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BOOK OF ABSTRACTS

Block C

C1 Carbon sequestration, roots and amendments

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C1 Carbon sequestration, roots and amendments

Session Description

Involved projects: MIXROOT-C, MaxRoot C

Conveners: Henrike Heinemann, José A. González-Pérez

Climate change mitigation and adaptation is a major challenge of modern agriculture. Increasing the incorporation of atmospheric carbon (C) as organic matter into soils through improved crop management seems to be a promising agricultural management option for supporting climate change mitigation. In order to build up soil organic C increased organic C inputs to the soil are urgently needed. In agricultural soils, crop roots are the major source of C inputs and pivotal for long-term C storage compared to aboveground biomass as their turnover is 2 to 3 times slower. Thus, sequestering carbon in soils through increased belowground C inputs from cropping systems, specifically increasing root carbon inputs could play a major role in mitigating climate change. The most viable yet to date neglected option to increase root carbon inputs is an increased and deeper root production of both main and cover crops in extensive and intensive cropping systems.

In MIX and MaxRoot-C we are developing assessment methods to estimate root C inputs of both staple and novel crops in cropland, grassland and agroforestry systems across Europe. In this session we seek contributions which cover topics such as: measuring root traits, root biomass, root stoichiometry, root architecture, isotope labelling and rhizodeposition, in conjunction with environmental factors, such as soil type, strength and fertility, to predict the effect of root systems on SOC stocks. We would also like to see results from the ongoing projects that might be of interest to the root community and the initial data or approaches from those working on modelling. In this session we hope to go beyond current knowledge, to evaluate the potential impact of promising C sequestering management interventions, such as: cover cropping, targeted breeding, and soil management in these diverse agricultural production systems aiming at widespread adoption of more sustainable carbon sequestering and soil restorative practices.

What is the stability of additional organic carbon stored thanks to alternative cropping systems and organic wastes products application? A multi-methods evaluation

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Purpose: The implementation of agroecological practices often leads to an additional soil organic carbon storage in these soils, of which we aimed to assess the biogeochemical stability. Different methods are available in the literature, insufficiently compared.

Methods: We used particles size and density fractionation, Rock-Eval® thermal analyses and long-term incubation (484 days), applied to topsoil samples (0-30 cm) from temperate Luvisols that had been subjected, in > 20 years long-term experiments in France, to conservation agriculture (CA), organic agriculture (ORG) in La Cage experiment, and to organic wastes products (OWPs) applications (biowaste composts, residual municipal solid waste composts or farmyard manure) in QualiAgro experiment. Conventional agriculture plot served as a reference.

Results: The additional soil organic C mineralized faster than the baseline C at La Cage but slower at QualiAgro. In OWPs-treated plots at QualiAgro, 60-66% of the additional carbon was stored as mineral-associated organic matter (MAOM-C), and 34-40% as particulate organic matter (POM-C). In CA and ORG systems at La Cage, 77-84% of the additional carbon was stored in MAOM-C, versus 16-23% as POM-C. Utilizing the PARTYSOC model with Rock-Eval® thermal analysis parameters, we found that most, if not all, of the additional carbon belonged to the active carbon pool (MRT ~ 30-40 years).

Conclusion: this comprehensive multi-methods evaluation indicates that the additional soil organic carbon is less stable over decadal and pluri-decadal time-scales compared to soil carbon under baseline practices. Divergent results observed between methods can be explained by the fact that they address different kinetic pools of organic C and care must be taken to specify which range of residence times is considered when using these methods, as well as when using the terms stable or

labile. The results observed in the different management options also highlight the need to maintain agroecological practices to keep these carbon stocks at a high level over time.

Using direct analytical pyrolysis (Py-GC/MS) to characterize SOM and explore processes and humification drivers

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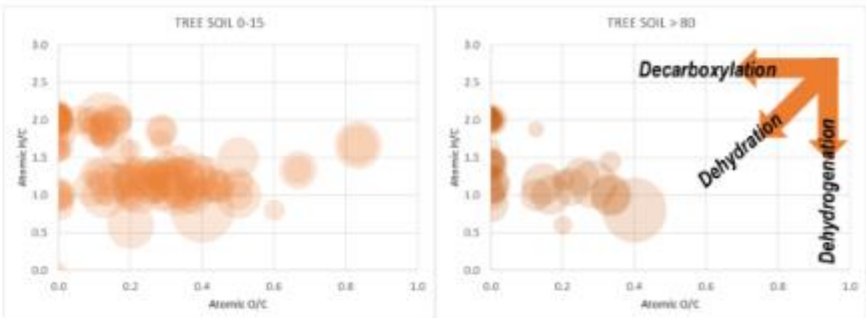
Soil organic matter (SOM) is an important factor in carbon sequestration that helps mitigate global change. Human activities such as land-use changes, agriculture, and forestry management can affect SOM dynamics. For example, practices like no-till agriculture or reforestation can lead to the accumulation of organic matter (OM) (Davidson et al., 2007). However, the changes made to the chemical structure of OM during the humification process in the soil, is what is critical to enhancing soil carbon sequestration. Differences in the molecular composition of SOM, resulting from its origin or evolution in soil, confer varying degrees of resistance to biodegradation, which is crucial for effective carbon sequestration in soils (Lal, 2004). In this work, we present a rapid and direct technique that can be used to characterize the chemical structure of soil organic matter and to evaluate the primary chemical processes that occur during organic matter evolution in soils. The technique combines analytical pyrolysis (Py-GC/MS) with a graphical statistical approach based in Van Krevelen diagrams (Van Krevelen, 1950). The Van Krevelen plots have the advantage of displaying the different SOM chemical components released during the pyrolysis in different regions of the H/C vs. O/C surface, which facilitates comparisons between samples and the possibility to infer main biogeochemical processes that may be involved in the stabilization of the SOM i.e. dehydration, aromatization, dealkylation, decarboxylation, etc. (Almendros et al., 2018).



Van Krevelen diagrams of soil pyrolysis products (400 °C) at two depths. Dot size indicates relative compound abundance

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Van Krevelen 1950. Fuel 29: 269–284.

Keywords: SOM dynamics, carbon sequestration, analytical pyrolysis, soil profile, humification

Root derived carbon input to soil: a case study for wheat varieties using a stable isotope approach.

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Promoting cropping systems with higher carbon sequestration in soils is an indispensable climate change mitigation and adaption measure. Crop roots are the major source of soil organic carbon (SOC) as belowground C inputs, namely root biomass C and rhizodeposition C, reside in soil longer than C derived from above ground crop residues and organic soil amendments. Hence, selecting varieties of main crops with increased belowground inputs has been proposed as a viable option to enhance SOC stocks without yield losses. However, little is known about the variability in root biomass C and rhizodeposition C of modern, commercial crop varieties. Moreover, there is a lack of data on the impact of different pedoclimatic conditions across Europe on this variability and few studies consider C allocation in deep soil layers.

Within the European Joint Programme Soil (EJPsoil) project MaxRoot-C, an in-situ multiple-pulse labelling with $^{13}CO2$ of four selected winter wheat (WW) varieties was carried out in the field in a replicated pan European experiment to determine belowground C inputs. We isotopically labelled the WW varieties throughout the active growth period. We sampled aboveground biomass and soil and roots after harvest by taking soil cores to 1 m depth. The separation of soil and roots is done by a series of soil sieving and root washing steps to end with crown roots, a coarse root fraction (>2 mm) and a fine root fraction (> 0.5 mm) to determine root biomass. Bulk isotope analysis is performed in the recovered roots and the sieved soil (<0.5 mm) to determine root biomass C and rhizodeposition C.

Results will include how the selected species differ in belowground C inputs and how the complex pedoclimatic conditions affect the amount of both root biomass C and rhizodeposition C. In addition, we will report the aboveground biomass and the grain yield to investigate whether genotype selection meets the needs for both food production and increased SOC build up.

Keywords: roots, rhizodeposition, winter wheat, isotope labelling.

Modelling belowground C inputs in agricultural soils: key processes and current limitations

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Root systems are a crucial source of stable C into soils. Quantitatively, belowground C inputs can be proportionally large in agricultural systems where biomass yields and possibly aboveground residues are exported. Qualitatively, it has been demonstrated that, per unit C input, root-derived C is stored more than twice efficiently in soils as compared to C from shoot origin. In a climate smart management perspective, enhancing belowground C inputs associated with plant growth appears much more feasible than manipulating intrinsic soil conditions favouring C stabilisation. Modelling belowground C allocation is therefore a powerful tool to exploring venues for increasing C storage in soils with enhanced root activities. Here, we first reviewed the key processes driving belowground C allocation and how some of these have been implemented in soil and agroecosystem models so far. We reviewed 31 mechanistic models used to simulate C dynamics in cultivated soils. Of these models, 19 considered root biomass inputs through allometric relationships, while 12 models used dynamic plant growth modelling. Rhizodeposition, i.e. the release of organic matter by living roots, was considered by 14 models, while 17 did not take it into account. Rhizodeposition is an important mechanism as a source of labile C, which can be stabilized in microbial biomass but also induce priming effect of the SOC. More than half of the models did not take soil N dynamics into account, while soil N has been shown to be a key driver of belowground C allocation. Most of the reviewed models were still single-soil-layer models, which is a strong limitation to simulating the dynamics and fate of root-derived C. The limited progress in the modelling of belowground C dynamics appears linked to the high degree of variability and the paucity of data on belowground C allocation. For example, our investigations of the EJP database of root-to-shoot biomass ratio for the main cereal crops in Europe show a high degree of variability. In light of such recent and ongoing studies, we analyse limitations and opportunities for better predicting belowground C allocation in a climate-smart soil management perspective.

Keywords: belowground allocation, root growth, rhizodeposition, modelling

Improving the sustainability of arable cropping systems by modifying root traits: a modelling study for winter wheat

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Crop breeding to increase below-ground production and inputs of organic matter into soil has been attracting increasing attention as a potentially effective strategy to enhance soil organic matter (SOM) stocks and thus the quality of soil and sustainability of arable cropping systems. We used the new soil-crop model USSF (**U**ppsala model of **S**oil **S**tructure and **F**unction) to investigate the potential for increasing SOM whilst maintaining or improving yields by modifying the root system of winter wheat in terms of below-ground allocation of carbon (C) and some specific key root traits. USSF combines physics-based descriptions of soil water flow, water uptake and transpiration by plants, with a crop growth model and a model of the interactions between soil structure dynamics and organic matter turnover that considers the effects of soil physical protection and microbial priming on decomposition.

The model was first calibrated against field data on soil water contents and both above-ground and root biomass of winter wheat measured during one growing season in a clay soil in Uppsala, Sweden. Based on five acceptable calibrated parameter sets, we created four model crops (ideotypes) by modifying root-related parameters to mimic winter wheat phenotypes with improved root traits. 30-year simulations were then performed to evaluate the potential effects of cultivating these winter wheat ideotypes on the soil water balance, soil organic matter stocks and grain yields.

Our results showed that a winter wheat variety that allocated ca. 25% more assimilate below-ground without affecting leaf area (i.e. reduced allocation to stem biomass) increased SOM storage in the soil profile by ca. 1.4% in a 30-year perspective without impacting grain yields. Ideotypes with deeper root systems or root systems that are more effective for water uptake were predicted to increase grain yields by ca. 3%, as well as increasing SOM stocks in the soil profile by ca. 0.4 to 0.5%. Combining all three improved root traits showed even more promising results: compared with the baseline “business-as-usual” scenario, grain yields and SOM stocks in the soil profile were predicted to increase by ca. 7% and 2% respectively in a 30-year perspective (as an average of the five parameter sets).

Keywords: soil organic matter, crop growth, roots, water balance, ideotype

Cover Crops Affect Pool Specific Soil Organic Carbon in Cropland – a Meta analysis

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Cover crops (CC) offer numerous benefits to agroecosystems, particularly in the realm of soil organic carbon (SOC) accrual and loss mitigation. However, uncertainties persist regarding the extent to which CCs, in co-occurrence with environmental factors, influence SOC responses and associated C pools. We therefore performed a weighted meta-analysis on the effects of CCs on the mineral associated organic carbon (MAOC), the particulate organic carbon (POC) and the microbial biomass carbon (MBC) pool compared to no CC cultivation in arable cropland. Our study summarized global research of comparable management, with a focus on climatic zones representative of Europe, such as arid,

temperate and boreal climates.

In this meta-analysis, we included 71 independent studies from 61 articles published between 1990 and June 2023 in several scientific and grey literature databases. Sensitivity analysis was conducted and did not identify any significant publication bias. The results revealed that CCs had an overall statistically significant positive effect on SOC pools, increasing MAOC by 4.8% (95% CI: 0.6% - 9.4%, n = 16), POC by 23.2% (95% CI: 13.9% - 34.4%, n = 39) and MBC by 20.2% (95% CI: 11.7% - 30.7%, n = 30) in the top soil, compared to no CC cultivation. Thereby, CCs feed into the stable as well as the more labile C pools. The effect of CCs on MAOC was dependent on soil clay content and initial SOC concentration, whereas POC was influenced by moderators such as CC peak biomass and experiment duration. For MBC, e.g., clay content, crop rotation duration and tillage depth were identified as important drivers.

Based on our results on the effects of CCs on SOC pools and significant moderators, we identified several research needs. A pressing need for additional experiments exploring the effects on CCs on SOC pools was found, with a particular focus on MAOC and POC. Further, we emphasize the necessity for conducting European studies spanning the north-south gradient.

In conclusion, our results show that CC cultivation is a key strategy to promote C accrual in different SOC pools. Additionally, this meta-analysis provides new insights on the state of knowledge regarding SOC pool changes influenced by CCs, offering quantitative summary results and shedding light on the sources of heterogeneity affecting these findings.

Keywords: effect size, MAOC, MBC, POC, synthesis

Rooting for roots: Climate change adaptation and mitigation potential by variety selection of winter wheat

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Climate change mitigation and adaptation is a major challenge of modern agriculture. Increasing the incorporation of atmospheric carbon (C) as organic matter into soils through improved crop management seems to be a promising agricultural management option for supporting climate change mitigation. In order to build up soil organic C increased organic C inputs to the soil are urgently needed. Furthermore, more and deeper roots can serve as a critical climate change adaptation measure.

This suggests, that variety selection towards increased root biomass can enhance root C inputs to the soil and could therefore increase C stocks and potentially facilitate C sequestration in soils. At the same time there is a potential to sustain yields under climate change, pointing out that increasing root biomass and selection for an adapted root system might be a win-win situation. As biomass production and allocation is driven by both, genetics and environmental factors it is necessary to conduct multi-site studies when broad conclusions should be drawn. To quantify whether biomass allocation and root system architecture (RSA) are affected by variety x environment interaction, we assessed root biomass, root distribution to 1 m soil depth and root:shoot ratios in a set of 10 different varieties grown at 11 experimental sites, covering a large European climatic gradient from Spain to Norway.

We found a broad variety-specific variation in biomass production and its allocation between roots and shoots. The median root biomass across all sites and varieties was 1.4 ± 0.7 Mg ha^{-1}. Root biomass could be increased by 20% by variety selection compared to the average root biomass without compromising yield. RSA showed high variability among varieties and sites, with certain traits varying up to a factor of 2 in a single site. Root to shoot ratios varied between 0.04 and 0.58 with a mean of 0.16. Higher root biomass has neither a clearly positive nor a clearly negative effect on yield depending on the site. Instead, the potential of variety selection depended on the site-specific yield level, indicating a high potential for increasing root biomass at moderate yield levels. More roots in deeper soil layers showed to be beneficial for yield, especially on warmer, dryer sites.

Increased root biomass and deeper roots may stabilise yields under future climate change conditions where increased frequency of drought events during vegetation periods are expected and may therefore be a climate change adaptation measure that increases crop resilience towards changing environmental conditions. Thus, improved variety selection can help to achieve both goals of modern agriculture: climate change mitigation and adaptation. This study sets an example for pan-European variety testing to identify varieties and their adaptation strategies that are best suited for different agroclimatic regions.

Keywords: root biomass, root system architecture, wheat, deep soil, variety choice

Soil carbon sequestration: insights from different farming practices

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Soil organic matter (SOM) accumulation and decomposition are influenced by various soil management practices such as crop rotation and fertilization. This study investigated the impact of different soil management practices on SOM dynamics over a ten-year period (2008–2018). Specifically, it compared conventional farming with mineral fertilization to organic farming with cover crops, with or without composted manure addition. Results showed that organic farming, especially with cover crops and composted manure, led to the highest soil organic carbon (SOC) sequestration rate. Soil fractions containing particulate organic matter (POM) (63–2000 µm) and mineral-associated organic matter (MAOM) (<63 µm) were separated. The highest concentrations of POM-C and MAOM-C were found in systems with cover crops and composted manure. This suggests that these practices promote SOC accumulation, potentially reaching saturation levels in the MAOM fraction. The formation of SOC stock related to the POM fraction was lower in conventional systems compared to organic systems, likely due to the promotion of POM decomposition by mineral N fertilizer fertilization. The cover cropping system exhibited the highest proportion of SOC stock related to POM. Simultaneously, it showed the lowest SOC stock related to MAOM compared to other treatments. In conclusion, it can be stated that organic farming methods, particularly the utilization of cover crops and composted manure, significantly promote the accumulation of soil organic carbon, potentially serving as crucial means for maintaining soil health and fertility while sequestering carbon in the soil.

Keywords: cover crop; carbon sequestration rate; organic farming; conventional farming

A simple profile-scale model of soil organic matter turnover accounting for physical protection and priming: calibration and sensitivity analysis

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Implementing soil and crop management practices to mitigate losses of organic matter in agricultural soils (SOM) would enhance the sustainability of agro-ecosystems under the pressure of climate change. Accurate prediction of the effects of alternative management strategies relies on the development of models that capture the important interactions between organic matter (OM) inputs and the physical and biological processes in the soil environment driving the decomposition and stabilization of SOM. We present such a model based on the simple two-pool model ICBM (Andrén and Kätterer, 1997). ICBM was further developed by Meurer et al. (2020) to account for interactions between soil structure dynamics and SOM turnover. Here, we extend this model to account for the effects of SOM on microbial activity (i.e. priming) according to Wutzler and Reichstein (2013) and to the soil profile scale in order to consider the vertical distribution of both root OM inputs and SOM.

The model was applied to a long-term experiment at Ultuna (Uppsala, Sweden) in which soils have been treated with different organic amendments since 1956. Three treatments were studied: a bare fallow with no OM amendment and two treatments with mineral-fertilized crops where all above-ground residues were removed. One treatment only received root residues, while the other was amended with a known amount of straw. This dataset is therefore well suited to test the ability of the model to estimate long-term changes in SOM contents with strongly contrasting OM inputs, both in terms of quantity and type, particularly as the measurements suggest that root-derived residues are more stable in soil. A GLUE (Generalized Likelihood Uncertainty Estimation) procedure was used to calibrate the model. The model could accurately match the measurements in the three treatments using a common parameterization. This suggests that the combined effects of physical protection and microbial priming may be important reasons for the greater persistence of root-derived OM compared with above-ground residues. As expected, significant correlations between three of the model parameters (ε, retention coefficient for SOM, k_o, the rate constant for decomposition of microbially-processed SOM and A_o, the microbial uptake limitation factor) were found. Nevertheless, all three parameters could be constrained, since a narrow optimum range of values of ε was clearly identifiable.

A sensitivity analysis was also performed for an analytical solution of the model that predicts steady-state SOM stocks. This showed that parameters regulating decomposition rates through the effects of priming and physical protection are among the most sensitive, followed by parameters controlling OM inputs, especially crop yields and the fraction of net primary production allocated to roots. The outcome of this sensitivity analysis is a simple multiple linear regression equation that could be used as a statistical model to predict SOM stocks under contrasting agro-environmental conditions, providing the decomposition rate constants in the model are adjusted for contrasting soil climates.

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Keywords: SOM turnover model, priming effect, physical protection, soil profile, sensitivity analysis

The impact of cover crop roots in soil carbon input across a European gradient

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Cover crops have been identified a key component for achieving both soil health and carbon sequestration EU Soil Mission goals. Currently they are cultivated on about 10% of the arable land area in Europe with large differences across regions, presenting ample opportunities for expansion. Cover crops provide soil coverage and protection and can contribute to the build-up of soil organic carbon. In many countries, cover crops were initially introduced to fulfil other specific objectives, for example, to achieve erosion control or as catch crops to reduce N-leaching. Thus, in recent years interest in cover crops has broadened to realize their role in fulfilling multiple ecosystem services, among other carbon sequestration, a source of biodiversity and acting as refugia for beneficial insects. They are also acceptable low-cost interventions for both conventional and organic farmers.

Increasing the mass and depth of cover crop roots could be a pioneering option for breeding for carbon inputs. Establishing an effective management for increasing below ground carbon inputs requires information on root quantities, location, and longevity as well as information on the impacts on following crops. Currently there is scant data on cover crop root carbon inputs across Europe and even less data on how inputs such as rhizodeposition and turnover contribute to increasing soil organic carbon stocks. This was highlighted in several recent review papers. One reason for this could be that cover crops use is often context specific, with different cover crop mixtures used to address farm specific issues. This adds complexity to assessing their benefits particularly in pan European experiments and design om cover crop mixtures for farming difficult.

To address the lack of root and rhizodeposition data to follow cover crops inputs to soil, we employed a suite of methodologies to quantify root inputs and turnover that could eventually be fed back into a cover crop design program. We also ran a pan-European experiment to get some initial assessment and range of the potential carbon inputs from cover crop and test the ease of implementation and utility of the methodologies developed. We standardised the methods for measuring sampling and

measuring root carbon and applied these on a series of cover crop trials in Denmark, Lithuania, Czech Republic, Austria and the south of France with both low and high diversity cover crop treatments, providing unique dataset as an output of MaxRoot-C, WP4. We showed that cover crops can add up to 2 Mg C ha^{-1} into the soil pool and that up to 50% of carbon can be in the form of rhizodeposits. We also showed that cover crop mixture composition has an impact on below ground inputs. This suggests there is scope for management and optimisation of cover crops performance as well as selection for traits for enhanced carbon farming.

Keywords: cover crops, crop diversification, roots, soil organic carbon, isotopic labelling

Impact of grassland management on soil carbon storage, CarboGrass

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Grasslands and pastures, spanning 40% of Earth's ice-free land, store 20% of global carbon (C). However, overuse and inadequate management, driven by food demand, have led to degradation and desertification. Addressing this presents significant climate protection opportunities, potentially sequestering up to 150 Tg of soil C annually through improved grazing or silvopastoral systems (SPS). Realizing this potential necessitates understanding carbon sequestration (CS) mechanisms across diverse environments and grassland systems. Despite various restoration and management attempts, a common framework to assess their CS impact is lacking. This project aims to i) assess improved grassland management's impact on soil C, nitrogen (N) cycling, and health globally; ii) analyze how environmental changes and management affect grassland CS; iii) provide standardized, high-quality datasets for benchmarking ecosystem models and iv) develop methods to enhance soil C stocks while improving productivity and livelihoods. Ten paired grassland sites across tropical and temperate regions will be selected to assess: management and environmental impacts on soil C stocks, CS potential, and soil C/N cycling; potential of improved management and restoration measures to mitigate land degradation. Standardized methods are applied to soil samples collected down to 30cm depth, analysing soil organic C, total N, texture, bulk density, pH, temperature, plant biomass and plant growth. Data will be related to soil characteristics, ecosystem management, restoration strategy, and environmental conditions. Comparing management practices' effects in diverse climates will elucidate their potential for enhancing soil organic C stocks, productivity, and ecosystem services.

Modeling CS with LandscapeDNDC, RothC, or other models using project data will inform decision tools to promote productivity while maintaining or enhancing soil organic C stocks.

Keywords: Soil health; Soil organic matter; Silvopastoral systems

A trans-European decomposition index study in arable soils, focusing on the impact of plant diversity using a common [13]C-labelled litter.

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Root carbon has been shown to be one of the most dominant forms of soils carbon inputs in agricultural systems. New paradigms about the decomposition of soil organic matter suggest the role of root derived soil carbon may have been overlooked. Current data and knowledge do not allow for prediction of the fate of root derived SOC storage in agricultural soils, specifically in relation to soil-depth and the complexity of the standing crop or intercrop.

Mixed species systems are currently gaining traction Europe providing opportunities for sustainable intensification of agriculture and other ecosystem-service co-benefits. Agroforestry systems cover about 9% of the utilized agricultural area and integrated crop livestock systems are both historically and culturally important in European agriculture, as they include perennial forage grasses and grasslands. Intercropping and other mixed cash crop systems are currently less developed in the EU. The aim of the EU EJP-SOIL funded MIXROOT-C and MAXROOT-C projects (2021-2024) is to gain a management-oriented understanding of the effect of mixed-species root systems on carbon flow and organic matter accumulation in European agricultural soils.

As part of the project, we have conducted a pan-European in-situ field experiments across pedo-climatic conditions. Treatments include:((i) monoculture (1 species), (ii) low diversity (2-4 different plant species in the mix culture) and (iii) high diversity (≥ 5 different plant species in the mix culture)) and different soil depths. The goal is to determine the impact of increased plant diversity organic matter breakdown to develop a trans-European decomposition index. To achieve this, we monitored the decomposition of [13]C-labelled maize litter in mixed agroecosystems and in the main crop monocultures across Europe. Using a hub spoke design, a common [13]C-labelled maize material was supplied to each participant and was mixed in a similar manner with the local soil from the treatment plots, packed in mesh bags and buried in the treatment plots. This was then excavated after six months and returned to Tulln for analysis.

This experiment, which includes many sites, climates and cropping systems, will provide key information on the rate of litter decomposition and the inclusion of litter C in different soil OM pools depending on the climatic condition, soil type and management. Furthermore, the experiment will provide information on litter turnover and link this process to soil C storage. We tested the null hypothesis that increased plant diversity does not increase the decomposition rate in the field. Initial results suggest that decomposition rates were 40-65% across sites and that diverse cover-cropping mixtures lead to lower decomposition rates.

These data and results could be used to guide model predictions of the fate pf belowground C inputs in single and mixed species systems at different soil depths.

Keywords* Mixed cropping, Diversity, ^{13}C labelled, Maize litter, Monoculture, Carbon