Preface

As part of the international quest to reduce greenhouse gas emissions into the atmosphere and on recommendation of the Kyoto Protocol, this book highlights alternatives to current soil management practices for turning agricultural soils into sinks of organic carbon. While common agronomic practices are based on traditional knowledge of soil transformation processes, this book indicates that modern or progressive understanding of complex biological systems in the soil ecosystem may already be exploited to devise new soil management practices. Explored in this book is the recent paradigmatic change in the chemical understanding of soil humus which has prompted new mechanisms for the control of soil organic matter stability. These mechanisms may be significantly more efficient at sequestering carbon in soil than current agronomic practices.

The body of this book reports findings of two methods for soil carbon sequestration related to their application in agricultural field trials. These methods are definitively based on the innovative understanding of soil organic matter chemistry as supramolecular association of small molecules (1) the protection from mineralization of labile soil molecules by the hydrophobic domains present in humified mature compost amended to soils, (2) the in situ oxidative photopolymerization of soil organic matter molecules after soil spreading with a biomimetic water-soluble iron–porphyrin catalyst.

The first method, although innovative in its mechanistic application, may be well considered within the current accepted soil management practices which makes use of exogenous organic matter (EOM). The second method is based on a catalytic chemical technology that appears still foreign within the traditional agronomic approach, to both the farming world and most agricultural scientists.

In the experience of the Editor of this book, proposing the catalytic mechanism of carbon sequestration in agricultural soil to a scientific audience was hardly received positively. There is a general skepticism of the use of biomimetic catalysts in agricultural soils, perhaps because of the possible negative consequences on the biological soil quality and the reduced nutritional functions of soils, due to a restricted availability of soil humus for microbial transformation.

The criticism was a beneficial stimulus to scale up research ambitions from laboratory or glasshouse to fully-fledged field agronomic trials, through which not only the effectiveness of the soil carbon sequestration methods could be verified in practice, but also the concerns about the eco-toxicological, biological, biotechnological and nutritional effects of the catalytic soil treatment could be dissipated.

A multifaceted research project was presented to the Italian Ministry of Research (MIUR) within the strategic FISR programme. The intention was to cover all possible aspects inherent in soil organic matter transformations in agricultural soils leading to enhanced soil carbon sequestration, while maintaining soil quality and the high levels of crop productivity required by the farming market. The project was titled "Metodi Sostenibili per il sequestro del carbonio organico nei suoli agrari. Valutazione degli effetti sulla qualità chimica, fisica, biologica ed agronomica dei suoli", with the MESCOSAGR acronym. The project was approved, under the coordination of this Editor, and was funded with a total budget of 2.5 Mio Euro over a 3 years working span.

The MESCOSAGR project relied on the work of six research units belonging to six different Italian Universities. In particular the University of Napoli Federico II comprised: the group of Prof. Alessandro Piccolo, for the determination of carbon and nitrogen sequestration in all treated soils, as well as the molecular transformation of soil organic matter upon soil treatments; the group of Prof. Fabrizio Quaglietta Chiarandà, for the evaluation of the agronomic effects of treatments on soils of the University experimental farm (Torre Lama); the group of Prof. Giancarlo Moschetti for the microbiological aspects of all project's treated soils; the group of Prof. Amalia Virzo for the evaluation of soil biological quality and emissions of greenhouse gases from field soils; the group of Prof. Stefano Mazzoleni for the development of a new modelling approach to predict soil organic matter dynamics in agricultural soils. The University of Torino was represented by the group of Prof. Carlo Grignani who led the overall agronomic experiments and conducted field trials at the University experimental farm (Tetto Frati). Dr. Giuseppe Celano was the head of the group of the University of Basilicata that had been in charge of ^{13}C and ^{15}N isotopic measurements in soil samples and conducted agronomic experiments under sorghum at the experimental farm of Battipaglia. The University of Bari was present with the group of Prof. Pacifico Ruggiero for the evaluation of genetic diversity in samples from treated soils. The University of Reggio Calabria took care of microcosm experiments and measurements of plant activities under the supervision of Prof. Maurizio Badiani. The group of Prof. Attilio del Re of the Catholic University of Piacenza evaluated the eco-toxicological parameters in all projects's soil samples and managed field trials at the local University experimental farm.

This book thus reports the main research findings of the MESCOSAGR project and amply responds to the queries placed by the early critics of the innovative methods for carbon sequestration in soil. Briefly, the methods were able to fix a significantly larger amount of carbon than that possibly sequestered by traditional methods. Concomitant to such very positive project outcome, both proposed

methods did not significantly alter the productive, physical, chemical, and biological potentials of the treated soils.

Readers will find in this book data and results of their own interest, but they will also have the advantage of being able to cross reference with other interdisciplinary subjects, thereby receiving a complete picture of the effects of the new soil management methods and their potential for practical application in farm management. I am also sure that the most perceptive soil scientists will find in the book several hints for new confirmative experiments, further ground for speculating on more soil–plant-technology interactions and the possibility to develop new methods or applications.

Finally, I take the chance to thank all the scientific and administrative collaborators of the MESCOSAGR project who made it possible, despite the many logistic difficulties often encountered, in reaching the project's ambitious objectives.

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