SoilCare
SOILCARE FOR PROFITABLE AND SUSTAINABLE CROP PRODUCTION IN EUROPE

Testing and promoting the adoption of soil-improving cropping systems across Europe

Newsletter 3 September 2018

WELCOME to the third newsletter of the SoilCare project.

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New Report: Inventory of opportunities and bottlenecks in policy to facilitate the adoption of soil-improving techniques

The uptake of innovations associated with potential benefits to soil quality, such as precision farming and conservation agriculture is slowly expanding across Europe. Yet, these innovations are not adopted to their full potential and are in some cases even abandoned, raising the question of why support and adoption of these practices by European farmers is still considerably weak. Understanding common barriers to the adoption of soil improving practices is an important prerequisite for identifying and designing policy measures to encourage farmers to adopt effective soil conservation practices. A second important foundation for developing appropriate policies is an appreciation of the effectiveness of soil conservation policies in agriculture.


SoilCare

Inventory of opportunities and bottlenecks in policy to facilitate the adoption of soil-improving techniques.

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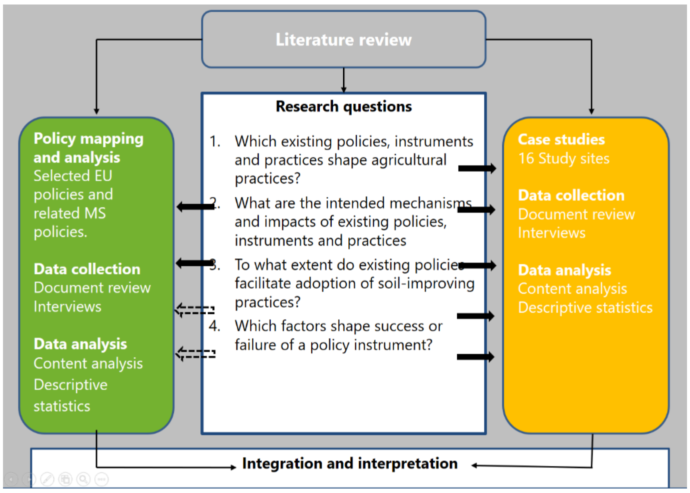
A new SoilCare report, available here, presents an inventory and analysis of bottlenecks and opportunities in sectoral and environmental policies to facilitate the adoption of Soil-Improving Cropping Systems (SICS). Using documentary reviews and interviews with policy-makers and stakeholders, we identify, describe and analyse relevant EU-level policies as well as national, regional and sub-regional policies in 16 European countries in support of the research questions presented in the figure below.

Cont. Pg 2 >



Research design

The findings of this study present the first step towards developing policy alternatives across various levels of governance with the aim of facilitating the uptake of SICS in particular, and of agricultural practices in general, which have demonstrated to be beneficial to soil quality. The following research questions were investigated:

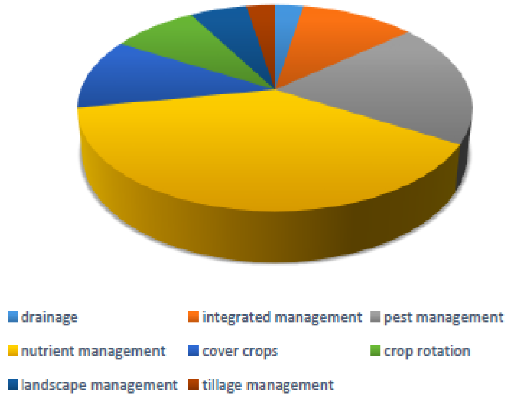
1. Which existing policies and policy instruments shape agricultural practices?

The protection, maintenance and improvement of soil quality relies on a number of sector and environmental policies that address different aspects of soil management. The study identified a number of policies and their specific instruments that explicitly and implicitly impact on farming practices and management in relation to improving soil quality. At EU-level, these include:

- Agricultural policies
- Water policies
- Nature policies
- The Sewage Sludge Directive
- The Sustainable Use of Pesticides Directive (SUPD)
- The Fertilisers Directive

At country-level, the policy landscape largely mirrors that at EU-level with only a few countries having a specific legislative or policy instrument with soil protection as its primary objective.

The figure below highlights the most frequently addressed SICS in the selected highly relevant policies. As can be seen, nutrient management together with pest management are the ones covered the most. These SICS are mainly addressed by water protection legislation as well as pesticides and fertilizers laws protecting primarily water sources and human health, with the protection of soil as an indirect impact of their implementation.



SICS components most frequently addressed by policies in 16 study site countries

2. What are the intended mechanisms and impacts of existing policies, instruments and practices

The analysis showed that, both at EU as well as country-level, SICS components are most frequently addressed by regulatory and economic instruments. Many of the identified regulatory policies use a mix of instruments, often including both mandatory and voluntary elements.

3. To what extent do existing policies facilitate adoption of soil-improving practices?

The analysis showed that some instruments address soil improving agricultural techniques directly, most of them indirectly. The existing policy framework is largely characterised by regulatory and economic policy approaches, with more than 80% of all policies in the covered countries emanated from policies formulated at EU level. Since many of these Directives and Regulations are subject to implementation and, as such, further definition at national and regional scale, impacts are bound to vary across countries.

- Concerns expressed by stakeholders over the impact of CAP on the environment and sustainable farming systems, included: the system of payments under CAP potentially encouraging farmers to engage in practices that are hazardous for the environment in order to obtain or maximise their payments; CAP instruments may actually support current industrial farming practices rather than promote a transition to more sustainable agricultural systems; the established system of payments may create a sense of entitlement that creates resentment when rules for payments are changed.
- Although the literature shows that the objectives of EU water policy are integrated into agricultural policy at the strategic level, the impact of this integration depends on the effective implementation of the agricultural policies. Some stakeholders have indicated that the Nitrates Directive has certainly changed the way manure is handled.
- Assessments of the Nature Directives show that outside Natura 2000 habitat sites, obligations set on farmers to protect threatened habitats, as well as species of Community importance, were often poorly defined, and the legislation was not enforced. It seems that even within Natura 2000 sites, management plans drawn up for each site have little impact on farmers' decisions.
- Member States (MS) have largely implemented stricter limits than those recommended by the Sewage Sludge Directive, but there is substantial variation between MS, with a number of MS using practically no sewage sludge in agriculture, preferring to incinerate it.
- Recent reviews of the SUPD show that on the one hand, MS have provided a high level of training and certification of professional users, distributors and advisors, carried out comprehensive information and awareness activities, implemented a range of measures to protect the aquatic environment from pesticide use and to reduce pesticide use in specific areas; and banned aerial spraying, with strict conditions on its use. On the other hand, the overall rate of compliance and an assessment of tangible results is missing in the absence of measurable targets in most national action plans.
- Evidence shows that many fertilisers sold under national legislation comply with the technical standards specified in the Fertilisers Regulation. However, there is no evidence supporting the argument that the Regulation has led to improvements regarding fertilisers' impacts on the environment, particularly regarding the presence of heavy metals in fertilisers, which may leach into soils.

4. Which factors shape success or failure of a policy instrument?

The documentary and analysis and stakeholder interviews point to the conclusion that the existing policy framework appropriately addresses key soil threats and functions. However, from an EU-level perspective, the evidence demonstrates that policy impact is largely defined by how these are implemented at national and regional level.

It is acknowledged that, whilst the CAP has the potential of delivering real impact, it is undermined by lack of proper implementation, control and sanctions or penalties for non-compliance. Reported research suggests that the financial incentives established by the CAP may be less effective than other types of instruments such as provision of information and advisory services, as they do not take into account nor can be tailored to other factors relating to farmer views and attitudes.

A recurring theme from the analysis is the need for better integration and policy coherence. Whilst commentators agree that the mainstreaming of soil concerns in agricultural and environmental policies has improved over the past decades, it is evident that a coherent, well integrated policy framework with clear objectives, targeted policy measures, and a well-defined monitoring process is needed to promote a transition towards agriculture systems and practices which support the protection, maintenance and improvement of soil resources across Europe.

For more details about the report, please contact Melanie Muro Melanie.Muro@milieu.be

Soil-improving cropping systems to be trialled in Study Sites

During the stakeholder workshops at the 16 SoilCare study sites, stakeholders successfully evaluated a range of soil-improving cropping systems, and reached a short-list of interventions for field trials. These trails are now described below:

Country	General Treatment Category	Study Site Experiment
Belgium	Tillage, cover crops, amendments	**1.Organic soil amendments in wheat fields** - mineral fertilization, soil pig manure, VFG compost, wood chips and pig manure + lava grit
		2.Soil cultivation and soil cover in maize - strip till in living rye cover crop; Strip till in destroyed rye cover crop; Undersowing grass; Non inversion tillage; Control- normal ploughing
		3. Demonstration fields - Novel crops- perennial wheat, soybeans, winter field beans, lupins (control: winter wheat); Controlled traffic
Norway	Cover crops	**1. Biological compaction release** (4 levels of compaction) - Cover crop with deep root crops (3 types of crops); No cover crops
		2. Cover crop- Catch crop - Undersown of Mix 1: Chicory, perennial ryegrass and alfalfa; Undersown of Mix 2: White clover, "Birdsfoot trefoil" and crimson clover; Sown after harvest Mix 3: Forage radish and ww. Ryegrass; Sown after harvest Mix 4: vetch, hairy vetch and pisum; No cover crop (Barley)
		3 Precision agriculture (demonstration)
Hungary	Crop rotations, tillage, fertilization	**1. Organic/inorganic N fertilization**
		2. Mineral fertilization in continuous maize cropping
		3. Organic/inorganic fertilization in different rotation
		4. Tillage in maize-wheat biculture
Switzer-land	Crop rotations, fertilization, controlled traffic	**1. HSE-grass verge + artificial meadow + «control traffic»** - Area with no grass verge but artificial meadow; Area with grass verge and artificial meadow
		2. UDE-Manuring/ CULTAN procedure (specific machinery for direct application of fertilization directly to the roots) - Cultan procedure with 2 ways of sampling; Green manure and liquid manure with drag house
		3. USE-Green and liquid manuring - Phacelia as green manuring and liquid manure; Phacelia + clover as green manuring and liquid manure; Fallow (if if needed with Glyphosate usage) – with special permission
Denmark	Crop rotations, tillage, fertilization	**1. CROPSYS crop rotations, organic and conventional/row cropping with catch crops** -Rotation (O2,O4,C4),O2 organic (S. barley: ley, Grass-clover, spring wheat, spring oats), O4 organic (S. barley, Faba bean, Spring wheat, Spring oats), C4 conventional (S. barley, Faba bean, Spring wheat, Spring oats). +/- catch crop, +/- manure
		2. CENTS / soil tillage intensities and cover crops (maybe) - Ploughed/ harrowed/direct drilled, crop type, catch crop type, +/- straw
		3. Screening different types of catch crops (maybe) - Different species of cover crops. This year also including mixtures of different species
		4. Askov and Samsø / as demonstrated during the 2018 annual meeting excursion (demonstration)
		5. Askov and Jyndevad / experiments with different levels of fertilization and liming (LT)

Country	General Treatment Category	Study Site Experiment
United Kingdom	Crop rotations, tillage, fertilization	**1.Compaction experiments -** Control – no till; Ploughing; Low disturbance sub soiling; Low disturbance sub soiling
		2. Introducing grass leys in rotation - 5 different deep rooting grasses; Mixture of ryegrass and clover (control)
		3. Digestate from sewage - Digestate ploughing
Germany	Tillage, cover crops	**1. Effect of cover crop termination with Glyphosate on soil microorganisms -** Glyphosate with cover crop; Glyphosate free with cover crop; Control 1: Glyphosate free + hand weeding; Control 2: Glyphosate only
Romania	Tillage	**1. Tillage experiments -** Deep ploughing (30cm); Subsoiling (50 cm); Non inversion till; 2 disk ploughing
Italy	Tillage, cover crops	**1. Loss of SOM and Compaction control -** Mouldboard plough and bare soil; Mouldboard plough and deep rooting cover crop (tillage radish); No tillage and bare soil; No tillage and deep rooting cover crop (tillage radish)
Poland	Cover crops, liming	**1. Soil management practices** - Control- mineral fertilization; Liming ($CaCO_3$ 5,6 t/ha); Cover crops (Lupines +Serradella + Phacellia, respectively: 130 + 30 + 4 kg/ha); Manure (30t/ha); Liming ($CaCO_3$ 5,6 t/ha) + Lupines + Serradella + Phacellia (130 + 30 + 4 kg/ha) + manure (10 t/ha)
Portugal	Crop rotations, cover crops, fertilization	**1. Bico da Barca - Organic rice in rotation with perennial lucerne -** Conventional rice monoculture (Control); Organic rice in rotation with perennial Lucerne (2 years of rice + 2 years of Lucerne) **2. Taveiro – Conventional grain corn in succession with legumes winter cover -** Conventional grain corn with Red Clover as cover crop in winter; Conventional grain corn with Persian clover as cover crop in winter; Conventional grain corn with yellow lupine as cover crop in winter; Conventional grain corn with white lupine as cover crop in winter; Conventional grain corn with no cover crop in winter (fallow- control) **3. São Silvestre - Conventional grain corn fertilized by urban sludge -** Grain corn receiving urban sludge fertilization; Grain corn receiving conventional mineral fertilization (control)
Greece	Cover crops, tillage, crop change	**1. Soil erosion rate assessment -** No till in organic olive orchards; Conventional till (15-20 cm) in organic olive orchards; Conversion from orange orchard to avocado; Conventional orange orchard; Cover crop (vetch) in organic vineyards; Bare soil in organic vineyards
Sweden	Sub soil loosening, tillage	**1. Sub soil loosening -** Sub soiling loosening; Sub soiling loosening with straw pellets; Normal mouldboard ploughing - control
Czech Republic	Tillage, fertilization	**1. Tillage experiments and different N application -** No till (all residues on surface); Reduced till (chisel ploughing up to 10cm-min 30% residues on soil surface); Conventional till (mouldboard ploughing up to 22 cm
Spain	Cover crops, tillage, irrigation management	**1. Desertification, wind erosion and organic matter decline -** Regulated vs Constant Deficit Irrigation and Minimum tillage in olive orchards; Regulated vs Constant Deficit Irrigation and Minimum tillage plus pruning residues added in olive orchards; Regulated vs Constant Deficit Irrigation and Minimum Tillage plus temporal cover crops (natural weeds and sowed) in olive orchards; Regulated vs standard irrigation and non-tillage (herbicide weed control) in peach orchards; Regulated vs standard irrigation and Non-tillage plus pruning residues added and temporal natural vegetation in peach orchards; Regulated vs standard irrigation and Non-tillage plus pruning residues and temporal cover crops sowed in peach orchards
France	Cover crops, sowing management , tillage	**Early sowing of wheat (August vs September vs end of October?) (2 or 3 treatments) -** Cover crops (oat vs mixed) (2 treatments); Soil tillage and soil cover (3 treatments)

Study site feature: Flanders, Belgium

There are 16 study sites within the SoilCare project each focused on trialing soil-improving cropping systems relevant to their local contexts. In this newsletter we focus on the study site in Belgium

The Belgian study site is located in Flanders to the east of the city of Leuven. The average annual temperature is 10.5°C, whilst the average annual rainfall is 850 mm. The study site is characterized by sandy, sandy loam and loamy soils.

The study site is characterised mainly by conventional cropping systems. However, also conservation cropping systems (e.g. reduced tillage) and to a smaller extent organic cropping systems are present. In general in Flanders, crop production is highly intensive (high inputs, high yields).

On Wednesday 20 June 2018, Bodemkundige Dienst van België organized the first Open Field Day as part of the SoilCare project. Around 60 visitors attended the event during which they were able to visit the 4 SoilCare field trials.

Solid pig manure and wood chips as applied on the first trial (© BDB)

The first trial concerned the use of soil-improving amendments to improve the organic matter content in soil, soil biodiversity and soil quality in general. In the SoilCare field trial various organic materials were incorporated, such as pig manure, vegetable, fruit and garden (VGT) compost (Ecowerf) and wood chips, and compared with control strips without fertilization or with only mineral fertilization.

Sowing machine for strip till in maize (© BDB)

At the second location, the theme of soil cultivation and soil cover in maize was discussed. This SoilCare trial examines how we can improve the soil quality in (monoculture) maize through various forms of reduced tillage and better soil coverage during the winter. In the experimental field the techniques of non-inversion tillage, strip-till in living or destroyed rye cover crop and under sowing of reed fescue are tested. The machines used for strip-till and sub-sowing were also exhibited.

In the third location, the introduction of "new" crops, in particular protein-rich crops such as soya, lupins and field beans, was explained. Also at this location, the opportunity was taken to, as a first in Belgium, sow perennial wheat and compare it with classic winter wheat. The idea of the development of perennial wheat originated in the Land Institute (US), from the observation that the continuous cultivation of annual crops in arable plots had an adverse effect on soil quality in the long term. In order to successfully cultivate annual crops, farmers have to repress or control the weeds every year and till the soil, resulting in loss of organic matter, soil erosion, nutrient leaching and soil subsidence. The idea is that perennial crops, since they do not have to be replanted or replanted annually and therefore do not require annual tillage or weed control in order to develop, can boost soil quality. The Land Institute has supplied a quantity of experimental seed to sow in a trial field, with the aim of further investigating the effects on soil quality.

Perennial wheat in the demonstration field in Lovenjoel, Belgium (© BDB)

Stakeholders visiting the demonstration field with perennial wheat during the Open-field day (© BDB)

Finally, in the fourth location, the topics of soil compaction and precision agriculture were presented together. At this location there is an experimental field belonging to the farmer, Michel Hendrickx (Hoegaarden), where he has been working for 10 years with Controlled traffic for spraying operations. The effects on the soil were illustrated using a soil profile pit. As part of the SoilCare project, measurements will be carried out in this field on the soil in and between the tracks in order to investigate the effects on soil compaction.

Soil pit on display (©BDB)

The main stakeholders who are involved in the study site are:

- Farmers
- Farmer associations (like Boerenbond and Algemeen Boeren syndicaat),
- Governmental extension services (ADLO in Flanders),
- Policy makers like VLM (Flemish Land Agency), LNE (the Environment, Nature and Energy Department of the Flemish Government)

For more information about the Flanders study site, please contact: Annemie Elsen aelsen@bdb.be or Mia Tits mtits@bdb.be

SICS Focus: Compaction-specific SICS

Each issue of the SoilCare newsletter will focus on soil threat-specific SICS. In this newsletter the focus is on compaction-specific SICS.

Compaction refers to increasing the density of soil and the distortion of soil pores. Soil compaction leads to lower water and air infiltration rates, water logging, risks of anaerobic conditions, a lower root penetration ability, lower crop yields, poor soil structure, lower biodiversity and biological activity, increased greenhouse gas emissions and erosion and runoff. Compaction of the subsoil is especially a concern because subsoil compaction is difficult to remediate (through natural processes and/or deep ploughing/soil lifting).

The SoilCare review of SICS (see Newsletter 2) has identified compaction-specific SICS that prevent compaction and/or lower the density of the soil, increase the water infiltration rate, lower the penetration resistance, and improve soil structure. Compaction-specific SICS address the cause of compaction as well as compaction itself and its effects. They may include the following substitution mechanisms:

- Lowering wheel loads and tyre pressures
- Reduced tillage - less intensive tillage system that employs fewer trips across the field than conventional tillage with ploughing
- Avoiding driving in the open furrow during ploughing
- Working in the field under proper soil and weather conditions.

Redesign mechanism are also important and relate to:

- Controlled trafficking - repeated used of the same wheel tracks for every machinery operation
- Growing deep rooting crops like cereals (in particular summer cereals), alfalfa, some cabbages and trees.
- Deep soil cultivation
- Stimulating biological activity through manuring

Compaction-specific SICS have then to be tailored locally, selecting and combining the best actions depending on soil, climate and available crops.

The most promising compaction-specific SICS have been identified as (i) prevent further densification of the (sub)soil, and (ii) remediate compacted soils and/or alleviate their effects. They may involve controlled trafficking, adjusting mechanization and the planning of activities, growing deep rooting crops, and stimulating biological activity through addition of organic matter (see the Table).

	Components of cropping system	Components of compaction-specific SICS	Change in profitability
A	Crop rotations	When possible: +deep-rooting crops	-/+
B	Nutrient management	Manuring	+/-
C	Irrigation management	optimal	+
D	Drainage management	optimal	+
E	Tillage management	Reduced tillage	+
F	Pest management	optimal	+
G	Weed management	optimal	+
H	Residue management	optimal	+/-
J	Mechanization management	Controlled traffic; low-wheel loads, low-inflation tyres	+ [1]

[1] Controlled traffic has been shown to increase yields significantly, while soil physical properties are improved. However, it requires investments in equipment and machines. On the longer term, benefits seem to outweigh the costs.

For more information about these different SICS, please visit the SoilCare website https://soilcare-project.eu/soil-improving-cropping-systems

Publications

Project deliverables

D2.1 A review of soil-improving cropping systems

D3.2 List of cropping systems selected for testing in WP5

D7.1 Inventory of opportunities and bottlenecks in policy to facilitate the adoption of soil-improving techniques

Journal articles

Peltre, C., Nyord, T., Christensen, B.T., Jensen, J.L., Thomsen, I.K. and Munkholm, L.J., 2016. Seasonal differences in tillage draught on a sandy loam soil with long-term additions of animal manure and mineral fertilizers. *Soil Use and Management*, 32(4), pp.583-593.
doi:10.1111/sum.12312

Christensen, B.T., Jensen, J.L. and Thomsen, I.K., 2017. Impact of Early Sowing on Winter Wheat Receiving Manure or Mineral Fertilizers. Agronomy Journal.
doi:10.2134/agronj2016.11.0677

Suarez-Tapia, A., Kucheryavskiy, S.V., Christensen, B.T., Thomsen, I.K. and Rasmussen, J., 2017. Limitation of multi-elemental fingerprinting of wheat grains: Effect of cultivar, sowing date, and nutrient management. *Journal of Cereal Science.*
doi.org/10.1016/j.jcs.2017.05.015

Reed, M.S., Vella, S., Challies, E., de Vente, J., Frewer, L., Hohenwallner-Ries, D., Huber, T., Neumann, R.K., Oughton, E.A., Sidoli del Ceno, J. and van Delden, H., 2017. A theory of participation: what makes stakeholder and public engagement in environmental management work?. *Restoration Ecology.*
doi:10.1111/rec.12541

Past Events/Presentations

4-5th Dec 2017 Poster on SoilCare presented at Inspiration project / Soils4EU World Soil Day Conference – Land, Soils and Science, Brussels.

26-28th Feb 2018 Bonares Conference, 'Soil as a Sustainable Resource,' Berlin. Jane Mills presented review work undertaken within SoilCare on farm advisory systems for soil entitled "Are advisory services 'fit for purpose' to support sustainable soil management? A review of advisory capacity in Europe".

8th March 2018 EIP-Agri Workshop "Interactive innovation in action – Multi-actor project learning from each other", Brussels.

29th May-1st June 2018 SoilCare 3rd plenary meeting held in Billund, Denmark, and hosted by colleagues of AgroIntelli and Aarhus University. The meeting included a visit to the Askov Research Centre (Aarhus University) to see the 120 years long-term experiment.

20th June 2018 Open Field Day at the Belgium Study Site. The event was an opportunity for local farmers, neighbours, advisers, scientists, policymakers and other interested people to learn more about the four SoilCare SICS trials.

Future Events

27-28th September 2018 The French partners will be running a SoilCare demonstration area at their organic agricultural show in France which is expected to attract over 8,000 participants. The area dedicated to soil quality will feature farm equipment/cover-crops, SICS demonstrations, and talks. The programme for the event, titled "La Terre est Notre Métier" is available to download here

SoilCare
SOILCARE FOR PROFITABLE AND SUSTAINABLE CROP PRODUCTION IN EUROPE

The SoilCare project has brought together a transdisciplinary team of 28 different organisations to identify, test and promote the adoption of soil-improving cropping systems across Europe.

PROJECT PARTNERS

1 Wageningen Environmental Research (Alterra), The Netherlands
2 University of Newcastle upon Tyne, United Kingdom
3 KU Leuven, Belgium
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6 Research Institute for Knowledge Systems, The Netherlands
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27 Fédération Régionale des Agrobiologistes de Bretagne, France
28 Scienceview Media B.V., The Netherlands

Participants at the SoilCare 2nd Plenary meeting 13th - 17th March 2017 in Crete, Greece (Photo: Erik van den Elsen)

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