Protocol for verifiers on how to measure and report the environmental performance of FAB measures

Deliverable WP 4 D2.2

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Project partners:

1 Introduction

Participating NWE countries of the Capitalisation WP of FABulous Farmers (WPT4) have developed user-friendly digital platforms that enable farmers to either sell directly or access other forms of financial provision for ecosystem services delivered by FAB measures.

To provide the verification required by investors, science-based metrics/practices are in place to verify the delivery and to quantify the positive effects of FAB measures. Each platform has individual protocols for this verification requirement. There are however common metrics and approaches applied.

In order to verify delivery of ecosystem services and functional agrobiodiversity the verification of measures must include both the evidence of practices in place e.g. photos, maps, self-assessed verification by farmer. In addition, the monitoring of environmental outcomes. This could be carried out by a third party or in some cases self-assessed by the farmer depending on audit requirements.

Each marketplace will support uptake of at least one of the FAB measures as defined by the FABulous Farmers project, this may be as part of a whole agroecological system practised on farm. These are:

- Crop rotation
- Mixed crops
- Field margin management
- Hedgerow management
- Agroforestry
- Modify manure quality
- Organic matter input
- Cover crops
- Non-inversion tillage
- FAB supporting action: physical and biological crop protection

This report provides an overview and comparison of the verification approaches for each platform. Detailing where metrics and approaches harmonise and overlap. Additionally, how the approaches verify FAB measures.

The details of the verification approaches are set out in the report appendix.

2 Overview of platform verification approaches (full details in Appendix)

Platform / Country	Verification approach	Ecosystem services targeted	FAB measures targeted
France / Pays de la Loire region, SOLENAT oversees the verification process of the biodiversity projects hosted on the crowd funding platform Yapla	1. Annual monitoring by the farmer through an assessment sheet where the farmer needs to record actions taken and field observations such as blooming dates. 2. Monitoring on one sample by SOLENAT : they are using the protocol from the OAB (Observatory of Agricultural Biodiversity) with: a. bee boxes b. butterfly monitoring	Nectar rich plants for pollinating insects	Field margin management Mixed crops Cover crops
Netherlands The platform GO2POSITIVE was developed to connect businesses with climate ambitions with carbon farmers in a local and transparent approach. The verified approach that is now used is the Agrocares Soil Scanner.	For verification of carbon sequestration soil samples are taken; baseline soil samples are taken at the start of a project and after 5 years for result measurement. NMI-Agrocares developed a sample design (using their Soil Castor programme) and then the soil samples are taken using the Agrocares Soil Scanner	Soil health / soil carbon sequestration	Crop rotation Mixed crops Modify manure quality Organic matter input Cover crops Non-inversion tillage
Germany/Belgium The Agora Natura platform uses the verification standard called Natur^{plus} to provide verification of projects	Certification or verification methods are continuing to be developed but for for the first projects offered they include:	Biological and genetic diversity Water and climate protection Pollination	Mixed crops Field margin management Hedgerow management

promoting biodiversity and ecosystem services.	Biological diversity (including Methods for recording valuable plant populations, protecting endangered animal species and recording of valuable habitats Water and climate services (including reduced nitrogen discharge from agricultural land, nitrogen reduction potential in groundwater and Reduced greenhouse gas emissions on peatlands) Pollination Genetic diversity Cultural ecosystem services	Cultural ecosystem services	FAB supporting action: physical and biological crop protection
UK The Soil Association Exchange platform is based around a verified protocol of metrics, satellite imagery, data models and surveys. Enabling a farm's ecological health to be assessed and verified, also benchmarked. Opening opportunities for Government and Private green finance. Also system improvements to reduce costs.	The verified assessment includes: ● Healthy soil (Soil Organic Matter, VESS, Bulk density, Earthworm Count, pH) ● Climate (Emissions, Sequestration in soils and vegetation, Carbon stocks and flows available) ● Water systems (Flood risk, prevention, Nutrient runoff, Nutrient balance, Turbidity, Water usage) ● Biodiversity (Landcover breakdown, Non-farmed habitat ratio, Woodland and hedge connectivity score, Grassland/ arable flora	Clean and plentiful water; Thriving plants and wildlife; Reduction in and protection from environmental hazards; Mitigation of and adaptation to climate change; Enhanced beauty, heritage and engagement with the natural environment	Crop rotation Mixed crops Field margin management Hedgerow management Agroforestry Modify manure quality Organic matter input Cover crops Non-inversion tillage FAB supporting action: physical and biological crop protection

	species abundance, Bird species abundance, Invertebrate species abundance, Biodiversity practice score, Hedgerow assessment)		

3 Comparison of platform verification approaches

As detailed below, although there are differences in the financing approaches for ecosystem services, all platforms have a farmer focus, and verify the implementation of direct on farm practices along with measurable outputs for ecosystem services.

Similarities/Differences	**Agora Natura / Natur^{plus}**	**SOLENAT (via Yapla)**	**GO2POSITIVE**	**SA Exchange**
Financing approach for ecosystem services	Multiple investment funding for specific biodiversity projects delivered by farmers direct on platform or partnering farmers and investors directly.	Multiple investment funding for specific biodiversity projects delivered by farmers direct on platform	Partnering farmers and investors directly. So investment in carbon credits provided by the farmer can be made directly with single investor	Enabling farmers to identify opportunities for financing ecosystem services through direct advice and evidencing what outcomes their practices provide.
Farmer focus	Yes: farmer to promote offer to investors	Yes: farmer to promote offer to investors	Yes: facilitating the link between farmer and investor	Yes: informing and enabling farmers to access green finance both public and private sector

Verification/validation: FAB measure actioned	Evidence of FAB farm practice delivered by project placed on marketplace. Project assessed against defined criteria	Evidence of FAB farm practice delivered by project is placed on marketplace	Farmers are implementing FAB measures whose effect on additional carbon sequestration has been substantiated by Wageningen UR. From small measures such as 'green manures' and the supply of compost to planting trees or switching over the entire business to FAB practice.	Details of FAB practices are captured on the platform. Additionally through recommendations farmers are advised to implement further measures and the potential impact of these is evidenced.
Verification/validation: Measurable outputs	Quantification methods implemented, focused on biological diversity, climate and water, genetic and pollination services	Self-assessment monitoring by farmer of outcomes delivered (e.g. flower abundance) and additional monitoring by external parties of bees and butterflies	The carbon stored through practices is measured via soil samples by an accredited agency.	Detailed outcome verification protocol implemented covering soil, biodiversity, water, climate, social and animal welfare metrics

4 Appendix – details of verification processes

1. France / Pays de la Loire region, SOLENAT

1 Annual monitoring by the farmer through assessment sheet where the farmer needs to record actions taken and field observations such as blooming dates. *Assessment sheet is confidential to SOLENAT but could be available on request.*

2 Monitoring on one sample by SOLENAT : they are using the protocol from the OAB (Observatory of Agricultural Biodiversity) with:

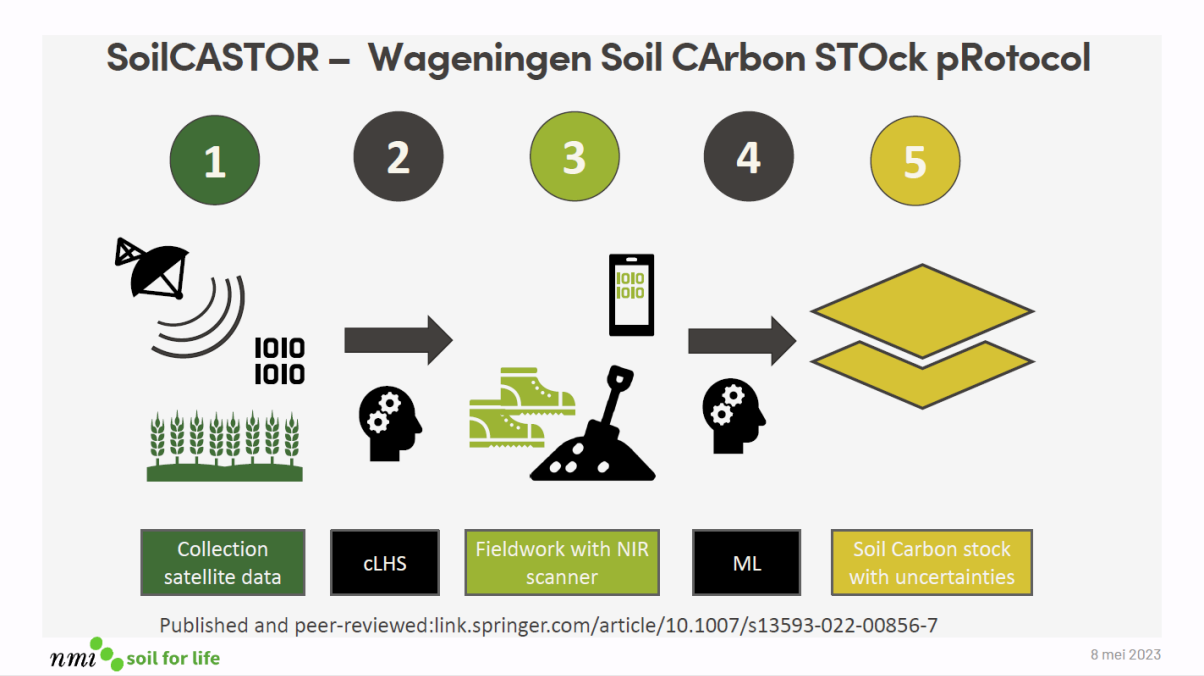
a. bee boxes

b. butterfly monitoring

2. Netherlands – GO2POSITIVE

For the verification of carbon sequestration soil samples are take; baseline soil samples are taken at the start of a project and after 5 years for result measurement:

NMI-Agrocares developed a sample design (using their Soil Castor programme) and then the soil samples are taken using the Agrocares Soil Scanner.



Find optimal sampling locations

Use the global model to estimate local carbon stocks

Global model contains:

I. Covariates from satellite data, WOSIS

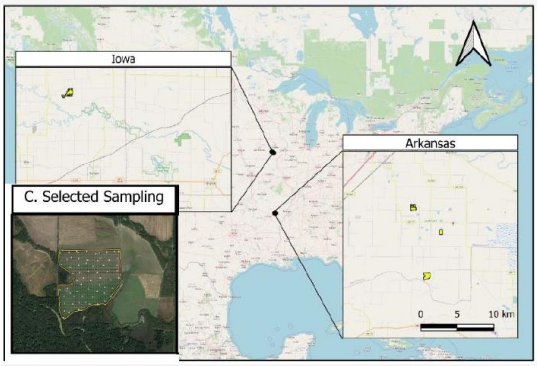
II. Pre-existing datasets NMI and AgroCares database (>18,000 samples from wet-chemistry and >120,000 NIR-scanner data)

nmi soil for life

Van der Voort, Verweij et al, submitted

8 mei 2023

The case study: USA Iowa and Arkansas Step 2



1. Run sampling algorithm (cLHS) using covariates from global model
   - Sampling captures maximum variability
   - Efficient sampling design

nmi soil for life

Van der Voort, Verweij et al, submitted

8 mei 2023

The case study: USA Iowa and Arkansas Step 3

Soil auger top 30 cm

NIR Scanner to measure soil organic carbon in-situ

Scanner simple to use

nmi soil for life

Van der Voort, Verweij et al, under review at Agronomy for sustainainable development

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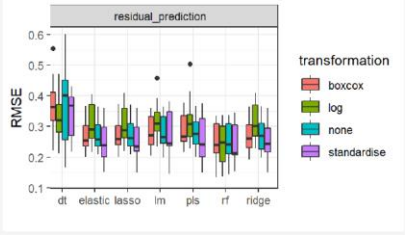
The case study: USA Iowa and Arkansas



1. Use global model for initial prediction
2. Use field data to improve prediction
3. Select optimal model and transformation by Grid search models and transformations
4. Select optimal model and target variable based RSME
5. Attain optimal results

Note: The lower the uncertainty, the higher the amount of credits awarded

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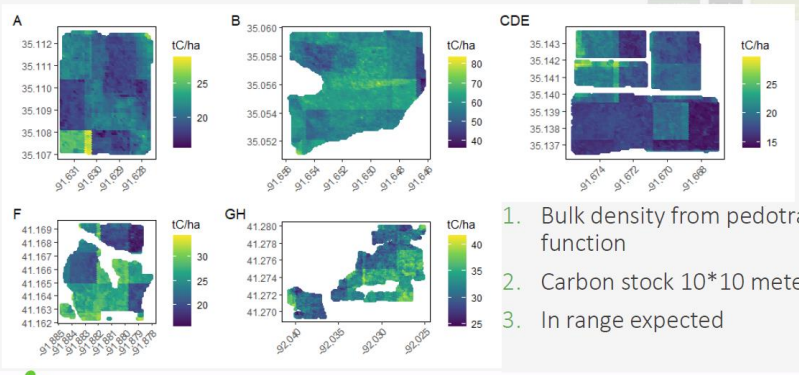
The case study: USA Iowa and Arkansas part 3



1. Bulk density from pedotransfer function
2. Carbon stock 10*10 meter resolution
3. In range expected

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Unique technology

1	2	3
Global Carbon Model	**NIR Scanner AgroCares**	**Carbon Stock Estimates**
Generates: Initial estimates SOC and density Optimal sampling locations	**Generates:** Field-based SOC, density and other nutrients (N, P, K)	**Generates:** Total Stock (tC/ha), SOC (%), density (g/cm³), other nutrients
Unique technology: Proprietary databases: >100,000 global NIR samples >18,000 wet-chem measurements Databases continually growing	**Unique technology:** Database NIR Scanner >18,000 wet-chem measurements State-of-the-art Deep Learning algorithms	**Unique technology:** Aligned with Carbon Credit offsetting protocols (Verra VCS) Generates data required for verification processes
Assets: Globally applicable Outperforms satellite-only models Scalable - used anywhere	**Assets:** Easy-to-use (single button + app) Yields other nutrients (N, P, K)* Useable at any depth	**Assets:** Accurate (95% certainty range) Peer-reviewed science Backed by Soil Carbon experts

* In calibrated regions, agrocares.com

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3. UK, Soil Association Exchange

a. Description of Methodology for Farm Sustainability Score

SA Exchange has been working together with Natural Capital Research to develop a comprehensive measuring and scoring methodology. SA Exchange's approach looks at six main impact areas: healthy soils, climate change, biodiversity, water, animal welfare and social benefit. To ensure cross-integration and compatibility, this metrics framework has been designed to interact with other important frameworks (e.g., 9 Planetary Boundaries, Sustainable Food Trusts Global Farm Metric, DEFRA's Public Goods etc.)

The measurement process is divided into two main steps:

Digital Models

Using SBI numbers, SA Exchange can gather large amounts of data on a land parcel from satellite imagery overlaid with c. 50 data sources. We use this information to support our calculations for a farms sustainability score and to create a stratified sampling map for on-farm tests. Crucial to this digital step is the farmer's input and verification of the data to ensure we have understood their farm correctly.

Farm Visit

Using the plan determined through the stratified map analysis, SA Exchange staff conduct a series of tests on the farm (as per the detailed metrics descriptions below). SA Exchange staff process data from these tests and submit samples to associated labs. Currently data collection is conducted manually via a spreadsheet, however, SA Exchange will soon be able to largely automate and streamline the process through an online platform.

b. Metrics in Greater Detail

Impact Area	Measure	Collected how?	Unit of Measurement	Frequency	Notes
Healthy soils	Soil Organic Carbon	Soil lab tests	Tons of Carbon per Hectare	Every 3-5 years	In the fields identified in the stratified sample strategy, we take 25 soil cores (W pattern) to a depth of 30cm to calculate disturbed bulk density and percentage SOC. Baseline testing will be more in-depth with a greater quantity of samples than subsequent testing. Lab work conducted by NRM Laboratories and the Carbon Check package.
	Soil Structure	VESS test	VESS Score 1-5	Annually	In the fields identified in the stratified sample strategy, we do 3 VESS assessments. The assessment is conducted by trained SA member of staff, supported by the farmer.
	Soil pH	Soil test	Deviation from optimum pH	Every 3 years	pH reading is taken from the same soil sample as the SOC. Also conducted by NRM.
	Soil Life	Earthworm count	Number of earthworms in 30 cm^3 soil core		Will be dependent on weather/season. Earthworms are an indicator of biological life in soil, large and small. Higher numbers can be an

Impact Area	Measure	Collected how?	Unit of Measurement	Frequency	Notes
					indicator of improved soil health. Counted from a 30 cm^3 soil core We measure number. 3 sample sites per field.
Climate Change	Greenhouse gases emitted	Modelled through farmer reported practice	Ton CO2e per year	Annually	Farmers calculate their emissions via one of the existing carbon calculators. We recommend using Farm Carbon Toolkit if a farmer has not done a calculator previously.
	Greenhouse gases sequestered	Satellite imagery to predict carbon sequestered in vegetations	Ton CO2e per year	Annually	We use satellite imagery and data modelling to predict carbon stored in vegetation with high-degree of accuracy.
		Model soil organic carbon from SOM reading	Ton CO2e per year	Annually	We use the figure generated from the SOC readings multiplied by land area.
Water	Surface runoff avoidance	Satellite imagery and modelling of gradients, proximity to	M^3 surface water runoff avoided per year	Annually	Helps measure flood and water body sedimentation risk. Calculated using VESS score, soil carbon and practices.

Impact Area	Measure	Collected how?	Unit of Measurement	Frequency	Notes
		water course and vegetation			
	Nitrate runoff	Lab test of water body on farm	NO3-N mg/L	Twice a year	We use a simple chemistry test. Where no body of water, just use the calculator detailed below.
		Nitrogen calculator	Nitrogen balance	Annually	We use the Farm Carbon Toolkit calculator methodology. Optimum is 30kg of Nitrogen excess, per hectare, per year.
	Phosphate runoff	Lab test of water body on farm	PO4-P mg/L	Twice a year	We use a simple chemistry test. Where no body of water, just use the calculator detailed below.
		Phosphate calculator	Phosphate balance	Twice a year	We will use the Farm Carbon Toolkit calculator methodology once released. Optimum is perfect balance on/off farm.
	Water usage	Farmer survey on water source for farm operations	Water usage score	Annually	Calculated using farmer practice questionnaire.

Impact Area	Measure	Collected how?	Unit of Measurement	Frequency	Notes
		Modelled score on the vulnerability of source			
		Farmer survey on water use practices			
	Turbidity	Secchi tube test	Nephelometric Turbidity unit	Twice a year	
Biodiversity	Non-farmed habitat breakdown on farm	Satellite imagery to categorise different non-farmed habitats	Ratio of non-farmed to farmed hectares on farm	Annually	Calculated from satellite imagery and data sets.
	Connectivity of non-farmed land	Satellite imagery	Connectivity score	Annually	Calculated from satellite imagery and data sets.
	Biodiversity practice score	Farmer survey	Biodiversity practice score	Annually	Uses questions from the Public Good tool. Also, collects information on planned agrobiodiversity.

Impact Area	Measure	Collected how?	Unit of Measurement	Frequency	Notes
	Flora score – Pasture and Arable Fields	Quadrat test:	Number of species	Annually	Using PictureThis, image recognition of number of species found in 1m x 1m x 1m quadrat. Three sample sites per field identified for sampling strategy.
	Flora score - Hedgerow	Hedgerow Assessment	Hedgerow Score	Annually	Take a series of measurements from hedgerows identified in sampling strategy. Measurements include: number and quantity of different tree species, dimensions of hedge, structure of hedge.
	Fauna score - Birds	Farmland bird count	Number and quantity of different species		The digital review will have identified several sites for random sampling. Identification of quantity and species is done through using audio recognition of bird song to automate.
	Fauna score - invertebrates	DNA sequencing of pan traps	Number of different species	Annually	A series of pan traps (1 yellow, 1 blue and 1 white trap) are deployed for 6 hours in the fields identified from sampling strategy. Contents is stored in denatured alcohol and sent to NatureMetrics for analysis.
Animal	Certification	Survey farmer	Score generated from ranking of different certifications	Annually	Use CIWF scoring/ranking

Impact Area	Measure	Collected how?	Unit of Measurement	Frequency	Notes
Welfare	Animal welfare outcomes (avoidance of the bad)	Welfare outcomes records data	Animal welfare outcome score e.g. mortality, cull rate, mobility and mastitis	Annually	
	Antibiotic usage	Extract data from existing medicine databases	Average grams of antibiotics used per kg of live animal weight	Annually	
		Survey farmers/vet			Where data doesn't already exist.
Social	Land access	Satellite imagery to show public access	Km of publicly accessible path on farm	Annually	
	Safe, meaningful and rewarding work	Survey farm staff	Staff work score	Annually	Optional. Currently not implemented

Impact Area	Measure	Collected how?	Unit of Measurement	Frequency	Notes
	Living wage	Survey farmer	% of farm staff receiving Living Wage	Annually	Optional. Currently not implemented
	Diverse and inclusive workforce	Survey farmer	Information on age, gender, ethnicity, disability etc.	Annually	Optional. Currently not implemented

4. Germany and Belgium, Agora Natura and Natur^{plus}

The AgoraNatura platform uses the verification standard called Natur^{plus} to provide verification of projects.

Naturplus serves to certify projects that effectively promote biodiversity and ecosystem services. The standard was developed jointly by colleagues from science, agriculture and nature conservation. It contains a generally applicable catalogue of criteria, which describe specific requirements for the development of projects and methods as well as rules for the measurement, reporting and verification of biodiversity and ecosystem services provided. The criteria are published in their most current form on the Naturplus Standard website.

Conservation projects that wish to meet the standard have to be audited by an independent institution (certification body). The agrathaer GmbH was confirmed as the first certification body for all nature conservation projects offered on the online marketplace AgoraNatura; further organisations are to follow (see WP CAP D2.4, in preparation) .

In cooperation with AgoraNatura, a certification report was prepared for a structured audit. The audit is based on the AgoraNatura project types recognised for the Naturplus standard. These contain recommendations for the selection of suitable areas, measures and methods for describing and observing the expected results.

c. Quantification methods:

Biological diversity	
Character species approaches: Methods for recording valuable plant populations	• For recording the High Nature Value farmland relevant throughout Europe, a specific approach was developed for Germany. On farmland, the number of certain character species along a transect is recorded. The nature conservation value of the area is derived from this. • Methods of the German federal states for grassland: The high nature value farmland approach in Germany has also been developed on the basis of some existing character species methods in grassland. These can also be used for the assessment of species-rich grassland. • Special approaches for arable land: In the project Agriculture for Biodiversity, an extended arable species list and a standardised recording method were

	developed, which especially seems necessary with regard to organic farmland.
Methods in projects to protect endangered animal species	• General animal observation: There are a variety of well-documented and scientifically accepted methods for recording the presence of animal species. Spontaneous observations are also possible. They can be a motivation to expand monitoring in the future to targeted observation of these species as well. • Auditory detection of amphibians: Auditory detection is a simple and practice-oriented standard method for the semi-quantitative and qualitative estimation of batrachian populations, including all vocal Central European frogs (number of a species as well as number of different species). • Temporary mouse burrow closure – foraging habitat quality for birds of prey: The temporary mouse burrow closure method measures the occurrence of field mice on a field section and is a suitable method for assessing the foraging habitat quality of an area, e.g. for red kites and other endangered species of birds of prey. On a field area of about 250 m² all mouse burrows are closed by stepping on them. All holes that have been re-opened after 24 hours are counted and the number gives information on the foraging quality of the area.
Recording of valuable habitats	• Orchard meadows: The status of valuable habitats such as orchard meadows can be assessed by mapping fruit trees and small-scale structures. Additionally, the high nature value farmland or other character species approaches as explained above can be applied. • Dry grasslands: Determination of the status of dry grasslands registered as flora fauna habitat (FFH) areas follows assessment criteria of FFH management planning, which are "integrity of habitat-typical habitat structures", "integrity of habitat-typical species population" as well as "negative effects". • Hedgerows: Here we record the structural diversity of the woody plants with associated fringe, the flowering period and the special features of the environment. For the assessment of the fringe, we refer to the identification species method for the recording of fallows according to the approach for High Nature Farmland and recommend mapping particularly valuable and endangered species.

Water and Climate Services	
Water services	• Reduced nitrogen discharge from agricultural land: To map the reduction of nitrogen discharge from nature protection measures, we currently refer to values from literature. Site-differentiated data will be provided in due course. For this purpose, simulations are carried out with the MONICA model (Model for Nitrogen and Carbon in Agro-Ecosystems). • Nitrate reduction potential in the groundwater system: In Brandenburg, assessment of nitrate reduction in groundwater is currently being developed with the MODEST model.
Climate and water services on peat soils	• Reduced greenhouse gas emissions on peatlands: GHG emission reductions are estimated using the Greenhouse Gas Emission Site Types (GEST) approach. These site types are based on an extensive literature review from which average annual emission values were calculated, as well as evaluation of other determining parameters such as water level, nutrient availability and soil type, from Central European peatlands. Results showed that the mean annual groundwater level, described in so-called water stages, is the best singular explanatory variable for carbon dioxide and methane emissions. • Reduced nutrient runoff on peatlands: Methods for assessing nitrogen emissions and retention on peatlands include the NEST approach and WETTRANS method. The NEST approach (N-emission site types) is a method to estimate the nitrogen discharge from a peatland, based on the vegetation. WETTRANS is a database-supported method for determining nitrogen retention in fens.
Pollination services	
Supporting the pollination with wild bees and honeybees	In order to assess the pollination services in a certain area, the following factors are recorded: • density of pollination and nectar plants • diversity (indicated by colour of blossoms) • flowering period • pollen plants for specialised wild bees. • Additionally, a diversity of wild bees requires habitats for nesting and hibernation, such as dead wood, open soil or unknown areas with dry stems in autumn and winter.

	The use of insecticides is a main cause for the loss of pollinators and must be avoided for their effective protection
Genetic Diversity	
Endangered crop plants	To draw attention to the decreasing diversity of crops in Germany and to support measures for the conservation and sustainable use of this diversity, the Red List of German Endangered Native Crops was compiled. It is maintained by the Federal Office for Agriculture and Food (BLE) and Coordination Centre for Biological Diversity (IBV). In order for a species or its variety or cultivar to be included on the Red List, it needs to meet the following four conditions simultaneously: native, endangered, significant (e.g. historically/culturally) and in terms of the legal status (no plant breeders' right and no variety protection).
Endangered livestock breeds	Unfortunately, many of the indigenous livestock breeds are threatened with extinction today. The diversity of breeds in livestock farming has been replaced in the course of intensification by individual breeds that dominate today. For the endangered breeds, their increased reintroduction into farming is the most sustainable form of protection. For more information on the red list, please refer to the BLE website.
Local seeds for wild plants	Since March 2020, any planting of alien species in the wild must be approved by the authorities. However, cultivation in agriculture, including flower strips and areas on agricultural land, is exempt from this regulation. The Federal Programme on Biological Diversity (BPBV) recommends the use of native wild plant regional seeds for all sowings, including on agricultural land and in settlement areas. Its document "Arbeitshilfe Blühmischungen" shows which mixtures and seed origins are prescribed, permissible and recommended on which land use type.
Native trees and shrubs	Region specific information on native woody plants are provided by the federal states.

More detailed information and practical guidance (in German) can be found online via https://agora-natura.de/hier-finden-sie-unterstuetzung/ (registration required).