CATCH-C: Soil Management for our Future

Challenge

Soil degradation caused by agricultural activity is considered a serious problem in parts of Europe. Current soil management contributes to several soil threats, including erosion, compaction, nutrient imbalances, and declining soil organic matter (SOM). In the long term, loss of soil quality and SOM compromises soil functioning and the ecosystem services provided by soil. Moreover, many soil management practices also affect an array of public interests directly, irrespective of whether soil degradation occurs or not. Emissions of herbicides, fungicides, nutrients, and greenhouse gases (GHG) into the biosphere, loss of above-ground biodiversity, and the consumption of finite resources are all directly connected with how soils are managed, even when the soils remain unaffected. Finally, soil management is an important factor affecting the economic sustainability of farming.

Aim and objectives

Given all these concerns, the **overall aim** of the CATCH-C project was to promote sustainable soil management in European agriculture, by providing practical knowledge, tools and insights for farmers, advisers and policy makers.

For brevity, improved practices are here referred to as 'Best Management Practices' (BMPs), even if no practice can be 'best' to serve all goals simultaneously. Among the many goals of sustainable soil management, three were specifically targeted by CATCH-C: soil quality, crop productivity, and climate change (CC-) mitigation (carbon sequestration, reduction of GHG emissions). Figure 1 reflects in a simplified manner that management affects each of these three goals directly, but also via a feedback loop connecting soil quality with primary production and CC-mitigation. The loop involves relations between soil quality, crop growth and resource use efficiency, and the accumulation of SOM. Obviously, diversity in EU farming conditions calls for a tailored approach that recognizes the differentiation in climate, soil type, topography, farm type, as well as in socio-economic and policy contexts in the different regions and Members States (MS).

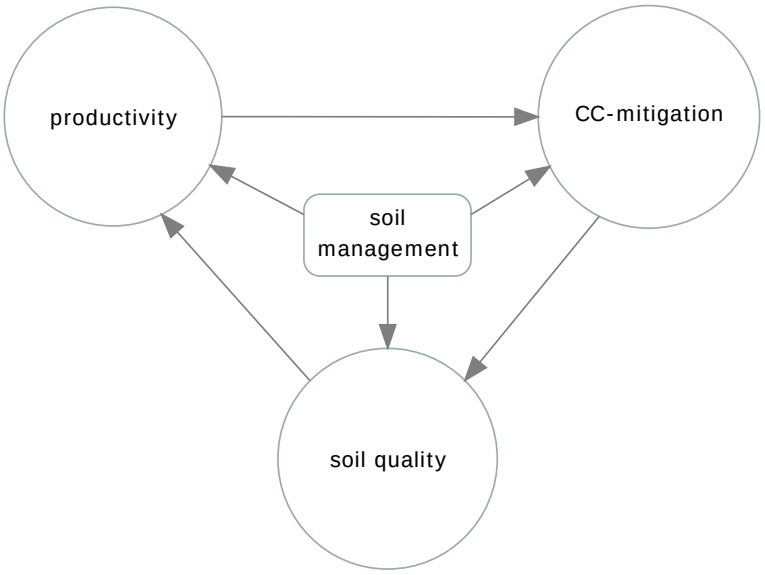

Figure 1. Sustainable soil management, its three principal aims, and their interrelations.

Specific objectives

The specific objectives of CATCH-C were:

- To identify the major farm types and agri-environmental zones in the CATCH-C partner countries;
- To document Current Management Practices (CMPs) and related soil degradation issues in these major farm types;
- To assess Best Management Practices (BMPs) for sustainable soil management and consolidate proof of the benefits they can bring, based on experimental evidence (long term experiments (LTEs));
- To compile outcomes in end-user format (web-tool) to help farmers select BMPs for their specific situation;
- To assess on-farm compatibility of BMPs, by identifying barriers preventing adoption in the respective major farm types, based on extensive farm surveys;
- To document field innovations enabling to overcome barriers against adoption of BMPs;
- To assess the policy context and provide guidelines on how soils policies can be made more effective.

Activities and Outcomes

Both for the analysis of LTEs and for the stratification of farmer surveys, CATCH-C developed a farm typology to ensure proper representation of the wide variety of agro-ecological conditions (climate, soil, topography) and farming systems that exists in Europe. A total of 24 major farm types were defined, three in each partner country, and our surveys addressed all of these (Figure 2).

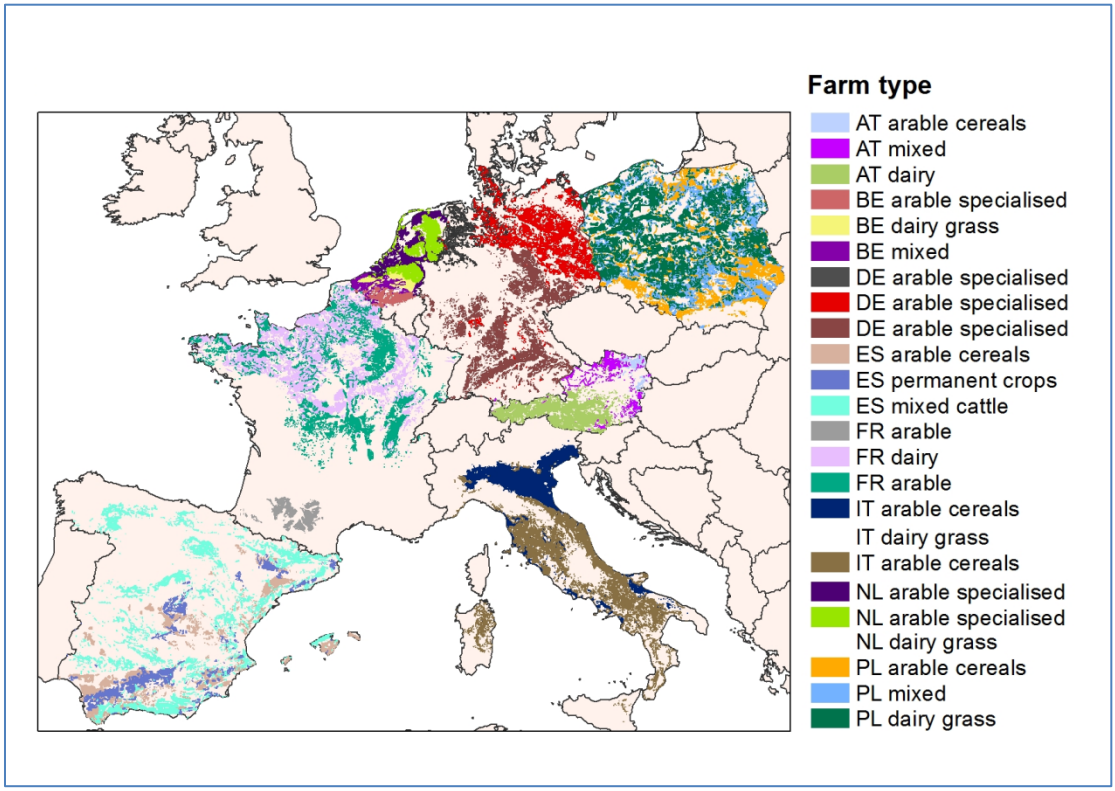

Figure 2. Map of major farm types in the CATCH-C partner countries. For three major farm types per country, current soil management practices were recorded via interviews, and farmer views on 'Best Management Practices' were collected through an extensive survey using questionnaires. (Austria AT, Belgium BE, Germany DE, Spain ES, France FR, Italy IT, the Netherlands NL, Poland PL.)

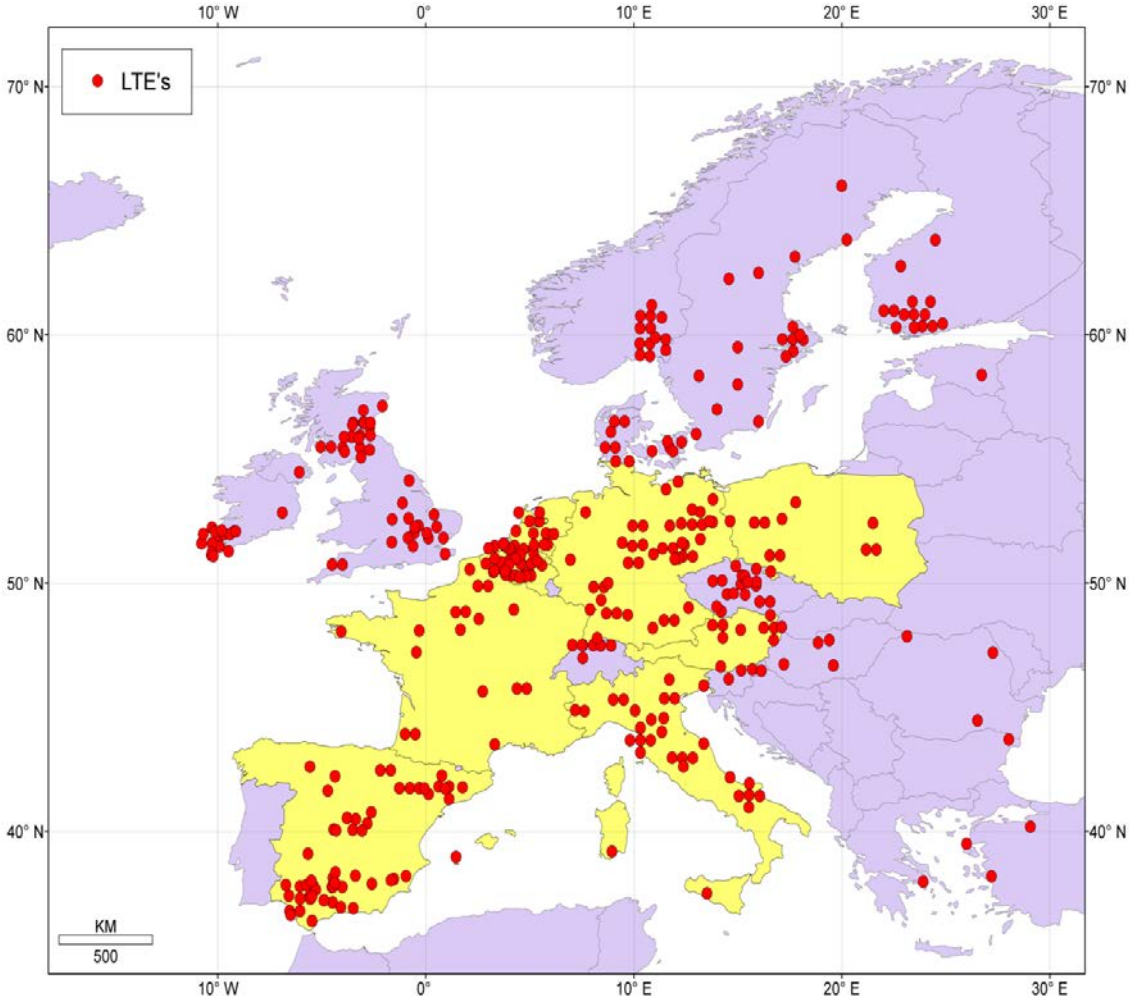

Figure 3. Locations of long term experiments (LTEs) evaluating soil management practices, outcomes from which were transferred into the CATCH-C database and analysed to assess the effects of practices on biophysical indicators, including the modulating roles of local conditions (co-variates).

CATCH-C assessed the merits of selected BMPs, notably their contributions to soil quality, to crop productivity and nitrogen use efficiency (NUE), and to the mitigation of climate change through carbon sequestration and reduction of greenhouse gas (GHG) emissions. The assessment was based on about 350 long term experiments (LTEs) from all over Europe that provided experimental evidence (Figure 3; not all are shown).

BMPs evaluated include options for cropping scheme, tillage, crop residue management, and nutrient and water management. They were evaluated against 'reference practices': monoculture, bare fallow, ploughing, removal of residues, and the use of mineral fertilisers and flood irrigation. BMPs include crop rotation, reduced or no tillage, incorporation of crop residues, organic manures, and water saving practices. The analysis showed that these BMPs indeed generally do improve soil quality (biological, physical and/or chemical). For example, all studied BMPs improve biological soil quality, and more so when they increase organic matter input (which is more effective than reducing soil disturbance). However, BMPs often come with trade-offs such as lower yield, lower NUE, and higher GHG emissions, notably N_2O. Local conditions strongly affect impacts, both their magnitude and direction. Climate, crop type or soil texture could sometimes explain the large contrasts found between LTEs. For example, impacts in permanent crops were very different from arable crops, and Mediterranean systems differed largely from those in Central or Northern Europe. A web-based support tool named 'KnowSoil' was developed to summarize these outcomes for practitioners, and is available in English,

French, German, Polish, Italian, Spanish and Dutch. http://www.catch-c.eu/KnowSoil/ (live from late June 2015).

The LTE-based assessment was complemented by an inventory of farmer views on selected BMPs, collected through surveys among thousands of farmers in the major farm types of partner countries (Figure 2). The questionnaire-based surveys yielded opinions from over 2,500 farmers on the compatibility of the BMPs with their respective farm types. Farmers' views were analysed by a uniform protocol that enables to quantify drivers and barriers to the adoption of BMPs. Drivers and barriers reflect perceived impacts from BMPs on yield and produce quality, required inputs and equipment, cost, work organisation, pest and disease pressure, and sometimes on biodiversity and environment. We found that drivers and barriers may depend on policy measures, but natural processes and financial constraints were frequently the most important. Weather and soil conditions play a dominant role in controlling – year by year - the suitability of a given BMPs in local practice. Improvement of soil quality was found to be a strong driver for many BMPs in many farm types: farmers are well aware of these benefits. However, increased weed pressure and disease risk, higher use of herbicides, fungicides and fertilizers, yield loss, cost and the need for specific equipment were generally identified as strong barriers for many BMPs and farm types. We produced a compilation of innovations that aim to overcome such barriers, but many challenges remain.

CATCH-C analysed EU and national policies to assess how well soil protection and sustainable soil management are embedded in four types of 'policy packages' as implemented in Member States: CAP-I, Rural Development Programs, 'Environment', and national initiatives. With some exceptions, it appears that the current policy framework is insufficient to provide general protection against gradual decline of soil properties and the ecosystem services that soils can supply. The current top-down (from the European to local levels) design of soil-related policy packages has resulted in most countries in poor embeddedness of soil stakes in policy objectives, policy measures and impact assessment.

A coherent policy framework, with clear and shared objectives and precise reporting of outcomes, is essential to establish a comprehensive strategy for sustainable soil management in agriculture. There are many features that argue for a European dimension to this framework. These include (i) the obvious under-provision of soil ecosystem services at regional and national levels, (ii) the existence of spillovers for many (even local) soil stakes, (iii) competition between regions in a context of food security challenges and its potential consequences in terms of resource depletion, (iv) opportunities to take advantages of local endowments to serve global goals (climate change mitigation; biodiversity) which require to implement redistribution mechanisms between Member States.
The European level should help to harmonize the monitoring of soil parameters and ecosystems services supplied throughout Europe, encourage Member States to use scientifically sound indicators to assess the impact of the policy measures they chose, and implement redistribution mechanisms between Member States to optimise the collective supply of ecosystem services from soils.

Future work should aim to quantify the synergies and trade-offs between a broader set of (public) goals, including environment and biodiversity. Also, better quantification is needed of the trade-off between carbon sequestration and N_2O emission in CO_2-equivalents, as both seem to go hand in hand for many BMPs. Further, many innovative and cost-effective solutions are still needed to address barriers that farmers face when adopting practices to improve soil quality and ecosystem services. Yet, contrasting views of adopters and non-adopters – on a number of practices - point at the potential contribution of focussed extension work, too.

More outcomes from each of the above activities can be found in CATCH-C publications on http://www.catch-c.eu/.

Project partners:

Coordination:

Stichting Dienst Landbouwkundig Onderzoek, Wageningen, The Netherlands

Coordinator: Hein ten Berge, hein.tenberge@wur.nl

UNIVERSITÀ DEGLI STUDI DI TORINO

www.catch-c.eu

Catch-C: Compatibility of Agricultural Management Practices and Types of Farming in the EU to enhance Climate Change Mitigation and Soil Health. Grant Agreement N° 289782