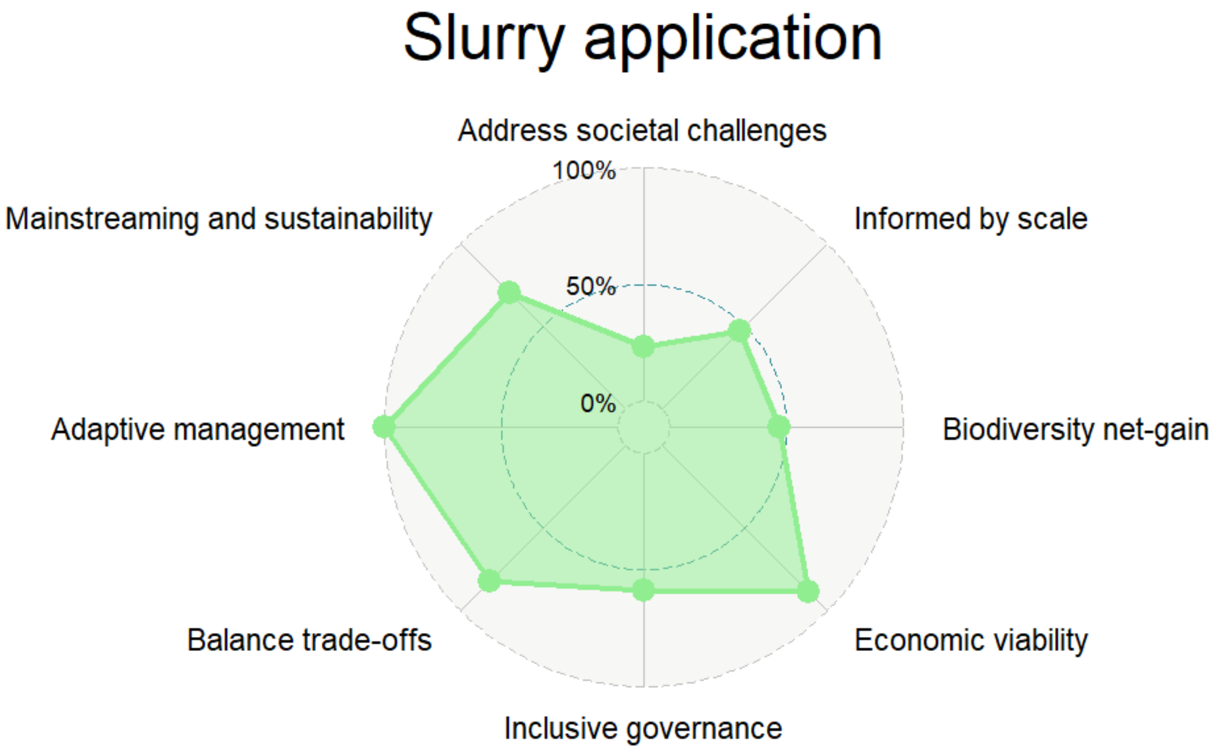

1.1.20 Permaculture

Permaculture is a holistic design system that emphasizes on creating sustainable and self-sufficient environments by mimicking the patterns and relationships found in natural ecosystems. Developed by Bill Mollison and David Holmgren, permaculture integrates land, resources, people, and the environment to create sustainable living systems that meet human needs while improving the health of the surrounding ecosystem. At its core, permaculture follows three main ethics: care for the earth, care for people, and fair share of resources (ensuring resources are distributed equitably). These principles guide the creation of productive landscapes that minimize waste, use renewable energy, conserve water, and promote biodiversity. Permaculture systems or rather gardens typically feature multi-layered plant systems, including trees (both fruit and timber trees), shrubs, herbs, and ground cover plants, similar to natural forests. Designs maximize resources in space and time, support diverse plant interactions, and enhance the resilience of the whole ecosystem.

Since resource (re-)cycling is a key aspect, permaculture also incorporates key practices like rainwater harvesting, composting, and using natural fertilizers to conserve resources. Companion planting and crop rotation further support plant health and productivity without relying on synthetic chemicals. Additionally, permaculture systems are designed to be low-maintenance, relying on natural cycles to sustain themselves

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over time. However, the initial face of implementation may be time- and resource-consuming.
Beyond agriculture, permaculture extends to sustainable living practices, community building, and energy-efficient designs, creating a comprehensive framework for living in harmony with the environment and nature in general. Its goal is to create resilient, regenerative systems that can thrive long-term.

1. Addressing Societal Challenges: Permaculture addresses climate change by promoting regenerative practices that enhance soil health and biodiversity. It also improves food security and water conservation by designing sustainable, self-sufficient systems that produce food with minimal external inputs.
2. Informed by Scale: Permaculture principles can be applied at various scales, from small urban gardens to large rural farms, creating resilient systems that integrate well with surrounding ecosystems. This approach has the potential to foster collaborations among diverse land users, promoting sustainability across community landscapes.
3. Biodiversity Net Gain: Permaculture designs emphasize diversity through polyculture and companion planting. By incorporating various plant species and animal systems, permaculture improves habitat conditions for diverse animals and promotes a well-structured, health soil, which has a beneficial effect on the soil macro-, meso- and microfauna.
4. Economic Viability: Permaculture encourages economic sustainability by reducing dependence on external inputs and fostering local food production. This approach can diversify income streams through the cultivation of multiple crops, herbs, and perennial plants as well as animal husbandry, while also attracting consumers interested in sustainable products.
5. Inclusive Governance: Permaculture promotes community engagement and inclusive decision-making, encouraging collaboration between practitioners, local communities, and consumers. This inclusivity helps align farming practices with the needs and values of the surrounding community, fostering a sense of shared responsibility for sustainable land management.
6. Balance Trade-offs: Permaculture balances the need for productivity with ecological integrity by designing systems that mimic natural ecosystems, promoting resilience. This holistic approach reduces waste, conserves resources, and enhances long-term sustainability while optimizing yields. The aim is not maximum, but optimum, production.
7. Adaptive Management: Permaculture systems are inherently adaptive, encouraging continuous learning and adjustment based on observation and feedback from the environment. This adaptability allows practitioners to respond effectively to changing conditions and integrate new techniques and technologies.
8. Mainstreaming and Sustainability: While still developing regulatory frameworks, permaculture practices are increasingly recognized for their role in sustainable agriculture and land management around the globe spanning from tropical to boreal biomes. By promoting ecological stewardship and resilience, permaculture aligns with broader sustainability goals and provides viable solutions for future food production.

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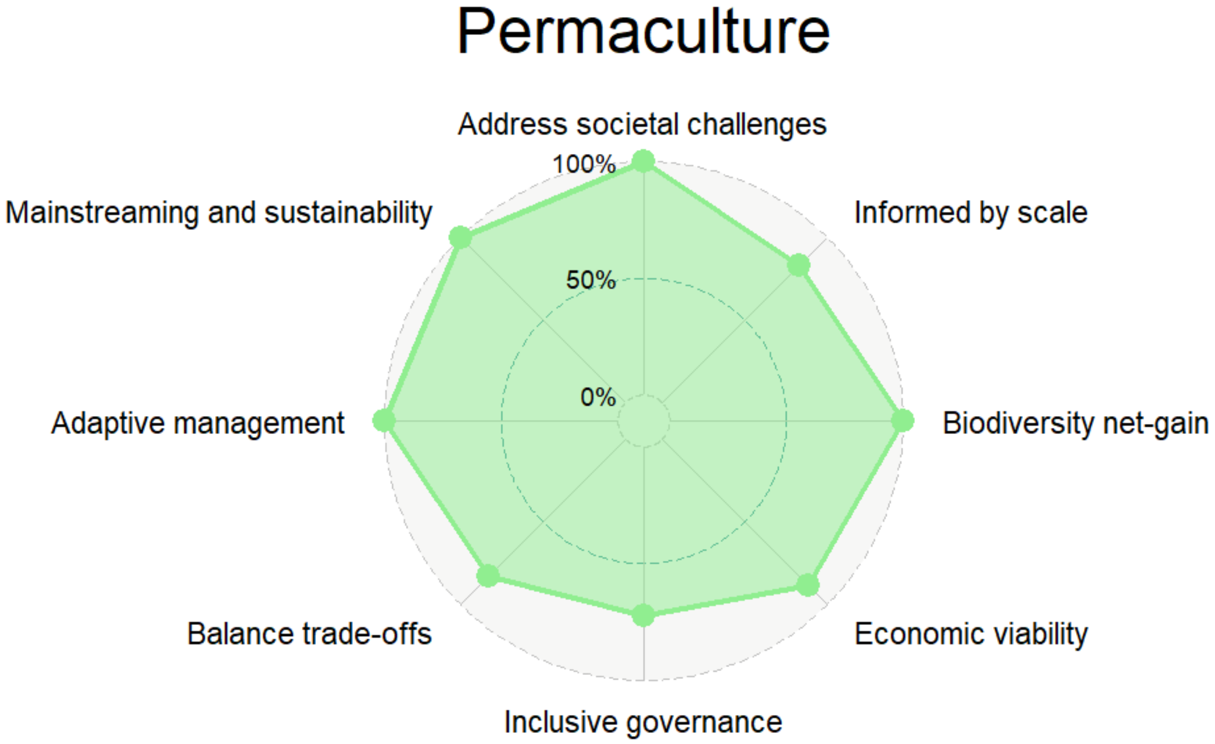

1.1.21 Syntropic agriculture

Syntropic agriculture is an agroforestry system that focuses on mimicking natural forest ecosystems to promote biodiversity, soil health and sustainable food production. Developed by Ernst Götsch, this approach integrates trees, crops and animal husbandry in a dynamic system that encourages natural succession and regeneration. The key principle of syntropic agriculture is to create a self-sustaining environment where every element of the system supports the others, leading to increased ecosystem productivity and resilience over time.

Syntropic agriculture is a small-scale agricultural system. Plants are arranged in different layers, from ground covers to tall trees, thus optimizing the use of sunlight and space. The system emphasizes constant pruning and biomass production, with most of the organic material being returned to the soil as mulch. This process enhances soil structure, increases moisture retention and nutrient availability which has beneficial effects on soil health. Over time, the soil becomes richer in nutrients, plant growth and productivity is enhanced and synthetic inputs like mineral fertilizers or pesticides are reduced at the same time.

Another key feature of syntropic agriculture is the focus on natural succession. By managing plant growth stages, farmers can guide the system through a process of continuous renewal, allowing more resilient and productive species to take over as conditions improve. This not only enhances biodiversity but also stabilizes the ecosystem, making it more resistant to climate extremes and other environmental stressors. Moreover, by having multiple crops during the year, the farming system is more resilient to losses of single crops due natural events such as pest infestation. Moreover, having multiple crops also distributes the workload better over the whole vegetation period.

Syntropic agriculture offers a regenerative and sustainable way to produce food and other goods, while also restoring ecosystems and sequestering carbon in the soil. Its holistic approach helps farmers to create resilient, self-maintaining landscapes that are productive and aligned with the rhythms of nature.

1. Address societal challenges: Syntropic agriculture enhances climate resilience by mimicking natural ecosystems, improving soil health, sequestering carbon, and supporting overall biodiversity. It addresses food security through regenerative practices that boost productivity while conserving natural resources.
2. Informed by scale: Syntropic agriculture integrates farm systems with surrounding ecosystems, thus closing nutrient cycles and increasing biodiversity across landscapes. Its methods can be adapted to both small and large-scale farms, as well as urban areas, enhancing overall environmental sustainability.

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3. Biodiversity net gain: Syntropic agriculture emphasizes on agroforestry and multi-species planting, which increases biodiversity both above- and belowground. The focus on species diversity supports ecosystem productivity and resilience, reduces soil erosion, and enhances resilience to pests and diseases.
4. Economic viability: Syntropic systems stabilize yields directly by enhancing the number of cultivated crops, and indirectly by positively affecting soil fertility, water retention and crop resilience. They also offer diversified income sources through the production of multiple crops and the potential to meet consumer demand for sustainably produced products.
5. Inclusive governance: Syntropic agriculture is often community-driven, encouraging collaboration between farmers, consumers, and local communities. It responds to consumer expectations for sustainable, regenerative farming and promotes shared stewardship of land and resources.
6. Balance trade-offs: Syntropic practices balance productivity with ecosystem health by promoting natural regeneration and reducing reliance on external inputs like chemical fertilizers. They ensure long-term sustainability by improving soil, water retention, and biodiversity. Trade-offs may appear with the use of farming machinery, since conventional devices may not be applicable. In this regard, new machines or rather devices may be needed.
7. Adaptive management: Syntropic agriculture is inherently flexible, evolving based on farmers' observations of ecosystem dynamics and feedback from the environment. It embraces innovation, integrating modern tools and techniques to enhance regenerative farming practices.
8. Mainstreaming and sustainability While not yet mainstream, syntropic agriculture is gaining recognition as a sustainable farming model outside the tropical and subtropical biomes. Its principles are adaptable to various contexts and environments, emphasizing long-term ecological health and economic sustainability for future generations.

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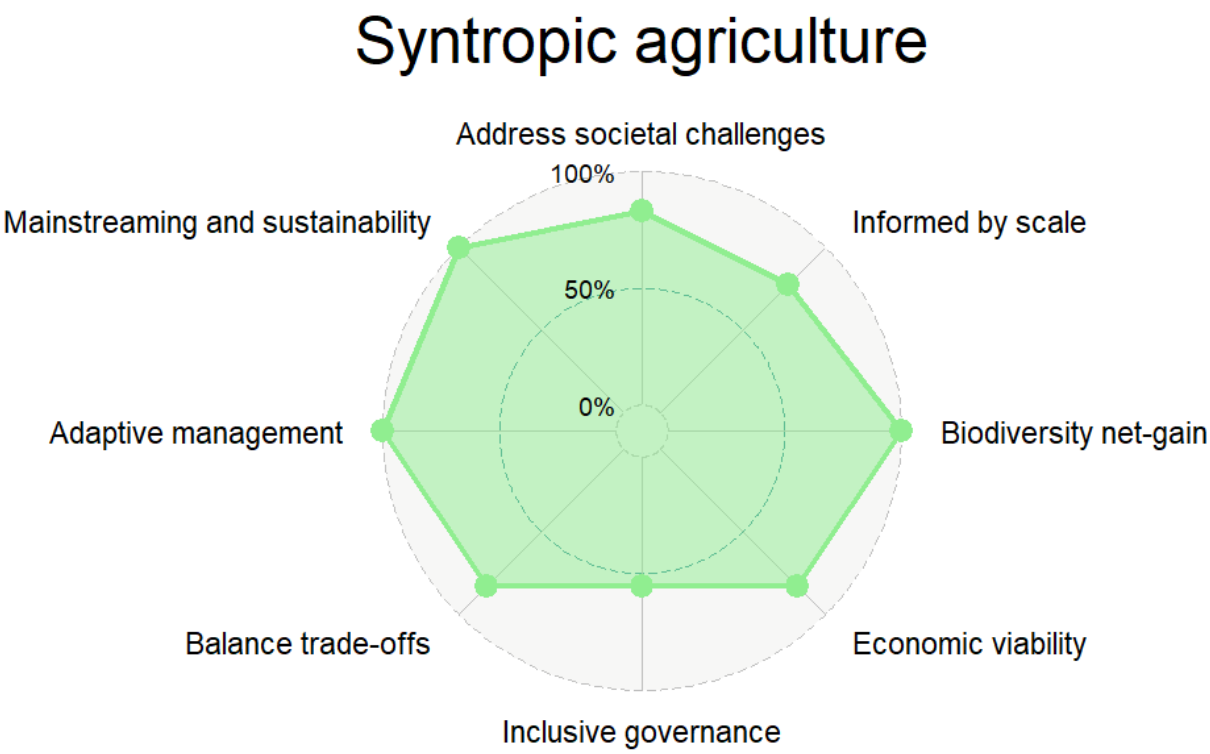

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1.1.22 Food forests

A food forest is a sustainable, self-sufficient agricultural system designed to mimic the structure and function of natural forests, while producing food from annual crops at the same time. This method of agroforestry creates a diverse, multi-layered ecosystem where trees, shrubs, herbs, and ground covers grow together in a harmonious balance. The idea is to cultivate a wide variety of edible plants – such as fruits, nuts, vegetables, and herbs – while also fostering ecosystem biodiversity and improving soil health.

Food forests are typically designed with multiple layers, similar to a natural forest: tall canopy trees, understory trees, shrubs, herbaceous plants, ground covers, and even root crops and vines. This multi-layer system maximizes the use of vertical space, allowing plants to thrive in their optimal conditions, whether sun or shade. The diversity of species helps protect against pests and diseases, reducing the need for chemical inputs. All these layers serve different purposes, from the production of timber and agricultural products to soil protection, increased ecosystem biodiversity and resilience.

One of the key benefits of food forests is their ability to build and regenerate soil. The fallen leaves and organic matter decompose, enriching the soil with nutrients and improving its structure over time. Deep-rooted plants help break up compacted soil and bring up minerals from deep layers, benefiting surrounding plants. Therefore, these systems are also protected from nutrient leaching, since-deep rooting tree roots can uprise nutrients otherwise lost for annual crops.

Food forests also play a vital role in water conservation. The rich, organic mulch layer helps retain moisture, reducing the need for irrigation. Additionally, by planting perennial species that return year after year, food forests – after a high workload when initiating such a system – require less maintenance compared to conventional gardens or farms, making them a low-input, high-output systems.

1. Address societal issues: By storing carbon and fostering biodiversity through a variety of perennial plants, food forests help to slow down climate change. By providing a robust, self-sustaining food source, they preserve water and restore soil health, so enhancing food security.
2. Informed by scale: By improving soil fertility and fostering wildlife habitats, food forests sustain ecosystems that extend beyond individual farms, benefiting both local and vast landscapes. They support sustainable food systems at different scales and are adapted to urban, peri-urban, and rural environments.
3. Net gain in biodiversity: Food forests' polyculture method promotes high levels of biodiversity both above and below ground. They improve soil protection, boost resilience against pests and diseases, and diversify habitats through multi-layered plant systems.
4. Economic viability: Food forests generate several sources of revenue and can be implemented on marginal land.
5. Inclusive governance: These systems can be established at small scales and therefore be self-organized, promoting inclusive governance.
6. Balance trade-offs: Food forests balance productivity with environmental health by creating self-sustaining ecosystems that require fewer external inputs and provide long-term yields. While initial establishment takes time, the benefits increase over time with minimal maintenance.
7. Adaptive management: Food forests are dynamic systems that evolve with ecological feedback, requiring continuous observation and adjustment. They integrate traditional knowledge with modern practices, fostering innovation in areas like plant selection, water management, and soil health.
8. Mainstreaming and sustainability: While still gaining momentum, food forests are increasingly recognized for their role in sustainable agriculture and resilient food systems. Their adaptable, low-input nature aligns with global sustainability goals, promoting long-term food production without degrading ecosystems.

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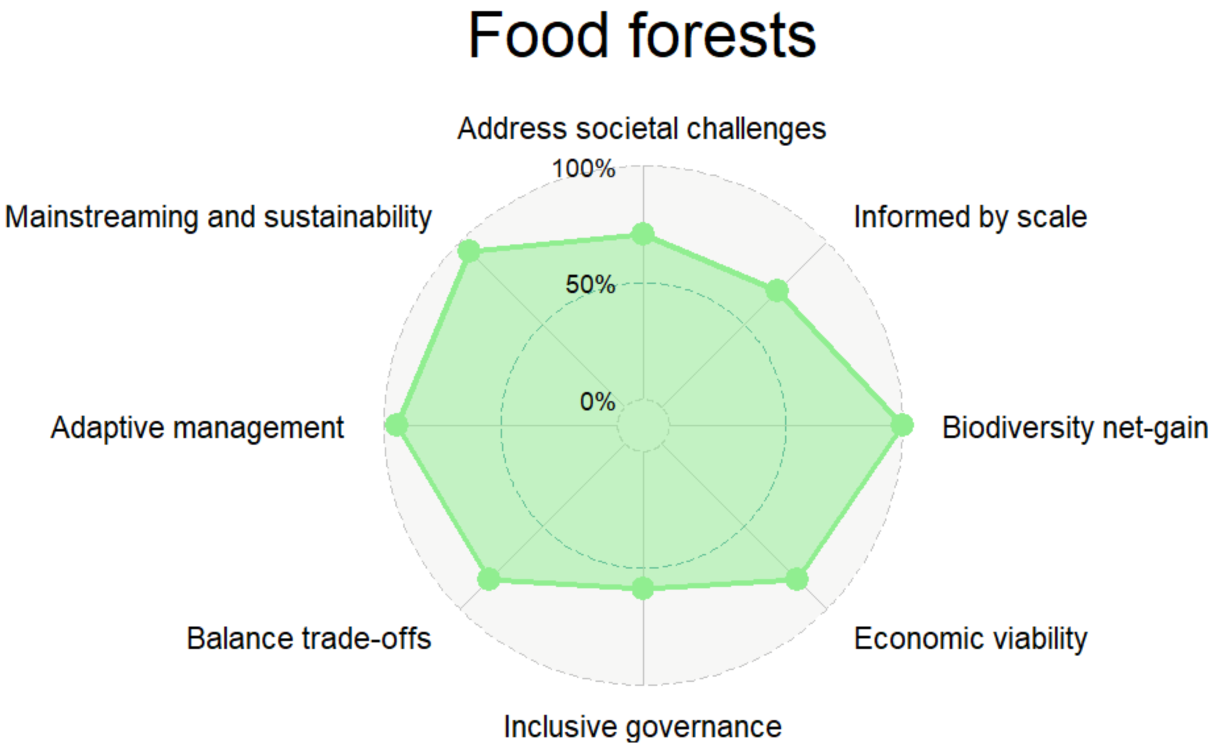

1.2 Bioremediation

1.2.1 Phytoremediation

Phytoremediation is an eco-friendly approach leaning on plants ability to remove, stabilize or degrade hazardous substances, as inorganic elements, and organic pollutants, from the environment. Different plants can absorb, accumulate, or translocate contaminants in different ways and, thus, diverse practices could be envisaged, namely phytoextraction, phytodegradation, phytovolatilization, rhizofiltration and rhizodegradation.

Phytoremediation is a practice for remediating polluted soils at defined locations with the aim of reducing toxic elements or compounds in the soil. The ultimate goal is to remove or immobilize pollutants that pose an acute toxic risk to the environment (soil, water, biosphere) or to humans. By achieving this, the soil can be made fit to provide its ecosystem functions (or agricultural production functions) or urban ground for construction and development without posing risks to people or the environment.

Phytoremediation seeks to achieve these goals by utilizing carefully selected plants and soil amendments (like manure or compost) over a number of vegetation cycles. The activities of the plants contribute to the removal of pollutants from the soil or their breakdown into metabolites. This happens often in conjunction with microorganisms.

Phytoremediation could be a successful cleanup measure to revegetate polluted soil in a cost-effective way but, to improve its efficiency, a better understanding of the site and crucial plant-specific mechanisms underlying contaminants accumulation and tolerance in plant is indispensable. Particularly, the use of phytoremediation needs a much more in-depth knowledge of the site-specific conditions, to select the most suitable technique.

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The effectiveness of phytoremediation technologies depends on several factors: i) type and characteristics of the substrate to remediate; ii) type, speciation, and number of contaminants; iii) bioavailability of contaminants; iv) intensity of contamination; v) plant species.

Among techniques, phytoextraction with accumulators or fast-growing plants has received the larger interest due to its versatility but has, currently, limitations due to the uptake rates, leading to long reclamation times. Phytodegradation and rhizodegradation of organic compounds are closer to a large-scale possible use, as many microbial consortia and enzymes are already commercially available, although their use is retarded from the cultural reluctance to adopt less controllable techniques.

Pollutants occur in soils due to previous industrial activity and is often the result of decades of human industrial and commercial activity. Pollutants in the soil that can be addressed through phytoremediation are:

- heavy metals like Zn, Cu, Pb, Cd, As, and others
- organic pollutants like PAHs (polycyclic aromatic hydrocarbons), stemming often from petroleum based oils, fuels and solvents
- pesticides and some of their metabolites stemming from intensive use of very persistent insecticides or fungicides in the past
- air emissions from industrial areas or from combustion engine exhausts. These can be very fine particulates containing traces of PAHs or heavy metals

What concentration levels of potential pollutants in the soil constitute a toxic risk of concern or even dangerous levels is defined by national or European guidelines. For example Zinc or Copper will occur naturally in soils and at certain low levels are even micro-nutrients necessary for plants and animals. But at higher concentrations their bio-toxicity can be a concern. Legal guidelines or scientific publications help to define wether remediation action is necessary or not.

The selected plants usually have notable absorbtion capacity for specific heavy metals and are selected based on the pollutants found at the site. The plants can be annual, bi-annual or perennial. They can be woody or herbaceaous. Some of the plants can be “exotic” and sub-tropical of origin.

Soil amendments for phytoremediation often include manures, compost, bio-char or others. In general the goal of adding the amendments to the soil is to increase the binding capacity of soils (basically increase its cation exchange capacity) as well as its general sorbtion and retention capacity. This reduces the risk of washing out of pollutants into the groundwater as well as supporting plant growth and metabolic activity. Sometimes deficient plant nutrients are added (like nitrogen for example).

Phytoremediation is a decontamination practice that requires several years to achieve satisfactory results. Compared to other soil decontamination practices it can be very cost effective and with low resource and energy consumption, but it usually takes a comparatively long time.

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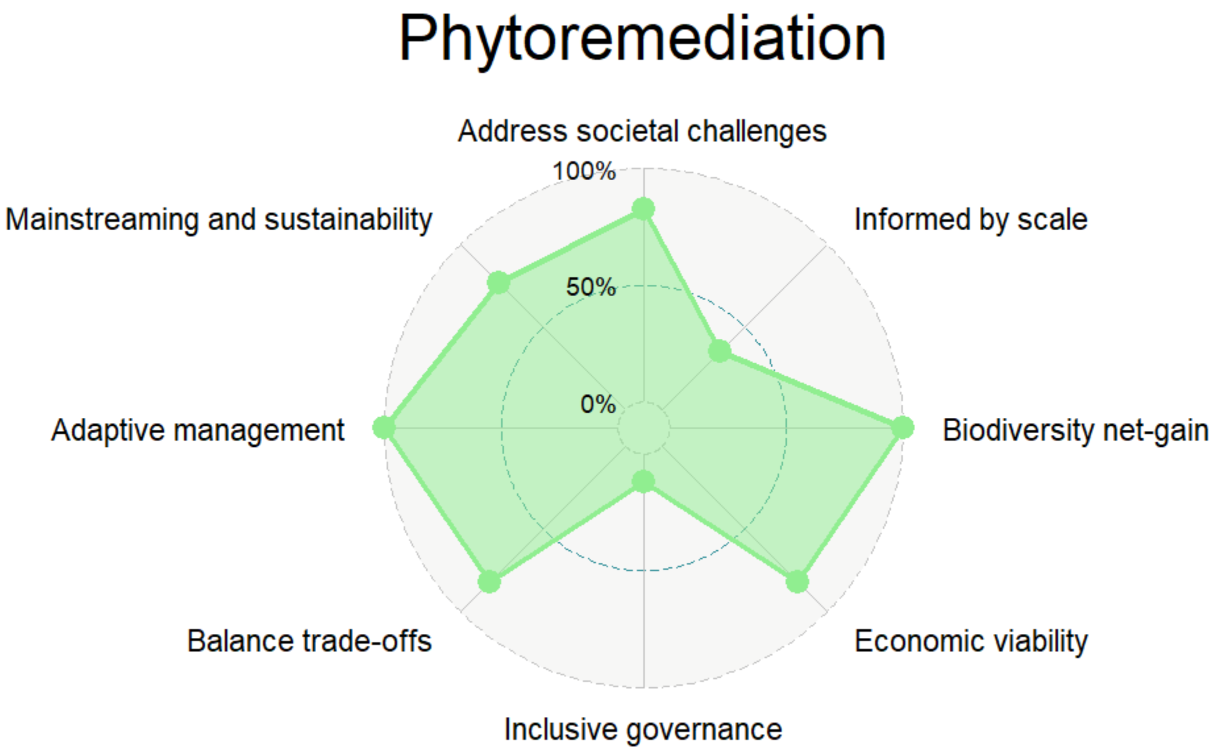

1. *Address societal challenges:* Main challenges addressed are risks from pollutants in soil, avoidance of waste generation (top soil to landfill disposal), recovering full potential of soil ecological functions.
2. *Informed by scale:* Technology is relatively new and with comparatively few practical case studies therefore large-scale adoption is not yet prevalent.
3. *Biodiversity net gain:* Plant biodiversity is enhanced by the intervention activities and soil biome is also actively enhanced.
4. *Economic viability:* Cost of phytoremediation is comparatively low to conventional soil decontamination options, but it requires much more time.
5. *Inclusive governance:* It is generally recommended that neighbors and possible stakeholders be informed of phytoremediation activities, but the interventions are guided mostly be scientific and technical parameters.
6. *Balance trade-offs:* The long time required to remediate soil pollution has to be weighted against the lower cash expense needs and the environmentally friendly characteristics of the technology.
7. *Adaptive management:* Monitoring of soil and plant health enables to react to eventualities.
8. *Mainstreaming and sustainability:* Phytoremediation is still undergoing research and development and

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most case studies are still in the academic realm. Notable success stories will help to boost its adoption into the mainstream. The utilization of living plants and natural metabolic processes confer the intervention with a high degree of sustainability.

Sources of information: *to be updated in subsequent version*

NBS-demo sites: Northern Austria, Torino Italy and Pulawy area in Poland

Courses on Nbs-Academy: *to be updated in subsequent version*

1.2.2 Bioremediation

Bioremediation techniques are biological methods involving the stimulation of the native soil microorganisms or the introduction of new species to enhance the degradation of organic contaminants in soils. They are considered interesting particularly for the treatment of mixed pollutants.

Among used techniques are *ex-situ* techniques, as biopiles, landfarming, and bioreactors (slurry-phase treatments), already at a commercial level, although with a small market-share, and *in-situ* bioremediation methods (as natural attenuation, bioaugmentation or bioventing), less developed due to the potentially longer remediation times even if less costly.

Bioremediation can also be performed together with phytoremediation, helping to degrade pollutants in the soil and make them less harmful and they can also help to promote plant growth and reduce stress. Some examples of microbes used in phytoremediation include bacteria such as *Pseudomonas putida, Rhizobium leguminosarum*, and *Bacillus subtilis*, and fungi such as *Trichoderma harzianum* and *Aspergillus niger*.

The main advantages of these approaches are the cost-effectivity and the sustainability because, as a natural process, they do not require the use of chemicals or heavy equipment. Conversely, using conventional techniques, the treatment activities have a strong impact on soil health, and treated soils must be amended to be reutilized. This low impact makes bioremediation methods, particularly *in-situ* ones, useful in various settings including urban areas, as they are socially and environmentally acceptable also in densely populated areas, having direct benefits to all soil ecosystem services.

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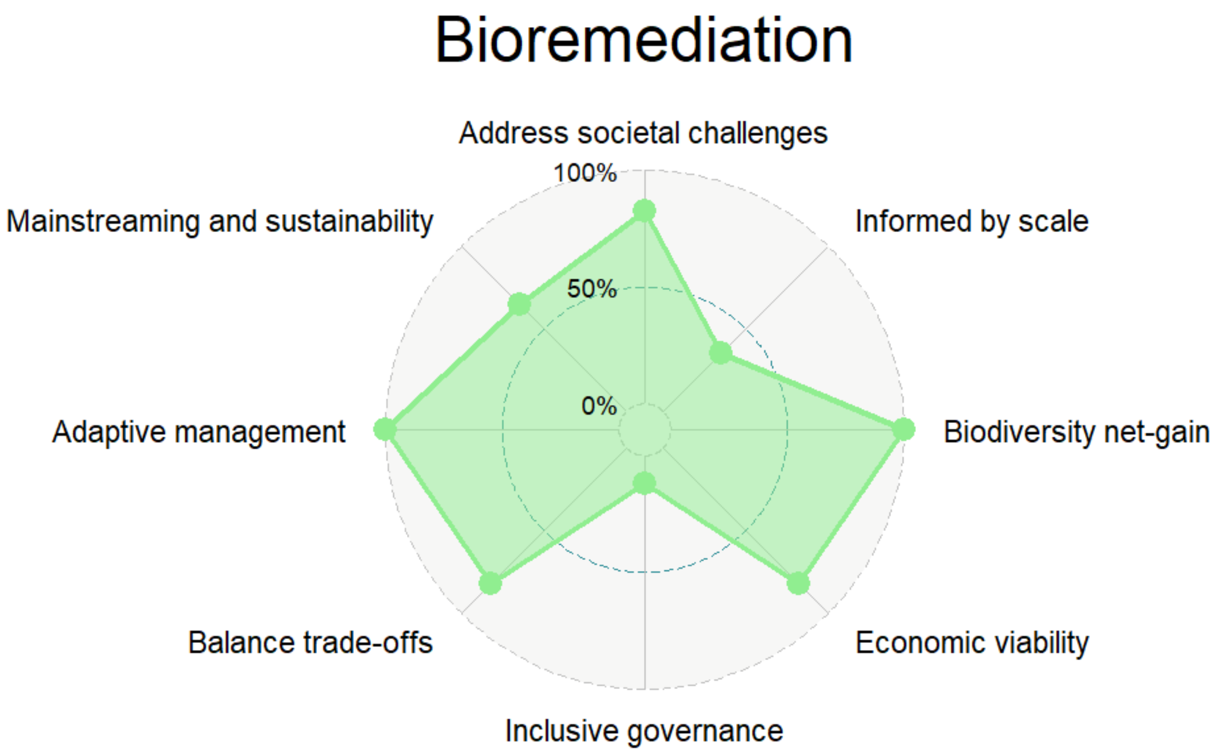

NBS-demo sites: *to be updated in subsequent version*

Courses on NBS-Academy: *to be updated in subsequent version*

1.2.3 Phytomining

Phytomining, literally "mining from plants," has emerged as an environmentally sustainable green technology for extracting valuable elements from contaminated soils, particularly in locations where traditional mining methods are not economically viable. This approach is a variation of the concept of phytoextraction, which involves the absorption or removal of soil or water pollutants through the cultivation of specially selected plants. The plants used for extracting elements for the metallurgical industry are typically hyperaccumulators of metals such as nickel, cobalt, selenium, zinc, or rare elements. Hyperaccumulators include flowering plants (e.g., *Alyssum bertolinii*; *Noccaea caerulescens*), trees (e.g., *Glochidon* cf. *sericeum*), and ferns (*Dicranopteris pedata*).

Phytomining operations involve planting hyperaccumulator crops on metal-rich soils (e.g., nickel-rich ultramafic soils for nickel phytomining), followed by harvesting and incinerating the biomass to generate a high-grade commercial 'bio-ore' from which the metal is extracted. The physical properties of the soil play a critical role in the success of phytomining. For example, well-drained soils are ideal for cultivating nickel hyperaccumulators, as poorly drained soils can reduce plant biomass production, thereby limiting the amount of nickel that can be extracted.

Phytomining is a subset of agromining, a broader concept that integrates agricultural practices into the process. Agromining involves cultivating "metal crops" on degraded or metal-rich soils with the dual purpose of soil

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remediation and metal recovery. This approach highlights the combined benefits of environmental restoration and the sustainable extraction of valuable metals from otherwise unusable lands.

1. Address societal challenges: Main challenges addressed are environmental degradation and biodiversity loss, human health and food and water security.
2. Informed by scale: Mostly directed to single areas where implemented. Larger-scale effects depend on governmental policies.
3. Biodiversity net gain: Provides a measure to diversify common crop rotations which can be readily implemented in most farming systems. Main biodiversity gains for soil (micro)organisms and insects.
4. Economic viability: The phytomining have almost a zero cost while a traditional soil remediation have huge costs and externalities as soil landifilling.
5. Inclusive governance: Mostly solution for individual fields and within a single farm. Non-farm stakeholders profit mostly from a diversification of agricultural landscapes (aesthetic value).
6. Balance trade-offs: Single management measures with few negative trade-offs beyond the immediate costs for implementation (economic trade-off).
7. Adaptive management: Plants during phytomining are continuously managed as a monitoring and evaluation plan should be developed to increase extraction rates. Adapted farming practices should be created by the farmer based on its experience.
8. Mainstreaming and sustainability: Phytomining is an intervention already sustainable and accepted from the public. The NbS is also economically transferable

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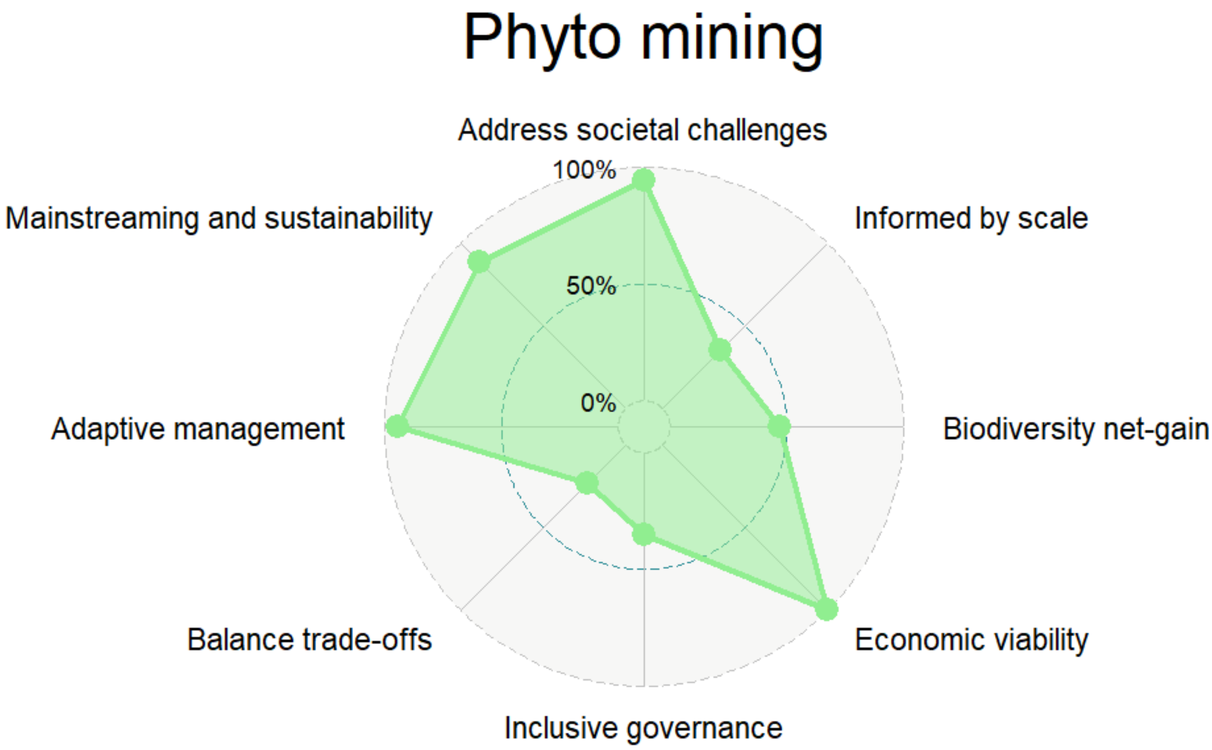

1.2.4 Phytomanagement

Phytomanagement is an innovative phytotechnology aimed at restoring contaminated sites through the strategic use of plants and their associated microorganisms. This approach not only focuses on ecological

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recovery but also emphasizes economic viability, making it a sustainable solution for managing polluted environments. By utilizing specific plant species that can thrive in contaminated soils, phytomanagement helps to restore soil ecological functions, reduce pollutant linkages, and generate economic returns through the production of non-food crops suitable for biomass-processing technologies. The environmental advantages of phytomanagement are multifaceted. It provides essential ecosystem services, including:

- Water Drainage Management: Plants enhance water infiltration and drainage, mitigating flooding risks.
- Soil Erosion Deterrence: Root systems stabilize the soil, reducing erosion caused by wind and water.
- Carbon Sequestration: contributes to carbon capture, helping to mitigate climate change impacts.
- Nutrient Cycling Regulation: Plants facilitate nutrient recycling in the soil, promoting healthier ecosystems.
- Xenobiotic Biodegradation: Certain plants can break down harmful organic pollutants, improving soil health.
- Metal(loid) Stabilization: can immobilize heavy metals in the soil, preventing their entry into the food chain.

Beyond ecological restoration, phytomanagement offers significant economic benefits as the cultivation of biomass crops can serve various industries, including biofuels. By utilizing contaminated sites for bioenergy production instead of fertile agricultural land, phytomanagement reduces pressure on food production systems while contributing to net-zero carbon emissions targets.

1. Address societal challenges: Main challenges addressed are environmental degradation and biodiversity loss, human health and food and water security.
2. Informed by scale: Mostly directed to single areas where implemented; however, the design could be integrated with complementary interventions in other compartments.
3. Biodiversity net gain: Phytomanagement employs various plant species to remediate contaminated soils, leveraging their natural abilities to absorb, stabilize, or degrade pollutants. Main biodiversity gains also for soil (micro)organisms and insects.
4. Economic viability: Beyond ecological restoration, phytomanagement offers significant economic benefits by choosing the current plant species. It creates a dual benefit: not only does it remediate contaminated lands, but it also generates revenue streams for local communities.
5. Inclusive governance: Mostly solution for individual fields and areas. Stakeholders could be involved in decision-making process if some specific risk are present.
6. Balance trade-offs: Single management measures with few negative trade-offs beyond the immediate costs for implementation (economic trade-off).
7. Adaptive management: Plants are continuously managed as a monitoring and evaluation plan should be developed to increase extraction rates. Adapted farming practices should be created by the farmer based on its experience.
8. Mainstreaming and sustainability: Phytomanagement is an intervention already sustainable and accepted from the public. The NbS is also economically transferable.

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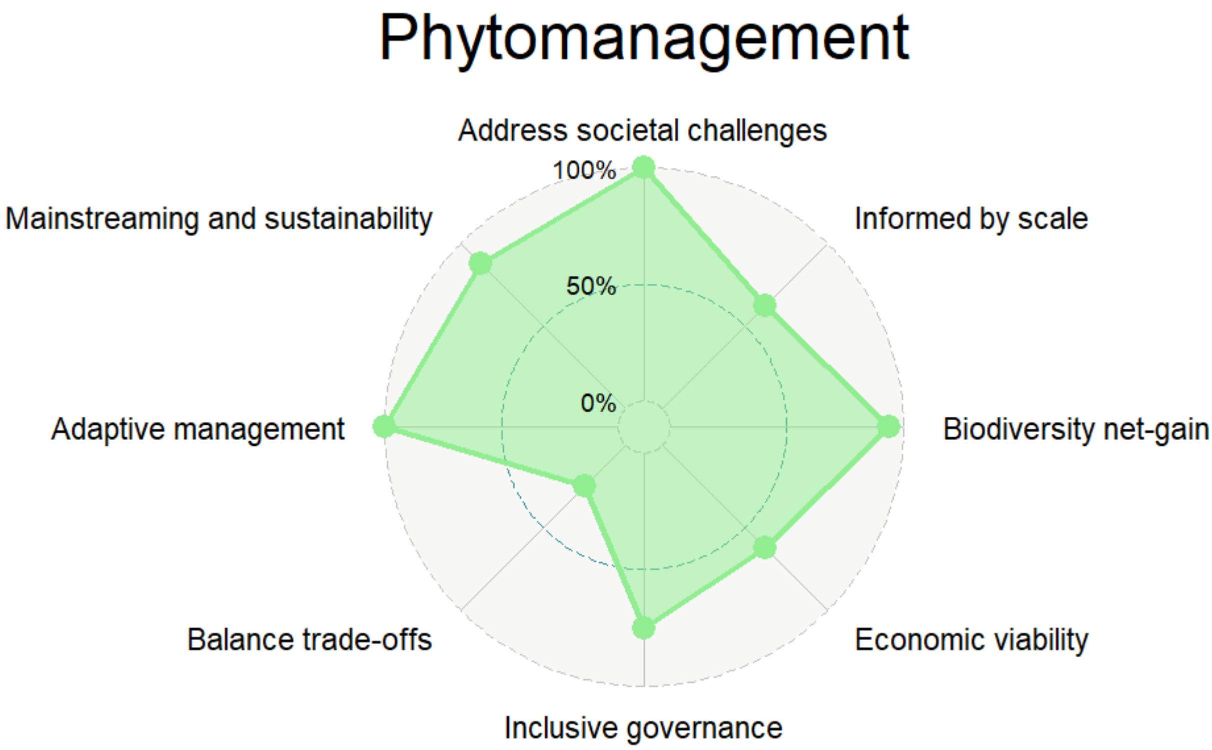

1.3 Blue-green infrastructure

1.3.1 Green infrastructure

Praxis abstract (max. 1500 characters – short summary for practitioners)

Green infrastructure is a planned network of natural and semi-natural areas designed and managed to provide ecosystem services. Examples of green infrastructure include parks, gardens, green roofs, ecological corridors or waterways. It may also arise through afforestation of abandoned industrial sites.

Green infrastructure provides many benefits. Urban greenery reduce the risk of flooding which is progressively important because the frequency of heavy rainfall events increases. It also cool the city in summer and decrease the urban heat island, mostly by evaporation and by tree providing shadow, and contribute to climate change mitigation. Another important profit is supporting biodiversity. Green infrastructure is a habitat for a wide variety of wildlife, in particular soil organisms, insects, birds and mammals. Soil organisms are essential for sustaining ecosystems in the city and the services they deliver. Urban green spaces contribute to human health and well-being too. Nature lowers stress, accelerates recovery after illness and reduce air dust and its damaging effect on human health. Urban greenery is usually used by residents as place for recreation and relaxation. Green infrastructure, especially parks, also affects the price of houses in its surroundings. Residents are willing to pay more knowing that they have a view of greenery.

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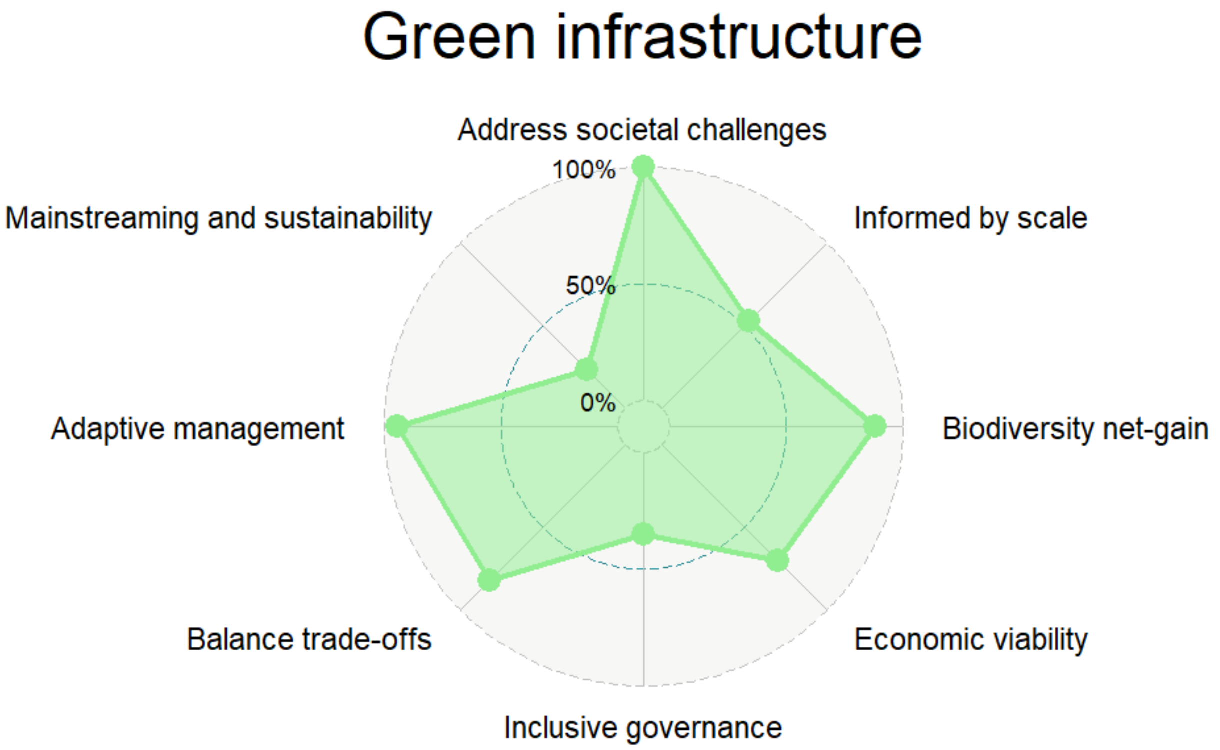

1. *Address societal challenges:* Main challenges addressed are environmental degradation and biodiversity loss, climate change mitigation and adaptation (buffering extreme rainfall events and urban heat island), disaster risk reduction (flooding), human health and economic and social development.
2. *Informed by scale:* Mostly directed to single districts. Scale effects can be found for neighboring districts.
3. *Biodiversity net gain:* Provides a habitat for many wildlife species: soil organisms, insects, birds and mammals.
4. *Economic viability:* Green infrastructure avoids costs associated with the use of air conditioners in summer and the disposal of excess rainwater. It also can affects the price of houses in its surroundings.
5. *Inclusive governance:* Mostly solution for residents in the city.
6. *Balance trade-offs:* In the long term, the trade-offs are balanced by the environmental benefits (climate change mitigation, disaster risk reduction).
7. *Adaptive management:* Properly designed neighborhood greenery can be adopted throughout the city and in other cities, regardless of size
8. *Mainstreaming and sustainability:* Not all cities have a spatial development plan, so green infrastructure is often marginalized at the planning stage of new settlements.

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Sources of information: https://www.fao.org/3/cb8617en/cb8617en.pdf

NBS-demo sites: *to be updated in subsequent version*

Courses on NBS-Academy: *to be updated in subsequent version*

1.3.2 Urban farming

Urban farming is a practice of cultivating, processing, and distributing food in or around urban areas. Many cities have communal urban gardens available to the public providing space for citizens to cultivate plants for food, recreation and education.

Urban agriculture has many environmental and social benefits. It contributes to increased local and healthy food production and increased biodiversity. A microgarden of one square meter can produce any one of the following: 30 kg tomatoes a year, 36 heads of lettuce every 60 days, 10 cabbages every 90 days, 100 onions every 120 days. It also helps mitigate the urban heat island effect and reduce the risk of flooding. From the cultural point of view it supports social ties through recreation and connection to nature.

A specific type of urban farming are green roofs. Green roofs reduce the urban heat island effect by increasing evapotranspiration. In winter they can reduce heat loss and energy consumption. Green roofs can also decrease the amount of rainwater runoff and they increase biodiversity and provide habitat for various bird species.

The plants on green roofs can capture air pollutants and dust which results in a decline in smog levels. Besides green roofs have excellent noise reduction. Because of those green roofs improve health and well-being of citizens.

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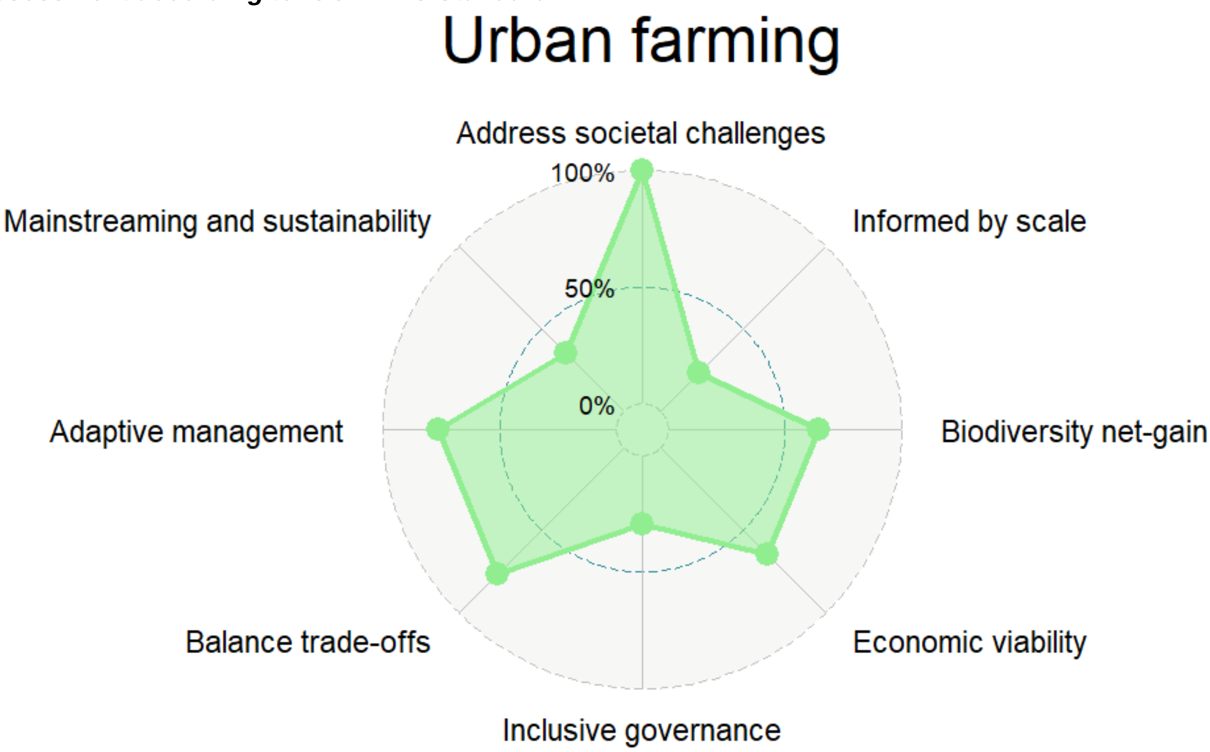

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1. *Address societal challenges:* Main challenges addressed are environmental degradation and biodiversity loss, climate change mitigation and adaptation (buffering extreme rainfall events), disaster risk reduction (flooding), human health and economic and social development.
2. *Informed by scale:* Mostly directed to single districts. Scale effects can be found for neighborhood.
3. *Biodiversity net gain:* Provides a habitat for many species: soil organisms, insects, birds and mammals.
4. *Economic viability:* Green roofs can reduce heat loss and energy consumption. Urban farming provides healthy and local food for city dwellers.
5. *Inclusive governance:* Mostly solution for residents in the city.
6. *Balance trade-offs:* In the long term, the trade-offs are balanced by the environmental and cultural benefits (disaster risk reduction, production of food, increase in biodiversity).
7. *Adaptive management:* Urban farming and green roofs can be adopted throughout the city and in other cities.
8. *Mainstreaming and sustainability:* Urban farming can help to contribute to create a sustainable development.

Sources of information: https://www.fao.org/soils-2015/news/news-detail/en/c/329009/

https://greenroofs.org/about-green-roofs

NBS-demo sites: *to be updated in subsequent version*

Courses on NBS-Academy: *to be updated in subsequent version*

1.3.3 Bioswales

Bioswales are engineered landscape features designed to manage urban stormwater runoff while improving water quality. They are typically shallow, vegetated channels that capture, treat, and infiltrate stormwater, making them an essential component of sustainable urban drainage systems. They integrate natural processes to manage and treat stormwater, effectively mimicking the functions of natural ecosystems.

Bioswales are often shaped like ditches with a parabolic or trapezoidal cross-section. They are lined with vegetation and can include layers of soil, gravel, or other materials to enhance drainage and filtration. The vegetation slows down water flow, allowing pollutants to settle and be filtered or absorbed by the soil and plant, enhancing water quality before it re-enters the groundwater or nearby water bodies. They help reduce flooding by allowing rainwater to infiltrate the ground rather than overwhelming drainage systems. This is particularly crucial in urban areas where impervious surfaces dominate.

Some variations include:

Grassed Swales: Simple vegetated channels primarily using grass.

Wet Swales: Designed to hold water for longer periods.

Dry Swales: Drain quickly after rainfall but still filter runoff

Bioswales can be designed with specific vegetation that promotes biodiversity, serving as ecological corridors that support wildlife and enhance urban green spaces. Beyond environmental advantages, bioswales can beautify urban landscapes, making them more appealing to residents while also providing educational opportunities about sustainable practices.

1. *Address societal challenges:* Main challenges addressed are climate change mitigation and adaptation, disaster risk reduction and environmental degradation and biodiversity loss.
2. *Informed by scale:* Mostly directed to single areas where implemented; however, the design could be integrated with complementary interventions in other compartments.
3. *Biodiversity net gain:* Bioswales can be designed with specific vegetation that promotes biodiversity, serving as ecological corridors that support wildlife and enhance urban green spaces.
4. *Economic viability:* Compared to traditional stormwater management systems like concrete gutters or

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underground pipes, bioswales are often less expensive to construct and maintain while providing multiple environmental benefits.

5. *Inclusive governance:* As a solution to be used in urban areas, bioswales should adhere to the legal and regulatory provisions.
6. *Balance trade-offs:* Bioswales have almost no trade-offs as their cost of implementation and management is lower than traditional systems.
7. *Adaptive management:* Their effectiveness should be monitored along time and plant should be studied to avoid excessive vigour and need of maintenance.
8. *Mainstreaming and sustainability:* Beyond their functional benefits, bioswales enhance urban landscapes by providing green spaces that support biodiversity. They can be designed with a variety of plant species to attract wildlife and improve the visual appeal of neighborhoods.

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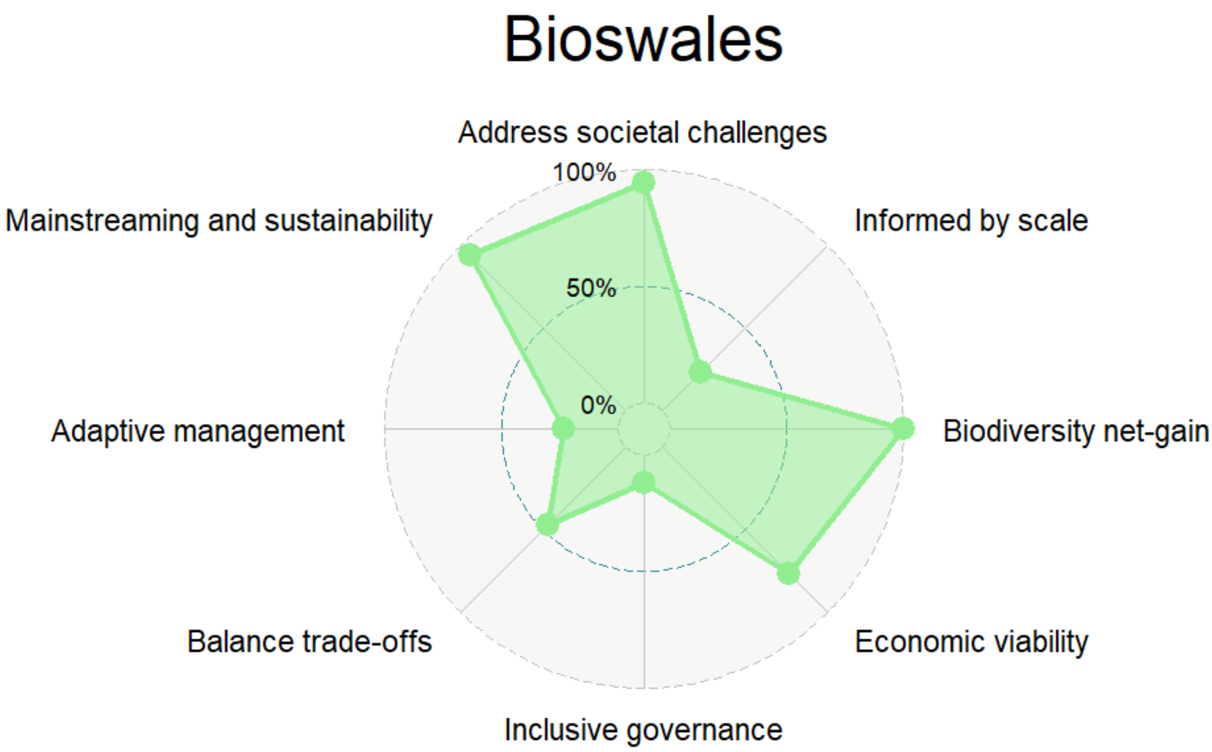

1.3.4 Regenerated soils

Regenerated soils, also known as Technosols, are engineered mixtures of inorganic and organic materials crafted to replicate natural soil, making them conducive to plant growth. In response to land degradation, and to the abundance of waste materials in urban environments, the tailored creation of Technosols has emerged as a viable strategy for rehabilitating areas and enhancing urban green spaces.

The formulation of a Technosol is influenced by several factors:

- *The problem to be tackled, as the area to be recovered can have remnants of previous activities such as contamination, rubbles, compaction.*

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- *The intended outcome, whether it's establishing an urban green space or remediating a mining site.*
- *The availability of the materials.*
- *The anticipated duration of the project.*

A diverse range of materials can be utilized in constructing Technosols, including both natural and recycled resources, such as construction and demolition debris, clay, sewage sludge, and others. This approach not only repurposes large volumes of materials that would otherwise contribute to landfill waste, but also supports the transition toward a circular and sustainable economy.

Selecting the right components is crucial, particularly with respect to the intended use of the regenerated soil; a park located in an urban center would necessitate higher-quality soil than a rehabilitated mining site. Similarly, if low-quality soil is used, it may still support pioneer plants that have minimal requirements. The effectiveness of the substrate in fulfilling essential soil functions is also influenced by local conditions such as climate, surrounding surfaces, and land use.

1. *Address societal challenges:* Main challenges addressed are climate change mitigation and adaptation, human health, environmental degradation and biodiversity loss.
2. *Informed by scale:* As for all urban green areas, the design should be integrated with complementary interventions depending on the area and the interaction with the people and the solution.
3. *Biodiversity net gain:* Regenerated soils are a way to restore the ecological functioning of an area, promoting biodiversity, serving as ecological corridors and enhance urban green spaces.
4. *Economic viability:* Compared to traditional land regeneration activities, regenerated soils are less costly as the starting materials are cheap.
5. *Inclusive governance:* Co-design activities should involve representatives from companies, research centres and authorization bodies depending on the area. Social involvement of the local population is key to increase awareness about the site.
6. *Balance trade-offs:* The choice to restore a degraded area with a green space has almost no trade-offs, as their cost of implementation and management is lower than traditional systems.
7. *Adaptive management:* The effectiveness should be monitored along time and the pedogenesys of the soil studied. However, is well designed, regenerated soils have the same management as natural ones.
8. *Mainstreaming and sustainability:* Despite major obstacles in the production and use of regenerated soil, barriers are mostly administrative, not technical (authorizations for use of land from excavation works). Compliance between the analytical quality of new soil material mixture and requirements for use in urban application pose implementation barriers. Also, long distances between the site of destination for soil and extraction sites may limit widespread use of NBS New Soil.

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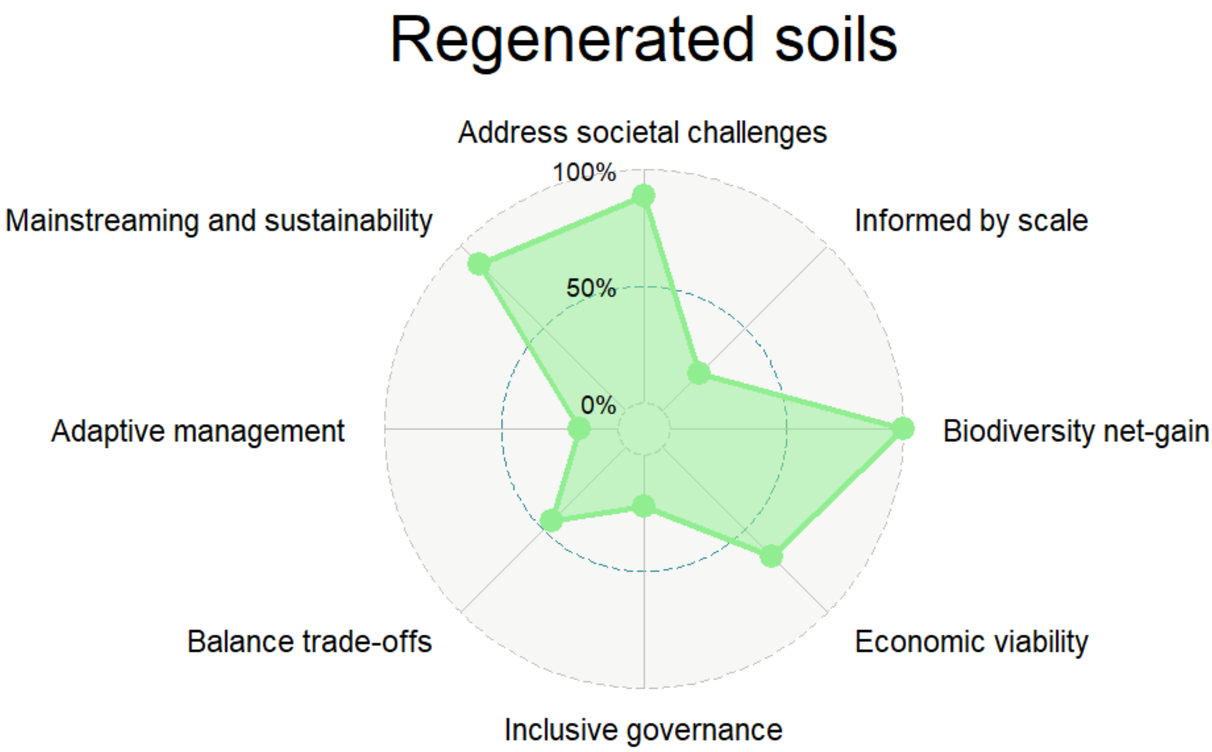

1.4 Forestry

1.4.1 Thinning

Thinning plays a crucial role in forest management by influencing tree competition, growth, and overall stand value. It accelerates tree diameter growth, strengthens stand stability, and promotes forest resilience. By selectively removing surrounding trees, thinning focuses growth potential on a selected number of valuable trees, known as Z-trees. These trees are carefully chosen to form the final stand – typically 60-80 trees per hectare in deciduous and up to 200 in coniferous forests. Planting forests at high densities is however crucial at the beginning, since a dense forest stand at young ages helps to reduced the risk of erosion due to a better soil cover and a denser root system.

Thinning requires careful planning and the use of appropriate timber harvesting machinery, such as chainsaws, harvesters, or forwarders. Proper machine selection is essential to minimize soil compaction and damage to the remaining stand. Technologies like tractors with cable winches or crane systems can further reduce the impact on the forest floor.

While the use of heavy machinery may compact soil and affect air and water supply, thinning also brings positive changes for a given forest stand. It enhances the microclimate, boosts soil microbial activity, and improves nutrient cycling. Increased light availability promotes photosynthesis and rapid tree growth, especially for light-demanding species like larch, pine, and oak. Over time, thinning fosters a healthier, more productive forest ecosystem, balancing growth, biodiversity and overall ecosystem functioning.

1. Address societal challenges: Main challenges addressed are climate change mitigation and adaptation,

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and environmental degradation.

2. Informed by scale: The implementation of the measure is relatively independent of larger-scale considerations, as it is currently led by single land owners. Scale considerations come into play when considering large areas of implementation due to working costs.
3. Biodiversity net gain: No direct net gain of biodiversity to be expected.
4. Economic viability: Lower investment costs make this practice economically viable, though lower large influxes (as with clear-cutting) are to be expected.
5. Inclusive governance: Co-design activities should involve representatives from companies, research centres and authorization bodies depending on the area. Social involvement of the local population is key to increase awareness about the site.
6. Balance trade-offs: Only relevant trade-offs are of economical nature to the land owner.
7. Adaptive management: The effectiveness should be monitored, as the unexpected emergence of biotic/abiotic stressors needs to be addressed.
8. Mainstreaming and sustainability: Mainstreaming is lacking, especially due to lack of information. Sustainability aspects are largely in favor of this metric.

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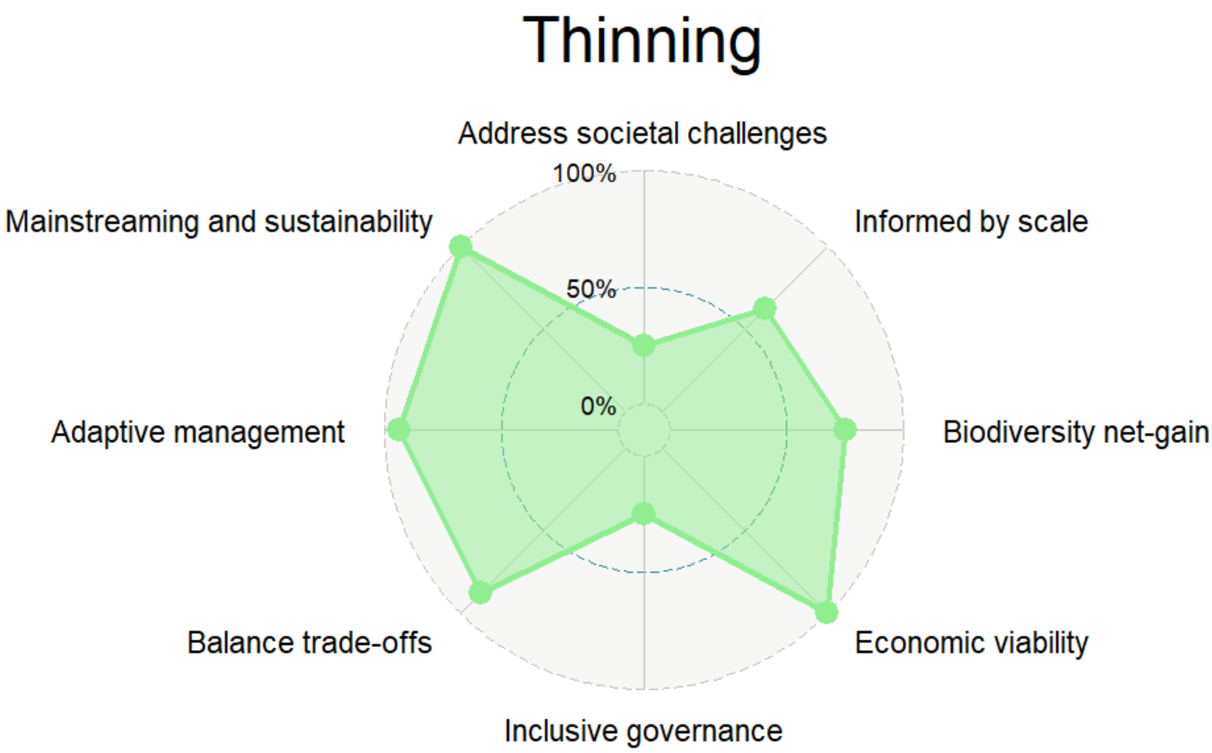

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1.4.2 Permanent forest

Permanent or plenter forest management is a method which seeks to replicate the natural dynamics of forests by creating multi-layered, uneven-aged stands, which support a rich diversity of plant and animal species. The goal is to avoid clear-cutting at large scales; instead, a permanent forest cover with selective harvesting of trees either individually or in small groups should be maintained, thus ensuring a structurally diverse forest. Instead of artificial planting, this system favors natural regeneration, meaning that trees regrow from seeds naturally dispersed within the forest. The result is a forest that more closely resembles a natural forest with all the ecological benefits that come from having a variety of tree species and ages.
One of the main challenges of this system is the need for careful timber harvesting. Since large-scale machinery and clear-cutting should be avoided, manual or low-impact mechanical methods are required. This increases operational costs, but the larger, high-quality timber produced from older trees often compensate these expenses.
By maintaining a continuous tree canopy, permanent forest management also helps to preserve the soil structure. The roots of trees, especially in uneven-aged stands, stabilize the soil and reduce the risk of erosion. The permanent presence of tree cover also enhances the development and diversity of beneficial fungi such as mycorrhiza, which play a crucial role in nutrient cycling.
In summary, permanent forest management is a sustainable approach to forestry that mirrors natural processes, maintains forest health, and provides long-term ecological and economic benefits. It promotes biodiversity, protects soils and helps mitigate the effects of climate change, all while ensuring a steady supply of timber through careful, selective harvesting methods. This method offers a sustainable forest management strategy that values both the environment and the long-term productivity of forest ecosystems.

1. Address societal challenges: Main challenges addressed are climate change mitigation and adaptation, environmental degradation and biodiversity loss.
2. Informed by scale: The implementation of the measure is relatively independent of larger-scale considerations, as it is currently led by single landowners.
3. Biodiversity net gain: Nature-like forests increase biodiversity, as they provide more ecological niches.
4. Economic viability: Lower investment costs make this practice economically viable, though lower large influxes (as with clear-cutting) are to be expected.
5. Inclusive governance: Co-design activities should involve representatives from companies, research centers and authorization bodies depending on the area. Social involvement of the local population is key to increase awareness about the site.
6. Balance trade-offs: The choice to change to a permanent forest has negligible trade-offs for wider society, therefore no need to balance trade-offs. Considerations need to be made at the landowner scale.
7. Adaptive management: The effectiveness should be monitored, as the unexpected emergence of biotic/abiotic stressors needs to be addressed.
8. Mainstreaming and sustainability: Mainstreaming is lacking, especially due to lack of information. Sustainability aspects are largely in favor of this metric.

Assessment according to IUCN NBS Standard

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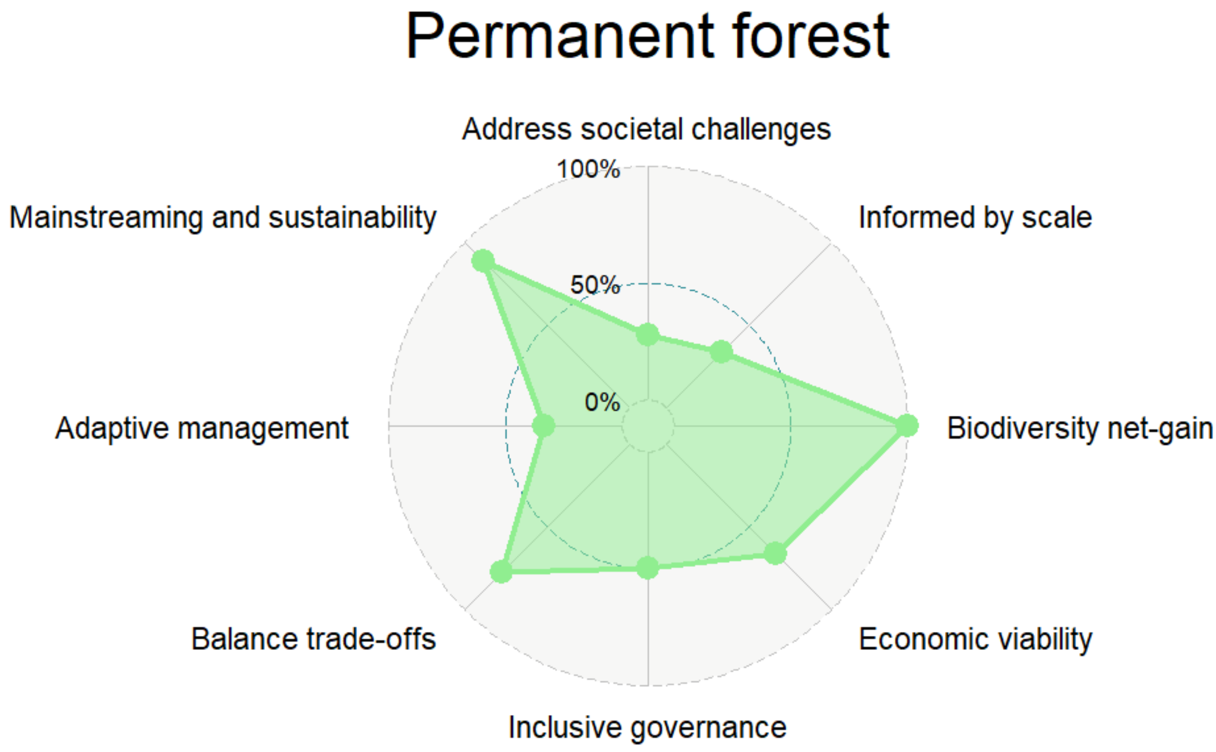

1.5 Paludiculture

1.5.1 Paludiculture

Paludiculture is the productive land use of wet and rewetted peatlands. Peatlands are a type of wetland critical for climate change mitigation, and through preserving the peat soil, paludiculture therefore minimises CO_2 emissions and subsidence of peatlands. Peatlands are unique ecosystems that serve as crucial global carbon sinks. They offer a win-win solution by restoring degraded peatlands and potentially providing new economic and social activities while contributing to climate change mitigation. The harvested biomass can be used as food, feed, fibres for industrial biochemistry, for production of construction materials, high quality liquid or gaseous biofuels, for heat production through direct combustion or for further purposes such as extracting and synthesizing pharmaceuticals and cosmetics. These diverse options for biomass from paludiculture show its great potential for future circular bioeconomy applications.

Drained peatlands are significant sources of emissions, but transitioning to paludiculture can help reduce greenhouse gas emissions..

Paludiculture offers several advantages, including:

(1) Improvement of regional landscape hydrology,

(2) Restoration of habitats for rare mire species and communities, as well as conservation of cultural landscapes,

(3) Revitalisation of rural economies by combining traditional land use with new productive practices, such as eco-tourism,

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(4) Adaptation to local climate change through increased evaporative cooling, regulation of water dynamics (flood control), and water quality improvement,

(5) Conservation and restoration of peatland-specific flora and fauna.

1. Address societal challenges: the main challenges addressed are climate change mitigation and adaptation, especially concerning water management, environmental degradation and biodiversity loss.

2. Informed by scale: direct interaction with the general public offering common goods in the form of preserving unique and declining wetland ecosystems.

3. Biodiversity net gain: restoring and developing peatlands and wetlands, which are even more valuable than forest communities in terms of biodiversity, biodiversity gains are the main goal through a high level of protection of disappearing habitats, creating opportunities for the inclusion of marginal environments in economic circulation.

4. Economic viability: paludiculture creates an opportunity to obtain economic benefits from potentially unproductive habitats. Good management of wetlands also provides a water reservoir for the surrounding agricultural land.

5. Inclusive governance: firstly, joint actions for the entire wetland area, taking into account the management of catchment waters, secondly, proposals for production solutions for specific farms, habitats and the scope of agricultural production.

6. Balance trade-offs: a holistic approach to wetlands and re-wetted areas, advice on the possibilities of productive use of habitats often considered marginal.

7. Adaptive management: specific agricultural systems adapted to the specificity of the habitat, feedback from the community of farmers farming on wetlands through various sources of information (digital), information and integration of technologies adapted to the conditions of high hydration of the area (e.g. specific machinery for moving on wetland).

8. Mainstreaming and sustainability: as part of the Green Deal, a strategy for the re-hydration of drained land is planned, it concerns hundreds of thousands of hectares. Mission Soil Health and Food aims to combat soil degradation caused by the drainage of wetlands, which is in line with Target 12 of the Fourth Strategic Action Plan of the Ramsar Convention. It is also an element of the EU Biodiversity Strategy to 2030.

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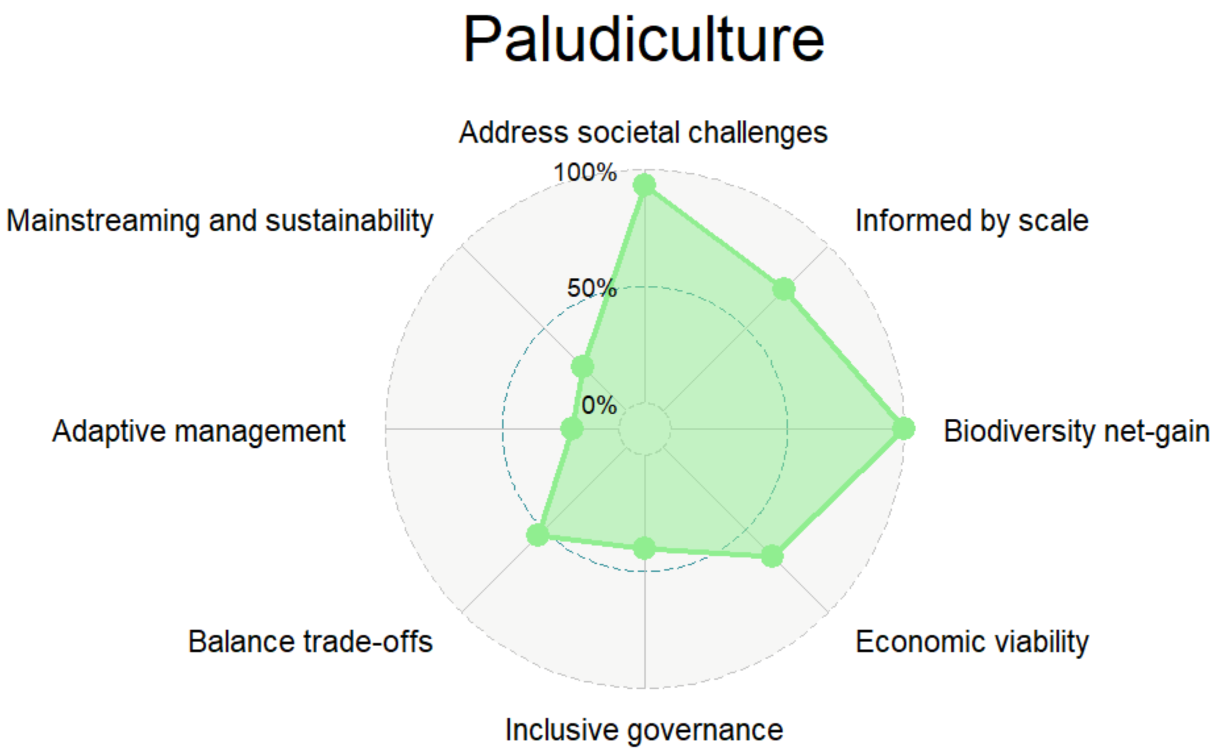

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