KZR INiG System/4.1

Guidelines for the preparation of the Soil Management Plan

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Structure of the Soil Management Plan (SMP)

A soil management plan must be completed and recorded according to Table 1. The SMP should be conducted for each field and aid the identification and management of soil related issues.

Table 1. Soil Management Plan

Sourcing area identification	Fields characteristics	Management Issue	Results / Comments

1. Sourcing identification

Identification and description of fields.

2. Fields characteristics

Details of the sourcing area (soil type, topography, field surroundings, risk of erosion, **classification of soil** etc.)

3. Management Issue

a) Crop rotation / Cover crops

It is the process of producing various products in the field one after the other from year to year respectively. Thus, different parts of the soil are utilized with different products, and pests and diseases that are specific to each product are prevented from spreading.
It is required At least a 3-crop rotation, including legumes or green manure in the cropping system, taking into account the agronomic crop succession requirements specific to each crops grown and climatic conditions. A multi-species cover crop between cash crops counts as one.
Cover plants (alfalfa, vetch, etc.) can be cultivated during off-season periods when the soil is bare and can be grown between the main plant rows. These products prevent soil erosion, renew soil nutrients, keep weeds under control, and protect soil health by reducing the need for herbicides. Sowing of cover/catch/intermediary crops using a locally appropriate species mixture with at least one legume. Crop management practices should ensure minimum soil cover to avoid bare soil in periods that are most sensitive.

Farms with more than 10 ha of arable land are required to cultivate at least 3 different crops on arable land.
A separate crop is considered to be:
- genus in the botanical classification of crops,
- spelled wheat *Triticum spelta*,
- winter and spring form of the same kind,
- a species from the Brassicaceae (*Brassicaceae*), Solanaceae (*Solanaceae*) and Cucurbitaceae (*Cucurbitaceae*) families,
- fallow ground,
- grass or other herbaceous forage.

Interruption of monoculture crops is one of the factors affecting soil degradation. The practice will limit the specialization of production, which in turn translates into a reduction in the consumption of industrial means of production, i.e. mainly mineral fertilizers, and plant protection products. It is necessary to design in detail what crops will be cultivated on the farm in particular fields.

b) No stubble burning, unless it is for plant health

Burning stubble causes great damage to the environment:
- burning grass causes soil sterilization and destroys beneficial insects, which in turn causes a reduction in plant yields,
- in fires, birds die, and their nesting places are destroyed, domestic and forest animals that accidentally are within the fire range die, many useful vertebrates die, e.g. frogs, lizards, moles, hedgehogs, hares, foxes, voles, shrews and other small rodents and invertebrates, including earthworms that fertilize the soil, spiders, centipedes and other insects,
- fires of grass and brush can move to further areas and cause fires in the forest or residential buildings, posing a direct threat to life.

The prohibition on stubble burning maintains the level of soil organic matter and prevents direct emissions of carbon dioxide and fine dust into the atmosphere.
The economic operator must implement a complete prohibition on stubble burning.

c) Controlling run-off and erosion

Soil structure including bulk density and the absence of soil sealing and erosion. Good soil structure as indicated by reduced bulk density, the absence of soil sealing and erosion allows for healthy root growth, reaching all parts of the soil and allowing infiltration of rainwater to prevent runoff and soil loss.
Reduction or no tillage. Intensive or traditional agriculture causes physical and chemical degradation of soil, loss of organic matter, reduced biological activity in the soil and consequently a decrease in crop production. On the contrary, the method of sustainable agriculture envisages a sustainable and profitable farming system based on three basic rules, including soil-free agriculture, continuous soil surface covered with plant or plant debris, and crop rotation.
For this issue, it is necessary to consider the risks of run-off and erosion when planning what to grow or how to manage livestock, especially on sloping land, and modify your management accordingly.
On arable land be prepared to introduce grass strips, or larger areas, to intercept flow on slopes or in valley features. It may help if you establish buffer strips alongside surface waters which are at the bottom of slopes. However, you should not rely on such areas at the expense of good soil management in the rest of the field. (Note: Buffers alongside surface waters may be ineffective in river catchments where the water flows below the land surface). If necessary, consider permanent grass, woodland, or similar land cover.

You should not plough permanent grass for arable production in places where the risk of erosion is high, such as on slopes or in river valleys that flood.

If run-off is channelled along farm tracks, you should maintain and improve the surface to reduce the flow and consider providing cross-drains to reduce and interrupt any that develops. Polluted run-off must not be allowed to get into field drains, ditches, or surface waters.

Where erosion occurs (despite your best endeavours), earth banks, other physical barriers or ponding sites may be used as a last resort to check the flow of water to reduce off-site impacts. They should be carefully designed and installed to achieve the field work required effect. Note this could include soil or spoil moved from another part of the holding.

In upland areas, fence off areas of eroding soil to help the vegetation to reestablish. Blocking grips and surface drains can also reduce erosion but you should consult the Environment Agency to ensure these practices work correctly and do not lead to more serious flooding downstream. Do not leave bare soil during bracken management or burn vegetation if it will leave a bare surface which will be at risk of erosion.

d) Precision nutrient management

Fertilization, which constitutes 10–15% of the costs of agricultural inputs, is critical for increasing product productivity by up to 50%. The application time and method are of great importance in the fertilization process which is applied to soil in order to meet the basic nutrients (nitrogen, phosphorus, potassium etc.) which are not enough in agricultural soils. Data's such as climate and weather conditions, soil characteristics and product types are important in determining the appropriate fertilization time.
The use of mineral fertilizers is aimed at:
- improvement of plant development,
- increasing the yield of plants,
- regulation of soil reaction,
- extending the vegetation period of plants,
- enrichment of crops with necessary nutrients.

Soil nutrients and pH. Essential nutrients for plant growth in part at least, derived from soils include N, P, K, S, Ca. A range of plant micro-nutrients usually found at very low concentrations (parts per million) in soils may limit plant growth, such as boron (B), chlorine (Cl), cobalt (Co), copper (Cu), iron (Fe), manganese (Mn), molybdenum (Mo) and zinc (Zn). Soil pH affects many chemical and biological processes, including plant nutrients availability and the balance and functions of soil microbial communities. In farmland and forestry soils, an optimal balance is required for growth. In supporting biodiversity-rich ecosystems, nutrient limitations provide an essential set of sub-optimal conditions to support a diversity of biota above and below-ground.

Reducing fuel use Mechanization tools that reduce labor requirements in agriculture generally use fossil fuels. Nowadays, the use of fossil fuel energies directly or indirectly in agriculture has not been economically profitable for producers. In developing countries, large amounts of fossil fuels are used in agricultural production, in particular fertilizer production and machinery use. It is not possible to carry out modern agricultural production processes without using fuel. However, the use of combined agricultural tools and machinery in one pass and the use of renewable energy sources instead of fossil fuels will reduce both the cost of fuel in agriculture and reduce the carbon emissions and make the agriculture sensitive to the environment.

Establishment of buffer zones along watercourses. Prohibition of using fertilizers and plant protection products on agricultural land near surface waters at a distance of at least 3 m.

In order to correctly determine the amount of mineral fertilization with individual elements, it is necessary to rely on the results of soil tests and its real abundance, comparing it to the needs of the planned cultivation. Calculations should also take into account the fertilizing value of organic fertilizers. It is necessary to take into account soil moisture, the time of transformation of fertilizers into the form taken up by the plant, as well as leaching by water. The basis for wise fertilization, however, is to obtain a soil pH close to neutral, because only in this case will most agricultural plants be able to optimally use the applied fertilizers. Therefore, for each field, which is a separate scenario, a fertilizer balance should be developed, enabling optimal fertilization of the soil and nourishment of the crop, without the risk of overfertilization and excessive inputs.

In agricultural practice, the importance of mineral fertilization is very often overestimated, and that of organic fertilization is underestimated or omitted. The soil is sometimes treated only as a place for sowing plants, without taking into account the importance of its fertility, which directly leads to the degradation of organic matter, and as a result to a continuous increase in inputs with a simultaneous decrease in yield.

If buffer zones are established, we reduce water pollution, in particular with fertilizers and plant protection products from agricultural sources.

Elements of Management Proposals may include:

- Soil pH regulation,
- Determining the amount of mineral fertilization,
- Fertilization balance,
- Characteristics of mineral fertilizers and their availability for plants,
- Foliar fertilization,
- Precision fertilization,
- Organic fertilizers of animal origin,
- Application of municipal sewage sludge,
- Storage of mineral fertilizers,
- Method of applying fertilizers,
- Analysis of the risk of water pollution, impact on the environment and consumers.

e) Water Management

Irrigation Effective irrigation is possible by determining the optimum water amount using different parameters such as soil humidity, effective precipitation rate and evapotranspiration and by determining the correct irrigation time with climate, weather forecasts and real-time weather data. In this way, effective and economical irrigation will be provided by protecting the limited water resources and the environmental and agricultural negative effects of leaching, salinity and fungal diseases caused by excess water will be prevented.
Water storage ponds Agricultural ponds are important water sources for irrigated areas. These structures collect water from small sources and allow for efficient storage and use of large flow rates when needed and help to regulate water flow.
Elements of Management Proposals may include:
- Yield-creating water management,
- Water retention in agricultural landscape,
- Water sources for irrigation,
- Quality of water used for irrigation,
- The actual water demand of plants depending on the development stage, practical water needs of crops,
- Optimization of water consumption,
- Selection of the irrigation system and the time to run it,
- Use of rainwater,
- Water treatment,
- Accumulation of water in the soil depending on the type of soil profile,
- Evaporation from soil and plants,
- Water in frozen or flooded soil,
- Areas of the farm at risk of runoff,
- Prevention of surface runoff,
- Greening zones (grassed) to prevent surface runoff,
- Waste water on the farm,
- Management of water contaminated with plant protection products, fuel, and fertilisers.

f) Biodiversity

Soil biodiversity. Presence of functional diversity of appropriate bacteria and fungi and of soil animal communities that are important for soil functions and services, such as soil structure, litter decomposition, organic carbon storage and nutrients cycling promotes all soil functions. Currently, nematodes and earthworms are well tested. Ongoing research will soon deliver indicators for soil microbial parameters.
Vegetation cover. The annual duration and diversity of the vegetation cover and its net primary productivity is essential for soil health, providing nutrients for soil biodiversity and carbon inputs to soil organic matter, also reducing erosion and surface runoff. A more diverse and long

duration cover indicates conditions favourable to soil biodiversity and health and increasing vegetation cover is also valuable for urban settings.

Landscape heterogeneity, including farmland (field size, fragmentation, presence of natural green elements), forestry (types of forest, monocultures, clear-cuts with bare land) and urban green infrastructures (adequate presence). The diversity of landscape elements (composition) and the way these elements are distributed, including their relative size and their location in relation to the morphology (configuration) strongly influence biodiversity, the water cycle and soil erosion.

Elements of Management Proposals may include:

- Application of the principles of integrated pest management,
- Protection zones (e.g. Natura 2000) and protected areas and their buffer zones,
- Resignation from the use of areas valuable for beneficial organisms,
- Compliance with the law of liquidation of wastelands and actions for biodiversity.

g) Soil Organic Carbon

Soil organic carbon. Organic matter is important for adsorbing nutrients, retaining water and for improving soil structure and workability of soils as well as plant productivity. Soil organic carbon (SOC) is a major constituent (56%) of soil organic matter and the global soil organic carbon reservoir of soils is two to three times bigger than the carbon as atmospheric CO2. Therefore, an increase in SOC concentration and stock allows drawing down CO2 from the atmosphere and an improvement in soil health.

Soil organic matter is a mixture of many substances - carbon compounds - with a complicated structure and various properties, depending on the degree of humification. It is formed as a result of biochemical transformations of products of biological decomposition of organic compounds that are part of dead plants and soil organisms. Soil organic matter is the basic indicator of soil quality, which determines their physicochemical properties, such as sorption and buffer capacity, and biological processes that determine many changes, referred to as biological activity. The high content of humus in soils is a factor stabilizing their structure, reducing susceptibility to compaction and degradation as a result of water and wind erosion. In addition, soil organic matter can be a source or storage of atmospheric carbon dioxide, depending on the use of the soil, vegetation cover and water conditions.

Intensive soil mixing, especially in combination with monoculture, destroys its structure, increases oxygenation, and accelerates the mineralization of humus, which results in the release of large amounts of carbon dioxide into the atmosphere. Among the human-dependent factors affecting the content of organic matter (carbon) in the soil, the most important are: land use (arable land, permanent grassland, forest), intensity of soil movement, crop rotation and organic fertilization. A decrease in the content of organic matter in the soil is a clear signal of degradation and a decrease in soil fertility. Irrational farming can lead to a decrease in the content of organic substances, as a result of e.g. the use of drainage meliorations or accelerated mineralization of humus as a result of too intensive soil cultivation.

4. Results / Comments

All soil problems that occur during the year should be recorded for the annual review. Enter the results and description of the tests carried out with reference to the blank sample and relevant indicators.

5. Sources

Soil Management in Sustainable Agriculture, DOI: http://dx.doi.org/10.5772/intechopen.88319

Towards climate-smart sustainable management of agricultural soils, Report on identified regional, national and European aspirations on soil services and soil functions [https://ejpsoil.eu/fileadmin/projects/ejpsoil/WP2/Deliverable_2.5_Report_on_identified_regional__national_and_European_aspirations_on_soil_services_and_soil_functions.pdf]

FAO 2017. Voluntary Guidelines for Sustainable Soil Management Food and Agriculture Organization of the United Nations Rome, Italy [https://www.fao.org/3/i6874e/i6874e.pdf]

Protecting our Water, Soil and Air A Code of Good Agricultural Practice for farmers, growers and land managers, Defra, 2009 [https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/268691/pb13558-cogap-131223.pdf]

Soil Biology and Soil Health Partnership (AHDB: 91140002) [https://ahdb.org.uk/soil-biology-and-soil-health-partnership]

Soil and Fertility Management in Organic Systems at https://www.dal.ca/faculty/agriculture/oacc/en-home/resources/soils-fertility.html

EIP-AGRI Focus Group Moving from source to sink in arable farming [https://ec.europa.eu/eip/agriculture/sites/default/files/eip-agri_fg_carbon_storage_in_arable_farming_final_report_2019_en.pdf]

EJP Soils: [https://projects.au.dk/ejpsoil/about-ejp-soil/]

CIRCASA: [https://www.circasa-project.eu/]

KIC CLIMATE: [https://www.climate-kic.org/]

ESDAC [https://esdac.jrc.ec.europa.eu/]

Przewodnik Zrównoważonego Rolnictwa [https://www.fao.org/3/T1079E/t1079e00.htm#Contents]

Table 1. Additional tools to calculate the economic values of soil carbon for farmers

Tool	Source
Smartsoil	https://web04.agro.au.dk/projectnet/smartsoilDST/
UK farm tool	http://www.farmcarbontoolkit.org.uk/
C-tool	Taghizadeh-Toosi A et al. (2014) C-TOOL: A simple model for simulating whole-profile carbon storage in temperate agricultural soils. cological Modelling 292:11-25
C-bank	http://c-bank.lu.se/
KnowSoil	http://www.catch-c.eu/KnowSoil/

6. Changes compared to the previous edition

Date	Issue No.	Section	Previous requirement	Current requirement
-	-	-	-	-