DSCATT

Dynamics of Soil Carbon Sequestration in Tropical and Temperate Agricultural ABSYSs

ABSTRACT

Questioned on the 4/1000 initiative on soil carbon (C) sequestration to face climate change (CC), several Labex Agro units and their partners propose to pull together their research capacities in order to provide new insights in soil C sequestration. The DSCATT project proposes to explore the potential for sequestering C in cultivated soils, taking into account the sustainability of agricultural practices in the context of global changes.
DSCATT operates at 4 sites (in Senegal, Zimbabwe, Kenya, and France). The project addresses 3 interrelated scales, i.e field, farm and territory or village scale.
At field level, research focuses on how biomass production and soil C sequestration relate, in different soil and climate conditions. Two approaches complement each other. One studies at the soil-plant interface the processes regulating the forms and residence time of C in soils. It includes the analysis of interactions between nutrients and C storage, the role of deep roots and in soils with contrasting storage potentials. The other approach determines the C balances under different practices.
Farms will be characterized in order to propose practices likely to improve complementarities amongst the activities of rural households. At this farm scale, DSCATT research will focus on farmers' practices (for crops, livestock, forestry…) and assess the impacts of farmers' practices on their objectives (income, food security…), taking into account their main constraints (cash, labour…). The project will assess the social and economic determinants of farmers' decisions and of trade-offs between farm activities.
At the territory (or farmers' network) level, the different compartments of agroecosystems and the organic matter flows will be studied. The project will analyze the role of the socio-economic and biophysical contexts and will test several possible changes and their impacts on soil C sequestration dynamics, economic performance of farms and food security.
This scientific knowledge and the viewpoints of the farmers involved will be shared and used for a transdisciplinary assessment of several C sequestration strategies in agricultural soils. Considering changes and uncertainties, a multi-criteria and prospective evaluation approach is proposed. It will allow iterations between evaluation and redefinition of strategies to cope with global changes in agriculture.
The sharing and dissemination of the knowledge enriched by the project will target several audiences (farmers, students and teachers, policy makers) through a variety of communication media and assessment tools.
DSCATT will link the knowledge on processes governing the preservation of C sequestration and farmers' multiple objectives and constraints.

Keywords : France, Kenya, Zimbabwe, Senegal, Modelling, Participatory research, Cropping systems, Farming systems, Soil carbon sequestration

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Research units in the network : CEE-M SELMET ABSYS
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Flagship project : no

Project leader : Dominique MASSE
Project leader's institution : IRD
Project leader's RU : ECO&SOLS SENS AIDA

Budget allocated : 1000000 €

Total budget allocated (including co-financing) : 1700000 €
Funding : Labex

GOAL

The overall goals of the project are
• to develop sustainable agricultural systems tailored for both higher productivity and higher C sequestration
• to raise awareness of the role of soil management for the mitigation of GHG emissions
• to assemble various research units from the Agropolis Foundations' scientific network and their partners in addressing major challenges with climatic change and food security.
The main research question is: What are effective and socially acceptable strategies to foster soil C sequestration in agricultural systems?
To answer to this question, we consider that:
• Efficient soil carbon sequestration (SCS), that is a net positive soil-plant systems C balance over a long period of time, can be achieved in ways that are economically, socially and environmentally sustainable and diffusible.
• The SCS strategies concern both farmers' practices at the field and farm level, and the local institutional arrangements, at the territory level.
• Prerequisites for farmers and local institutions to adopt SCS practices are: (i) the long-term soil C impact of present agricultural systems are known, (ii) technical changes or social arrangements enhancing SCS are identified and evaluated, (iii) social, economic and environmental impacts of targeted innovating SCS farmer practices or social arrangements are assessed.
Consequently, the following knowledge is needed:
• Long-term SCS dynamics and their determinants at the field, farm and landscape levels;
• Determinants of individual and collective capacity to adopt new practices over the long term;
• Indicators and tools helping multi-actors to assess and decide objectively the best strategies to intensify SCS;
The present project will identify and examine interactions between biophysical and socio-economic drivers and processes across the temporal and spatial scales to better understand the determinants and social and institutional conditions of adoption of soil C enhancing farming and institutional strategies. Studying processes and interactions implies transdisciplinary work using a conceptual social-ecological systems framework.
The DSCATT project will be carried out on 3 study sites in Sub Saharan Africa and 1 site in the mediterranean region of France.
Specific objectives:
• To quantify and analyze the soil C sequestration dynamics in different agricultural systems at the field, farm and territory scales
• To implement crop-soil, farm and landscape models to simulate long-term SCS
• To deliberate amongst stakeholers about soil carbon sequestration pathways
• To share knowledge to scale out and to scale up innovate methods or soil management options

ACTION

The project works on 4 sites representing different agro ecosystems : Senegal, Zimbabwe, Kenya and France
The project is based on 3 interdisciplinary actions :
1- Quantifying, understanding and modelling soil carbon sequestration dynamics at different scales: soil-plant or field, farm, landscape and territory (WP1 to WP3)
2-Deliberating amongst stakeholders about soil carbon sequestration pathways, by iteratively designing and assessing options (WP4)
3- Sharing knowledge, tools and experiences on soil carbon management options (WP5)

Action 1 :
At plant level, the questions are: Can best agricultural practices improve crop productivity and at the same time enhance Soil Carbon Sequestration (SCS)? Does a saturation threshold of soil carbon content exist ? What is the role of the root system in soil carbon sequestration ? What is the impact of

agricultural practices on the GHG balance and on negative emission through soil carbon sequestration ? the obejctif consists on assessing practices increasing nutrient and water use efficiency at the field scale, analyzing soil carbon and its stability under various cropping systems,Analyzing the link between plant productivity increase and SOC changes through root dynamics, and Soil and drawing up an ecosystem baseline for GHG balanc.
At farm leveil, How does allocation of farm resources best increase long-term soil sequestration, whilst maintaining or increasing overall farm productivity? What are the synergisms and trade-offs?
At Farm level, the question is : How does allocation of farm resources best increase long-term soil sequestration, whilst maintaining or increasing overall farm productivity? What are the synergisms and trade-offs? the research activities consists on characterization (including social economic and agronomic aspects) on each site and dentifying the synergies and trade-offs between farm activities.
At territory level, the socio-economic, policy and environmental levers for long-term soil C sequestration are analysed.What are the impacts of patterns of C and nutrient fluxes, social arrangements and public policy on long-term soil C sequestration at the village and territory scale? this WP aims at making Inventory and simulation of carbon and nutrient fluxes at the landscape scale in study sites of Sub Saharan Africa, analysing social, institutional, and economic context potentially driving C fluxes and sequestration and defining Innovative policy instruments to trigger the necessary changes in farming practices that increase C storage in soils.
Action 2:
The part of the project consists on co-design and evaluation of best farm practices for soil C sequestration. What are the options and how do they compare, for strategies that both address farmers' objectives and constraints when dealing with their soil fertility, and carbon sequestration sustainably within a long-term outlook? to answer this question, three activities are lead : Processing of multi-stakeholder socio-ecosystemic modelling, comparating assessment of SCS options and implementating exploration and characterization of scenarios and/or trajectories

RESULTS

expected results :
- Documented strategic pathways to foster soil carbon sequestration
- Adjusted multi-stakeholders approaches on land use management and soil carbon sequestration
- Toolkits that help local and institutional actors to consider soil carbon sequestration issues in their development strategies
- Databases and multi-scale models on long-term dynamics of soil carbon

PERSPECTIVES

More knowledge, relevant field measurements and data at multiple scales are needed to better simulate and assess soil carbon sequestration issues and impact in future agricultural intensification pathways. Farmer's decisions and farm activities are the results of synergies and tradeoffs (for instance yield versus larbor, benefits and risks). These affect carbon and nutrients cycles, and consequently the soil carbon sequestration potential, and in fine the sustainability of the agricultural systems. So, a multi-actors and a systemic approach is necessary to define relevant agricultural practices that jointly address farmers' objectives and global stakes (food security, ecological conservation, climate change mitigation...) in changing conditions (demographic, markets, climate)