Interreg North-West Europe
FABulous Farmers
European Regional Development Fund

Shortlist of suitable metrics/indicators: methods and capacity for verifying outcomes of FAB measures

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Project partners:

1 Introduction

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

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.

This report provides a shortlist of possible metrics and indicators to assess the FAB measures in detail, along with methods and the capacity needed for verification and assessment. The use and application of these measures will vary across the platforms across the NWE regions however there is a standardised agreement around the value of these measures to determine the outcome of the FAB measures.

2 Metrics and indicators to assess the outcomes of FAB practices

Capacity or time requirement has been scored; 1 = Low time input, 2 = medium time input, 3 = High time input

Accuracy of assessment and therefore level of scope for verified evidence in practice audit has been scored; 1 = direct evidence, 2 = indirect evidence; 3 = subjective evidence

Impact Area	**Measure**	**Method/Metric**	**Unit of Measurement**	**Protocol/Source**	**Accuracy level (1-3)**	**Capacity: Time requirement (1-3)**
Soil	Soil Organic Matter	Data sets and satellite imagery	Varies	Various	Dependent on source	Dependent on source
		Soil lab tests	% SOM (LOI)	Soil organic matter (LOI) (Ball, 1964) (If TGA is used Carbonate can also be determined)	SOM (2)	LOI is less labour intensive (2) for sampling
		Organic matter input , T/Ha	Tonnes per Ha	Application rate data	2 - input incorporation to SOM will vary, but application input will have impact	1 (data recording low time, application time varies)
	Soil Carbon	Soil lab tests	Active carbon (mg/kg)	Varies between lab	1 - High accuracy for active carbon	Field sampling (2), laboratory analysis (1)

Impact Area	Measure	Method/Metric	Unit of Measurement	Protocol/Source	Accuracy level (1-3)	Capacity: Time requirement (1-3)
		Soil lab tests	Organic carbon stock (Ton/Ha) (DUMAS)	Samples are very small so care must be taken when sub sampling	Total C high accuracy (1) but carbonate must be accounted for.	Field sampling (2), 25 bulked samples per field plus laboratory analysis (time 1) for sampling
	Soil Structure	Visual Evaluation of Soil Structure (VESS)	VESS Score 1-5	https://soils.vidacycle.com/wp-content/uploads/2019/08/VESS_score_chart.pdf	3 - field based subjective assessment	30 minutes (Time 2)
		Soil Bulk density		Each lab will likely have it s own method. Descriptions of methods can be found here: Blake, J.R. and Hartge, K.H. (1986): Bulk density. In: Klute, A. (Ed.): Methods of soil analysis, Part 1, Physical and mineralogical methods, 2nd edition, pp. 363-376, Soil Sci. Soc. America, Madison Wl.	1 - if completed accurately can provide detailed data	Time (2) for sampling
		Soil aggregate stability		There are different approaches, sector mentor uses a field based slake test. A more standard lab	2 - data can infer stability	2 - sampling and analysis time

Impact Area	Measure	Method/Metric	Unit of Measurement	Protocol/Source	Accuracy level (1-3)	Capacity: Time requirement (1-3)
				test would involve using a machine with a sieve that goes up and down in solution using air dry aggregates.		
		Infiltration		For farmers: https://vines.vidacycle.com/portfolio/infiltration-rate/	1 - data can be informative if protocol followed well	2 - field sampling takes time to do accurately
		Rooting depth	Depth of roots (cm)	Dig down soil profile to measure depth of roots	1 - simple process to provide clear soil profile data	2 - field sampling must be done carefully as not to damage roots
	Soil Erosion	Slip test				
	Soil pH	Soil test	pH	Most labs will offer this, the standard is pH in water on an air dry sample	1 - accurate data	1 - quick field soil sample time
	Soil Life	Earthworm count	Number and type of earthworms in 20x20x20cm soil sample	Number and type of earthworms in 20x20x20cm soil sample	2 - accepted approach to sampling, but must be aware of other impacts on earthworm presence (i.e. soil moisture)	2 - field sampling takes time

Impact Area	Measure	Method/Metric	Unit of Measurement	Protocol/Source	Accuracy level (1-3)	Capacity: Time requirement (1-3)
		Abundance of soil dwelling arthropods	Presence and absence of soil dwelling arthopods	PITFALL TRAPS: One pitfall trap (containing antifreeze mix) placed at each sampling point. Suitable to collect soil dwelling arthropods.Schipanski et al. used Pitfall traps to assess activity-density of five major arthropod groups: Spiders (Order Araneae), harvestmen (Order Opiliones), ground and tiger beetles (Order Coleoptera, Family Carabidae), rove beetles (Order Coleoptera, Family Staphylinidae), and centipedes (Order Chilopoda).	2 - provides representative data, although not complete survey of all presence	2 - must leave trap out and identify species (unless bulking sample for e-DNA analysis)
	Soil microbial diversity	Soil lab tests	Ac ve and Total Bacteria Ac ve and Total Fungi Hyphal Diameter Organsim Ra os Protozoa (#, type) Nematodes (#, % feeder type) Mycorrhizae colonisa on (Ecto or Endo)	Lab test	1 - high accuracy data	Field samples (1) lab time (2)

Impact Area	Measure	Method/Metric	Unit of Measurement	Protocol/Source	Accuracy level (1-3)	Capacity: Time requirement (1-3)
		Soil respiration	CO2, CH4 and other GHG respiration data	Varies based on equipment used.	1 - high accuracy data (depending on instrumentation used)	3 - data is complex and requires expert analysis
		"my undies protocol"	Rate of degradation		3 - subjective assessment giving indication of soil activity	2 - little time active, yet requires long time left in soil
	Soil visual inspection	Signs of soil erosion, compaction, ponded water indicating infiltration problems, gate damage.	Area of a field	https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/901821/CS_Runoff_and_Soil_Erosion__CS11_v1.00_.pdf	2 - accepted approach, yet results can vary between surveyors	3 - takes time to conduct in multiple locations for mean score
	Soil nutrients	Soil lab tests	Lab analysis N,P,K,Mg	Most labs will offer this to farmers	1 - High accuracy if sampled well	3 - time consuming for sampling
		Remote sensing	Varies	Various	2 - technology developing	3 - requires expert analysis, but can cover large areas quickly once model data calibrated

Impact Area	Measure	Method/Metric	Unit of Measurement	Protocol/Source	Accuracy level (1-3)	Capacity: Time requirement (1-3)
Climate Change	Greenhouse gases emitted	Modelled through farmer reported practice	Ton CO2e per year	Calculated using carbon calculators e.g. FCT https://calculator.farmcarbontoolkit.org.uk/; Agrecalc https://www.agrecalc.com/	2 - not direct measurements, yet based on baseline understanding	2 - desk based
	Greenhouse gases sequestered	Satellite imagery to predict carbon sequestered in vegetations	Ton CO2e per year	Florian Zellweger *et al* 2022 *Environ. Res. Lett.* **17** 074004 https://iopscience.iop.org/article/10.1088/1748-9326/ac74d5	2 - modelled data where accuracy is developing	2 - requires expert analysis, yet can cover larger areas quickly once model calibrated
		Model soil organic carbon from SOM reading	Ton CO2e per year	Various	2 - modelled data, improving development	2 - requires expert analysis, yet can cover larger areas quickly once model calibrated
Biodiversity	Non-farmed habitats on farm	Satellite imagery to categorise different non-farmed habitats	Ratio of non-farmed to farmed hectares on farm	Land cover map is generated from the best available open-source data (i.e. UKCEH Land Cover Map)	2 - estimates space for biodiversity	2 - requires expert skill set to assess data

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	Connectivity of non-farmed land	Satellite imagery	Connectivity score	Use of models (Saura and Pascual Hortal, 2007; Saura and Rubio, 2010) to work out the overall connectivity of the landscape	2 - modelled response of biodiversity	2 - requires expert analysis
	Biodiversity practice score	Farmer survey	Biodiversity practice score	Platform dependent	2 -anticipated response from practice	1 - desk based analysis
	Flora	Quadrat test: - Field headland - Grassland - Arable flora - Hedgerow	Number of beneficial and non-beneficial species; Mean Species richness Mean % cover of +ve indicator species Mean % cover of –ve indicator species Diversity	Countryside survey technical reports:https://countrysidesurvey.org.uk/publications/technical-reports	1 - direct data of abundance (accuracy surveyor dependent)	3 - time intensive (depending on experience)
	Fauna	Farmland bird count	Number and quantity of different species	Countryside survey technical reports:https://countrysidesurvey.org.uk/publications/technical-reports	1 - direct data of abundance (accuracy surveyor dependent)	3 - time intensive (depending on experience)
		Abundance of invertebrates	SWEEP NET SAMPLING: Sweep net sampling was done along transects corresponding to other collection/trapping sites and was restricted to dry days with wind speeds	Species count, or DNA lab analysis	2 - representative example	2 - quicker survey

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			below Beaufort force 4 (i.e., “Moderate Breeze).			
		Abundance of flying or windborne arthropods	WATER TRAPS: Coloured green to blend with the vegetation and hence passively sample insects, placed at canopy height. Suitable to collect flying or windborne arthropods	Species count, or DNA lab analysis	2 - representative example	2 - quicker survey
		Abundance of soil dwelling arthropods	PITFALL TRAPS: One pitfall trap (containing antifreeze mix) placed at each sampling point. Suitable to collect soil dwelling arthropods. Schipanski et al. used Pitfall traps to assess activity-density of five major arthropod groups: Spiders (Order Araneae), harvestmen (Order Opiliones), ground and tiger beetles (Order Coleoptera, Family Carabidae), rove beetles (Order Coleoptera, Family Staphylinidae), and centipedes (Order Chilopoda).	Species count, or DNA lab analysis	2 - representative example	2 - quicker survey, but requires leaving trap out

Impact Area	Measure	Method/Metric	Unit of Measurement	Protocol/Source	Accuracy level (1-3)	Capacity: Time requirement (1-3)
		Earthworm count	Number and type of earthworms in 20x20x20cm soil sample transect	Number and type of earthworms in 20x20x20cm soil sample transect	2 - accepted approach to sampling, but must be aware of other impacts on earthworm presence (i.e. soil moisture)	2 - field sampling takes time
		No. bird/butterfly species from GWCT/BMS indicator list	Species type, count, distribution			
		BIMAG - monitoring (Moths)	Species type, count, distribution			
		Distribution and abundance of small mammal species	Species count, distribution			
	Management practice	% unproductive land	% Habitat type (dry grassland condition assessment)	Farm mapping http://www.naturplus-standard.de/de/quantifizierungsmethoden/biologische-vielfalt/29-trockenrasen-zustandserfassung	3 - represents area for biodiversity	2 - desk based
		Area under trees/woodland/plantations	% or Ha	Farm mapping, survey	3 - represents area for biodiversity	1 - desk based
		Type of trees, number, species, age	Type of trees, number, species, age	Farm mapping, survey	3 - represents area for biodiversity	1 - desk based

Impact Area	Measure	Method/Metric	Unit of Measurement	Protocol/Source	Accuracy level (1-3)	Capacity: Time requirement (1-3)
		Hedgerows length, width, species, age	Hedgerows length, width, species, age	Farm mapping, survey http://www.naturplus-standard.de/de/quantifizierungsmethoden/biologische-vielfalt/40-hecken-zustandserfassung	3 - represents area for biodiversity	1 - desk based
		Conservation area of farm	Ha	Farm mapping, survey	3 - represents area for biodiversity	1 - desk based
		Biodiversity management program participation / agri-environment scheme participation	Enrolment on scheme	Farmer survey	3 - suggestive of improvement and benefit (scheme dependent)	1 - desk based
		Land use/habitat change - deforestation/loss of soil/waterlogged area	% or Ha	Farmer survey	3 - represents area for biodiversity	1 - desk based
		Other environmental restoration activity/participation /on farm/off-farm	% or Ha	Farmer survey	3 - represents area for biodiversity	1 - desk based
		Timing of mowing or grazing	% or Ha	Farmer survey	3 - represents area for biodiversity	1 - desk based
		Uncultivated/unmown land	% or Ha	Farmer survey	3 - represents area for biodiversity	1 - desk based

Impact Area	Measure	Method/Metric	Unit of Measurement	Protocol/Source	Accuracy level (1-3)	Capacity: Time requirement (1-3)
		No. of varieties of farm habitats	% or Ha	Farmer survey	3 - represents area for biodiversity	1 - desk based
		Key indicator species (existing within farmed area of high nature value)	An indication of the habitat diversity on-farm as a driver of animal and plant biodiversity	High Nature Value farmland indicator species approach - http://www.naturplus-standard.de/de/quantifizierungsmethoden/biologische-vielfalt/23-high-nature-value-farmland-kennartenansatz	3 - represents area for biodiversity	1 - desk based
		Non use of chemical fertilisers	Application data	Farmer survey	3 - represents area for biodiversity	1 - desk based
		Use of non-chemical pest control	Application data	Farmer survey	3 - represents area for biodiversity	1 - desk based
Water	Surface runoff avoidance / Catchment modelling	Satellite imagery and modelling of gradients, proximity to water course and vegetation	M3 surface water runoff avoided per year	Varies	2 - model based	3 - requires expert analysis
	Chemical quality of rivers/water bodies	Lab test of water body on farm	NO3-N mg/L	FreshWater Watch analysis protocol	1 - high quality depending on sampling schedule and planning	2 - field & lab sampling
		Nitrogen calculator	Nitrogen balance	Use of calculators, FCT https://calculator.farmcarbontoolkit.org.uk/; Farmscoper	2 - benchmark based outputs	1 - desk based

Impact Area	Measure	Method/Metric	Unit of Measurement	Protocol/Source	Accuracy level (1-3)	Capacity: Time requirement (1-3)
				https://adas.co.uk/services/farmscoper/		
		Lab test of water body on farm	PO4-P mg/L	FreshWater Watch analysis protocol	1 - high quality depending on sampling schedule and planning	2 - field & lab sampling
		Phosphate calculator	Phosphate balance	Use of calculators, FCT https://calculator.farmcarbontoolkit.org.uk/; Farmscoper https://adas.co.uk/services/farmscoper/	2 - benchmark based outputs	1 - desk based
	Biological quality of rivers/water bodies	Species survey	Identification of amphibians	http://www.naturplus-standard.de/de/quantifizierungsmethoden/biologische-vielfalt/26-verh%C3%B6ren-von-amphibien	1 - high quality (depending on surveyor)	3 - time intensive field survey