CORE organic DOMINO

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DYNAMIC SOD MULCHING AND USE OF RECYCLED AMENDMENTS TO INCREASE BIODIVERSITY, RESILIENCE AND SUSTAINABILITY OF INTENSIVE ORGANIC FRUIT ORCHARDS AND VINEYARDS

Guidelines for standardized soil sampling and analyses

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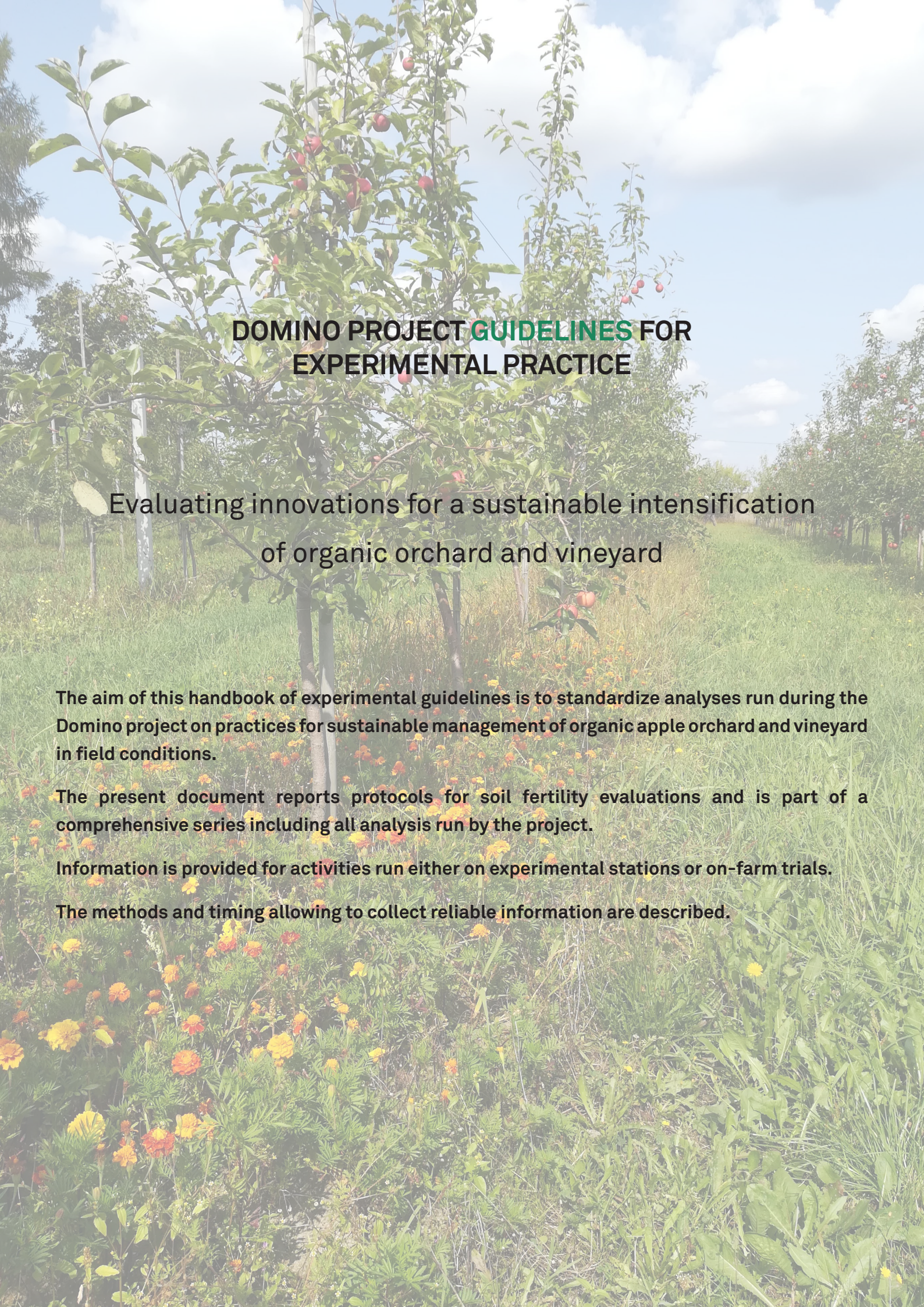

DOMINO PROJECT GUIDELINES FOR EXPERIMENTAL PRACTICE

Evaluating innovations for a sustainable intensification of organic orchard and vineyard

The aim of this handbook of experimental guidelines is to standardize analyses run during the Domino project on practices for sustainable management of organic apple orchard and vineyard in field conditions.

The present document reports protocols for soil fertility evaluations and is part of a comprehensive series including all analysis run by the project.

Information is provided for activities run either on experimental stations or on-farm trials.

The methods and timing allowing to collect reliable information are described.

1. Soil sampling

Sampling is performed with an auger from the soil at a 0 to 30 cm depth. In perennial crops it is important to standardize where the samples are taken between the trees in the tree row. At least 6 sub samples per treatment should be extracted and mixed together to form a mixed sample on which the analysis will be performed. Handling of the sample can vary, depending on the analysis and it is thus specified under the relevant headings.

2. Soil physical parameters

Soil water status: tensiometers or relative soil moisture on soil samples.

Soil water status in the field trials should be measured at least yearly during the period characterized by higher risk of water stress with tensiometers or other specific probes. Moisture of soil samples is measured by classical soil drying method.

Soil temperature: It can be measured with thermometers or probes specific for this measure.

3. Soil chemical parameters

For a detailed description of the analytical methods, see the table in Annex I.

Soil organic matter (C): The soil sample can be dried before this analysis. Soil organic matter is determined by the combustion method on finely ground samples from the fine earth fraction of the soil. To be measured twice: once at the establishment of the trial and at its end.

Total N and S

The soil sample can be dried before this analysis. The methods for testing can vary depending on the laboratory (see Annex I). To be measured at least twice: once at the establishment of the trial and at its end. C_{org} and N data are used for the calculation of the C/N ratio.

N_{min} S_{min}

Plant available nitrogen or mineral nitrogen is considered the sum of nitrate ($N\text{-}NO_3$) and ammonium ($N\text{-}NH_4$) nitrogen found in the soil in a given moment. It indicates the amount of N which is available for plant uptake at sampling time. In an apple orchard the measure of this parameter has to be done at least during the bloom and in fall because these are the more critical times for nitrogen availability of the orchard. If possible, further measures can be done in March at the beginning of the vegetation period and in August. Immediately after the field sampling, the samples should be stored in a cold and dark place and analysed within a day. If that is not possible they have to be frozen until the day of the analysis. The sieving is done with the wet sample and the sample is processed immediately afterwards to avoid N losses. Sampling and sample processing for the determination of S_{min} is performed similarly or the same extract used for N_{min} is used also for S_{min} determination.

Available P, K, Mg

For plant available nutrients (P, K, Mg) methods used in the different laboratories can differ. Especially for plant available P, the methods which have to be applied according to national standards for recommendation of fertilization depend highly on the soils of the region, in particular their pH. In Central Europe, in soils with pH values < 7 and > 5 plant available P is usually extracted by organic acids like lactic acid, often plant available K is extracted with the same method and measured in the same solution. Plant available Mg is usually extracted by salt solutions. The soil sample can be air dried, sieved to < 2mm and then extracted. The sampling is done every year in the trials at the beginning of the vegetation period.

Exchangeable bases, potential cation capacity (CEC_{pot})

The methods to be used depend on the laboratory. In most cases a strong buffered or unbuffered salt solution (e.g. $BaCl_2$, an ion that only rarely occurs in soils) with high molarity and neutral to alkaline pH is used to exchange all bases from their exchange sites on the soil particles and on soil organic matter. In the next step, the soil is washed and then loaded again with another strong salt solution in which the first ion is exchanged with the other and the potential cation exchange capacity is determined in the second solution. The exchangeable bases and the potential cation are measured at least once at the establishment of the trial and at the end of the trial. For determination of CEC_{pot} and exchangeable bases, air dry soil, sieved to < 2mm is used.

4. Nutrient elements in fertilizers

Sampling shall be performed according to national rules. In principle, an aliquot of the product shall be collected from the whole mass of product, sampling several sub-samples from different positions in the bag/package (in case of a solid product) or after mixing (in case of a liquid product). When the product is kept in different packages, sub-samples should be collected from each of them.

Analyses are performed according to standard methods (see Annex I).

5. Nutrient elements in plant materials

Leaves should be collected for foliar diagnostics of nutrient elements in June-July, after fruit set/drop. About 100 leaves, positioned on the central part of 1-year old shoots shall be gathered from a sufficient number of trees and shoots per tree, in order to fully represent the nutritional status of the orchard. The sample shall be delivered to the laboratory possibly on the same day, using a refrigerated container, to reduce tissue respiration.

Analyses are performed according to standard methods (see Annex I).

ANNEX I

Overview of methods for laboratory analyses

Soil Analyses

Parameter	Method
Dry matter	10 g soil, dried at 105°C for 72 h
pH	Extraction with 0,01 M $CaCl_2$ (VDLUFA 1991) or with with 0,1 N KCl or H_2O
Particle Size Distribution	Sedimentation method according to Köhn (DIN ISO. 11277, 2002 (equivalent to Gee and Bauder, 1996)
$CaCO_3$	Combustion, together with C_t (550 °C) at 900 °C Sensorial analysis with HCl
Ct, Nt, St	Combustion Combustion, method Duma's ISO 10694:1995; DIN ISO 13878; No St
CEC_{pot} and exchangeable bases	Extraction with $BaCl_2$ at pH 8.1 (Mehlich, 1942/Meiwes et al. 1984) Extraction with ammonium acetate 1 M, pH 7,0 Extraction with $BaCl_2$ unbuffered
Plant available P	Extraction with calcium lactate at pH 3.6 (VDLUFA 1991)
Plant available K	Extraction with calcium lactate at pH 3.6 (VDLUFA 1991)
Plant available Mg	Extraction with 0,1M CaCl2 (VDLUFA 1991) or CAT method (VDLUFA Metodenb. A641) or Extraction with 0,025 N CaCl2
Total contents of macro (Ca, Mg, K, P, Na) and micronutrients (B, Zn, Mn, Fe, Cu)	Aqua regia, measurement with ICP-OES

N_{min} and S_{min} in Soil

Parameter	Method
N_{min}, S_{min}	Samples are taken with an auger (0-30 cm), frozen at -18 °C until analysis, thawed, sieved to 5mm and 25g are extracted with $CaCl_2$ (VDLUFA 1991), determination of NH_4-N and NO_3-N with flow analyser Extraction with acetic acid 0,03 N, determination with potentiometric method

Nutrient elements in fertilizers

Parameter	Method
N_t (separated in N_t and NH4-N) prior to application	Kjeldahl with fresh samples Dumas' DIN ISO 13878
Dry matter	Adequate aliquot dried until constant weight is reached (for all fertilizers including the liquid ones) or freeze drying
Content of macro nutrients (P, K, Ca, Mg, Na)	Microwave digestion, then analysis with ICP-OES
C_t, N_t, S_t	Combustion Combustion, Dumas' ISO 10694:1995; DIN ISO 13878; No St

Nutrient elements in plant materials

Parameter	Method
Dry matter	Adequate aliquot dried until constant weight is reached Adequate aliquot dried (60°C) until constant weight is reached
Content of macro nutrients (P, K, Ca, Mg, Na) and micro nutrients (B, Fe, Mn, Zn) in leaves	Microwave digestion, then analysis with ICP-OES
Content of macro nutrients (P, K, Ca, Mg, Na) in leaves and fruits	Microwave digestion, then analysis with ICP-OES
C_t, N_t, S_t	Combustion