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Assessment of promising agricultural management practices

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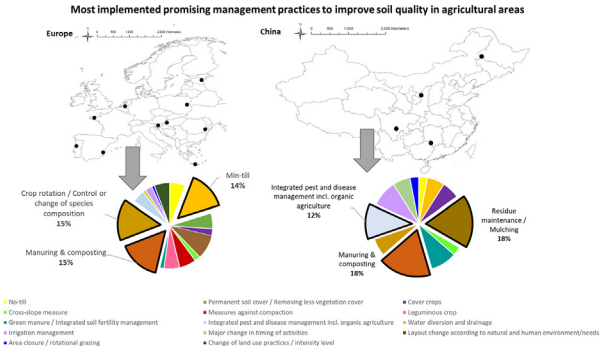
HIGHLIGHTS

- Promising agricultural management practices (AMP) adopted by farmers improve soil quality.
- iSQAPER project aims to develop an app to advise farmers on selecting the best AMPs.
- Some of the most promising AMP was Crop rotation and Manuring & Composting.

GRAPHICAL ABSTRACT



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ABSTRACT

iSQAPER project - *Interactive Soil Quality Assessment in Europe and China for Agricultural Productivity and Environmental Resilience* - aims to develop an app to advise farmers on selecting the best Agriculture Management Practice (AMPs) to improve soil quality. For this purpose, a soil quality index has to be developed to account for the changes in soil quality as impacted by the implementation of the AMPs. Some promising AMPs have been suggested over the time to prevent soil degradation. These practices have been randomly adopted by farmers but which practices are most used by farmers and where they are mostly adopted remains unclear.
This study is part of the iSQAPER project with the specific aims: 1) map the current distribution of previously selected 18 promising AMPs in several pedo-climatic regions and farming systems located in ten and four study site areas (SSA) along Europe and China, respectively; and 2) identify the soil threats occurring in those areas. In each SSA, farmers using promising AMP's were identified and questionnaires were used to assess farmer's perception on soil threats significance in the area.
138 plots/farms using 18 promising AMPs, were identified in Europe (112) and China (26).Results show that promising AMPs used in Europe are Crop rotation (15%), Manuring & Composting (15%) and Min-till (14%), whereas in China are Manuring & Composting (18%), Residue maintenance (18%) and Integrated pest and disease management (12%). In Europe, soil erosion is the main threat in agricultural Mediterranean areas while soil-borne pests and diseases is more frequent in the SSAs from France and The Netherlands. In China, soil erosion, SOM decline, compaction and poor soil structure are among the most significant. This work provides important information for policy makers and the development of strategies to support and promote agricultural management practices with benefits for soil quality.

1. Introduction

The growing world population poses a major challenge to global agricultural food and feed production (United Nations, 2015). So far, agriculture was able to cope with the increasing demand, but changes in diets food wastage and the challenge of feed more than 9 billion people by 2050 rises the pressure on agriculture sector. Increasing agricultural outputs can be reached either through more land area dedicated to agriculture (FAO, 2011) or through productivity increases (Tilman et al., 2011). Both solutions cause an overall set of impacts such as: a) mining and disruption of nutrient resources, such as the nitrogen (N) and phosphorus (P) cycles, through increasing use of fertilizers (Gruber and Galloway, 2008; Obersteiner et al., 2013), and decrease of soil organic matter (SOM); b) loss of soil structure (Tiessen et al., 1994) and increasing susceptibility to erosion, namely due to high mechanization; c) decrease in soil biodiversity, though the conversion of natural habitats and loss of endogenous *flora* and *fauna* (Chapin et al., 2000; Newbold et al., 2015); d) decrease of water quality (surface and groundwater), through sediment and nutrients exports by runoff and leachate, as well as consumption of fresh and groundwater for irrigation (Scanlon et al., 2007); e) increase in atmospheric greenhouse-gases, through livestock, consumption of fossil fuels and adoption of management practices that induce greenhouse gas emissions from biological soil processes (Robertson, 2000).

Whether in developed or developing regions such as Europe and China, agricultural intensification based on conventional approaches has resulted in severe soil degradation (Lal, 2015; Ramankutty and Foley, 1999) and the consequent failure of agricultural soils to deliver the more than ever required ecosystem services, comprising more than the provision of food, feed, fibre and fuel. Indeed, soil is currently under several threats that compromise its functions and the ecosystem services potential. Some examples of threats affecting soil are erosion, soil organic matter (SOM) decline, compaction or biodiversity loss (Stolte et al., 2016). These threats interfere and compromise the organic matter level in soil, the water and air circulation, the diversity of micro and macro fauna among others. Therefore agricultural management practices that halter ongoing soil degradation, promote sustainable land management capable to produce more from less, and to change the conventional agricultural paradigm are required (Hurni et al., 2015; Tilman et al., 2002; Wall et al., 2015). These promising agricultural management practices are considered here as those maintaining healthy soils, or have been improving the soil quality status markedly (Schwilch et al., 2011).

The focus on the soil as a resource and the need to use it in a sustainable way was patent in the *Soil Thematic Strategy* developed by the European Commission in 2012. The four pillars of the Strategy, namely awareness raising, research, integration, and legislation, intend to preserve the soil functions while also restore already degraded soils. Therefore the consolidation of harmonized soil monitoring and soil quality indicators is necessary to better compare the soil performance along different countries (European Commission, 2012). Integrated in this context, the H2020 iSQAPER research project – *Interactive Soil Quality Assessment in Europe and China for Agricultural Productivity and Environmental Resilience* – aims to develop a Soil Quality app (SQAPP) to link agricultural management practices (AMP) to soil quality indicators. This easy-friendly tool will provide a direct and convenient way to advise farmers and other stakeholders regarding the best management practices to be adopted in specific conditions to improve soil quality.

Soil quality is a difficult concept to establish, and several indicators/parameters have been considered by different authors during the last decades (Bünemann et al., 2018). Thus, iSQAPER project includes the development of a soil quality index to be used by the app. However, there is also an urgent need to link the impact of different agricultural management practices to the soil quality impacts, in order to ensure both soil protection and the sustainability of the agriculture sector. Some promising management practices have been suggested and adopted to prevent soil loss, the decrease of organic matter or soil salinization all over the world. These practices, including no-tillage, cover crops or soil cover, have been randomly adopted by farmers once they are faced with soil degradation problems in their fields. However which practices are already in used by farmers and where are they mostly adopted remains unclear. This information is important for policy makers, farmer's management advisers and scientists actively engaged in developing and promoting agricultural management practices to correctly address the local soil problems.

iSQAPER project has 25 partners, of which 14 are participating as study site areas, located in a variety of pedoclimatic areas from Europe and China, and object of agriculture research for long time. This study, developed under iSQAPER project, aims to (i) map the distribution of promising AMP's (pre-selected from a list developed by the WOCAT consortium) along the study site areas of Europe and China; and ii) identify the most severe soil threats in each