IIRB Seminar *Carbon farming options in sugar beet cultivation*

11th & 12th of December 2025, online (Zoom)

INTERNATIONAL INSTITUTE OF SUGAR BEET RESEARCH

IIRB seminar

Carbon farming options in sugar beet cultivation

THURSDAY, 11TH OF DECEMBER

CARBON SEQUESTRATION IN SUGAR BEET CROP ROTATIONS

		Time (CET)
Opening and introduction		13:00-13:10
Session 1: Challenges in agriculture and policy		
Chair: André van Valen (IRS, NL) & Remy Duval (ITB, F)		
1.1 An overview in carbon storage and GHG emissions	Toby Townsend (ADAS, UK)	13:10-14:35
1.2 Goals and policy from EU perspective	Edouard Lanckriet (Agrosolutions, F)	13:35-14:00
1.3 Contribution from sugar beet cultivation	Christel Roß (IfZ, D)	14:00-14:30
Coffee break		14:30-14:50
Session 2: Effect of sugar beet on soil carbon stocks		
Chair: André van Valen (IRS, NL)		
2.1 Soil carbon balance under sugar beet cultivation	Anna Jacobs (IfZ, D)	14:50-15:20
2.2 Rotational effects on soil organic carbon stocks	Dennis Grunwald (IfZ, D)	15:20-15:50
2.3 Impact of measures to increase SOC sequestration	Jenny Bussell (The Allerton Project, UK)	15:50-16:20
Closing words day 1		16:20-16:30

FRIDAY, 12TH OF DECEMBER

GHG EMISSIONS IN SUGAR BEET CULTIVATION

		Time (CET)
Opening and introduction		09:00-09:05
Georgina Barratt (BBRO UK) & Maarten Schut (IRS, NL)		
Session 3: GHG emissions in sugar beet cultivation		
Chair: Georgina Barratt		
3.1 GHG losses in sugar beet cultivation	Bernard Longdoz (University Liège, B)	09:05-09:30
3.2 Data from BBRO field trials	Georgina Barratt (BBRO, UK)	09:30-09:50
3.3 N_2O losses from crop residues	Klaus Dittert (University of Göttingen, D)	09:50-10:20
Coffee break		10:20-10:40
3.4 Measures to reduce GHG emissions	Marisol Campoverde (ARTB, F) & Rémy Duval (ITB, F)	10:40-11:10
3.5 Calculation methods and tools	Gebhard Müller (BGD, D)	11:10-11:40
Wrap up		11:40-11:55
End of the seminar		11:55-12:00

TOBY TOWNSEND

RSK ADAS Ltd., Spring Lodge, 172 Chester Road, Helsby, WA6 0AR, UK - Cheshire

1.1 AN OVERVIEW IN CARBON STORAGE AND GHG EMISSIONS

Reducing greenhouse gas emissions and enhancing carbon removals in sugar beet production systems are required to support the move towards Net Zero. Achieving this requires that growers and supply chains have a clear understanding of what best practice looks like and have access to effective innovative products and technologies. They also need to able to measure and track progress in reducing their climate impacts, which requires robust methods of emission and removal quantification that are consistently applied. This presentation provides an overview of the topic and includes insight into work being undertaken to improve how emissions and removals are measured and data is communicated along the supply chain. It includes the key insights from work undertaken by ADAS for the UK's Department of Environment, Food and Rural Affairs (Defra) that considered approaches to harmonise farm carbon accounting across agricultural carbon calculators. The presentation concludes with a look at the challenges that remain and the steps that are being undertaken to address these.

EDOUARD LANCKRIET

Agrosolutions, 83 avenue de la Grande Armée, F - 75782 Paris Cedex 16

1.2 GOALS AND POLICY FROM EU PERSPECTIVE

Agriculture is a key sector to reach European objective of climate neutrality: it is the only sector that can both reduce its emissions and store carbon in the soil by removing it from the atmosphere. Still, farmers may face technical difficulties and costs to implement the practices needed to achieve this objective. So the European Commission is creating an incentive scheme: farmers will be paid for their climate actions, via carbon credits. Creating such a scheme harmonized at EU level requires harmonizing methods and digital tools for measuring climate impact at farm level, coordinating scope 3 approaches (such as SBTi FLAG) and the production of carbon credits, and, above all, creating an economic model that will guarantee the purchase of carbon certificates produced by the farmers. The presentation will discuss these objectives, the challenges raised, and the options currently explored by the EU Commission.

CHRISTEL ROß

Institute of Sugar Beet Research, Holtenser Landstr. 77, D – 37079 Göttingen

1.3 Greenhouse gas emissions from sugar beet cultivation

Awareness of greenhouse gas emissions and the enormous effort required to reduce them is also a matter of course in agriculture. In addition to this task, farmers are subject to certain restrictions in their choice of cultivation methods. They must cope with the given soil, climate and weather conditions. There are legal regulations and economic constraints. All of this is taken into account when deciding on a particular cultivation method and must be considered when developing recommendations for reducing greenhouse gas emissions during sugar beet cultivation. Furthermore, under practical conditions, the effect of many measures is unclear, as many cultivation measures and their effects interact with each other.

The largest share of greenhouse gas emissions from sugar beet cultivation comes from fertilisation, specifically from the production of mineral fertilisers and direct and indirect losses during application and mineralisation. Although fertilisation has declined somewhat in recent years due to adoptions in fertilizer legislation, it is still the most important factor. In particular, the proportion of fertiliser used for catch crops has declined in recent years, even though a larger proportion of farms are growing catch crops bevor sugar beets. By growing catch crops, a certain amount of carbon can be fixed in the soil and may counterbalance the increased N_2O emissions of catch crop cultivation compared to fallow land to some extent. These emissions vary depending on location, weather conditions and management practices. Furthermore, the efficiency of the measures should not be neglected, i.e., the relationship to the ton of harvested sugar beets should be established. Therefore, the cultivation of catch crops, fertilisation, soil cultivation and the expected yield of sugar beet must be coordinated, the measures must be carried out properly and tailored to the location of the land and weather conditions in order to ensure successful management with low greenhouse gas emissions.

ANNA JACOBS

Institute of Sugar Beet Research, Holtenser Landstr. 77, 37079 Göttingen

2.1 SOIL CARBON SEQUESTRATION IN CROP CULTIVATION

A permanent sequestration of carbon in soil is accepted as a carbon fixation within the context of carbon farming as well as a negative emission technology within the context of greenhouse gas emission reporting. Thus, the development and the current status of soil organic carbon stock in arable soils are of interest. Organic carbon enters arable soil through aboveground and belowground harvest residues and by applications of organic amendments, such as organic fertilizers. The soil fauna promotes processes leading to sequestration as well as mineralization of organic material, thereby exhaling carbon as CO_2. These biological processes are mainly driven by environmental parameters such as oxygen availability and temperature. Arable soil management is therefore limited in affecting the dynamic of sequestration and mineralization of organic carbon. Moreover, heterogeneity of carbon content within one field and analytical errors increase the uncertainty of forecasting a certain carbon stock within carbon farming certificate programmes. Sugar beet could face a negative image, and did so in Germany, regarding its effects on soil organic carbon due to very low belowground harvest residue input and harvest erosion of soil adjacent to the beet. On the other hand, sugar beet as a spring crop offers to cultivate cover crop during foregoing winter. However, the effect of sugar beet on soil carbon development has not been sufficiently investigated so far. This contribution shall give an overview on soil carbon sequestration, while investigations and results of a long-term field experiment with sugar beet will be presented by the following talk.

DENNIS GRUNWALD

Institute of Sugar Beet Research, Holtenser Landstr. 77, 37079 Göttingen

2.2 CROP ROTATION EFFECTS ON SOIL ORGANIC CARBON STOCKS

Since sugar beet is always cultivated in crop rotations with other crops and is usually only grown only every third to sixth year on a given field, the development of soil organic carbon (SOC) stocks in a soil may depend more on the crop rotation as a whole than on the question if sugar beet is cultivated.

An ongoing long-term crop rotation trial near Göttingen, Germany, was used to monitor SOC development in different crop rotations with and without sugar beet. In a sampling campaign twelve years after trial start, no differences were found between crop rotations with sugar beet every third or every sixth year. In a later sampling, a loss of SOC between 2008 and 2020 was found for four different crop rotations, yet a crop rotation with sugar beet did not show higher losses than the rotations without sugar beet. In fact, the only clear difference between different crop rotations in the trial so far is apparent on plots where silage maize is grown, either in crop rotation or in monoculture. Either way, silage maize cultivation, which is practiced without organic fertilization in the trial, led to lower SOC stocks than in crop rotations without maize.

Further, aboveground crop residues were constantly monitored for all crops and, in the last few years, also belowground residues. Generally, sugar beet residues provide a lower amount of biomass carbon than wheat or oilseed rape which can be seen as potentially detrimental for SOC stocks. A key question here may be whether cover crops are cultivated before sugar beet, which is the case in the studied trial, adding additional biomass carbon and at least partially compensating the lower inputs by sugar beet.

In total, a loss of SOC due to sugar beet inclusion in a crop rotation could not be found in the studied trial.

JENNY BUSSELL

The Allerton Project, Visitor Centre, Loddington, LE7 9XE, UK - Leicestershire

2.3 RESEARCH INTO REGENERATIVE AGRICULTURE AND SOC SEQUESTRATION AT THE ALLERTON PROJECT

At the Allerton Project we have been investigating some of the key principles behind regenerative agriculture, such as green cover, and reduced soil disturbance, focusing on the impacts on soil activity, soil organic carbon and greenhouse gas emissions. Changes in soil can be slow, and so we focus on the accumulated benefits of long term experiments, taking into account the impacts of farm rotations. We will report on the results of changes in soil organic carbon after 8 years of following 'on farm regenerative principles' compared to a conventional approach. The results from this experiment are contrasted with other research from the Allerton Project, including a more scientific approach which looks at soil carbon change over 13 years of direct drilled and continuously ploughed plots. This includes both the improvements in soil activity and SOC, and the problems of compaction, subsequent waterlogging and yield loss which come from poor weather and a non-flexible approach to soil remediation.

BERNARD LONGDOZ, QUENTIN BEAUCLAIRE, BERNARD HEINESCH

TERRA Research Unit, Gembloux Agro-Bio Tech E, Avenue de la Faculté d'Agronomie 8, B - 5030 Gembloux

3.1 GREENHOUSE GAS BALANCE FOR A SUGAR BEET CROP IN BELGIAN HESBAYE

Belgium has committed to reducing its greenhouse gas emissions by 55% between 1990 and 2030, which corresponds to a target of 64.3 Mt CO2 eq. In 2022, we were far from this target (103.2 Mt CO2 eq), with agriculture accounting for 11% of these emissions (11.5 Mt CO2 eq). All sectors must continue to make efforts, and for agriculture this means reducing its production of methane (CH4, linked to livestock rumination) and nitrous oxide (N_2O, linked to fertilization) and improving its carbon balance. In sugar beet crops, the main flows in this balance are CO_2 capture through photosynthesis, CO_2 emissions by plant respiration and soil organic matter mineralization, carbon added through organic fertilization, and carbon removed during harvesting.
We will show how it is possible to measure all these flows for several entire sugar beet growing seasons on a plot in Hesbaye and establish its carbon balance. We will compare this carbon balance with those of winter wheat and potato crops grown on the same plot. We will also examine what proportion this carbon footprint represents in the total greenhouse gas footprint of the plot, including N_2O emissions. This final result will demonstrate and quantify the impact of a sugar beet plot on the climate.

GEORGINA BARRATT

BBRO, Centrum, Norwich Research Park, Colney Ln, NR4 7UG, UK – Norwich

3.2 OPTIMISING SUGAR BEET MANAGEMENT PRACTICES TO REDUCE GREENHOUSE GAS EMISSIONS

With a UK target to reach net zero in agriculture by 2040 it is important that emissions are quantified and addressed on farm. Currently this is driven by the use of carbon calculators. These calculators are a starting point in getting growers to think about emissions and how they might reduce them. However, each calculator uses a different approach to calculating emissions, and it is often unclear how the data used for this has been sourced. There is a need to measure actual emissions to understand where we are, rather than relying on questionable data. This also needs to be taken further as there is little data on the impact of some key crop management decisions on emissions, for example we know reducing fertiliser input will reduce emissions but what impact do cover crops and ploughing have?

This project is an industry leading carbon measurement project. A pair of flux towers in two neighbouring fields are measuring carbon emissions from and uptake into the sugar beet crop. So far, the project has highlighted the issue of weeds supressing sugar beet growth and reducing carbon efficiency as well as allowing a comparison between the sugar beet crop and the following cereal crop. The project results from two years of sugar beet and cereal monitoring will be shared.

KLAUS DITTERT

Section of Plant Nutrition and Crop Physiology, Dept. of Crop Sciences, University of Goettingen, Carl-Sprengel-Weg 1, 37075 Goettingen, Germany

3.3 DRIVERS AND PERIODS OF N_2O EMISSIONS IN SUGAR BEET CROPPING SYSTEMS

In many European countries the nitrogen fertilization levels have experienced large reductions over the last decades while even improving productivity. Hence, nitrogen fertilizer use efficiency has greatly improved and it has reached a high level that can hardly be found in other crops. However, the emissions of nitrous oxide (N_2O) still require substantial improvement which is related to the sugar beet's demand for highly fertile soils. Unfortunately, apart from their high fertility and exceptional water storage capacity, loamy soils are particularly conducive to high N_2O production rates. In the humid-temperate climates of Western Europe, denitrification is the key process producing N_2O in these soils, and a large number of scientific field experiments have shown that the denitrifying activity is driven by oxygen (O_2) shortage, the availability of nitrate and degradable organic compounds in the soil. However, the latter, degradable organic matter has received too little attention when it comes to identifying effective reduction strategies.

Based on numerous field and laboratory studies, the process controlling factors will be highlighted. They reveal that denitrification should be seen as an emergency process that is "dormant" under well-aerated, aerobic soils conditions. A wealth of organic matter-degrading soil bacteria, archaea and fungi is capable to switch their organic compound degradation using O_2-dependent respiration into denitrification when soil O_2 gets short. So, organic compounds deliver the energy for their life and only in situations of O_2 shortage, they use nitrogen oxides such as nitrate as electron acceptors instead of O_2. Therefore, all kinds of (inter-)crop residues play a crucial role in providing the energy for the denitrifying process. While soil moisture, one of the key drivers of soil O_2 availability is largely beyond the control of our crop management options, the management of (inter-)crop residues and soil nitrate need to be seen as the key regulators to be addressed in the search for effective N_2O emission reduction strategies.

MARISOL CAMPOVERDE[1], RÉMY DUVAL[2]

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3.4 MEASURES TO REDUCE GHG EMISSIONS AND IMPROVE SOIL CARBON SEQUESTRATION ON SUGARBEETS

The European Union plans to become carbon neutral by 2050. Agriculture is no exception and must play its part in this ambition. Therefore, different methodologies have been developed to calculate the carbon footprint of farms while quantifying how new “low carbon” practices or levers can reduce it.

In France, the « Low Carbon Label of Field crops » framework was approved during the summer of 2021 by the French Ministry of Ecological Transition. This method allows farmers to determine the carbon footprint of the existing cropping system in the farm and, according to the situation, activate low-carbon practices or levers to reduce GHG emission and to enhance soil carbon sequestration over a minimum period of 5 years.

To explore the most efficient options available for sugarbeets, the French technical institute for sugar beets (ITB) and the association for technical research on sugarbeets (ARTB) carried out a study using a set of 4 reference sugarbeets farms (standard cases) to match distinct regional contexts.

Using the “Field crops” methodology, the carbon footprint of the 4 reference farms was calculated. Different low-carbon levers – applied only on sugarbeets - where then considered to assess their quantitative impact on farms’ GHG emissions.

GEBHARD MÜLLER

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3.5 GHG EMISSIONS IN SUGAR BEET CULTIVATION. CALCULATION METHODS AND TOOLS

GHG emissions from sugar beet account for a significant share of sugar's carbon footprint. It is therefore important to assess emissions from sugar beet cultivation as accurately as possible. In the available GHG calculators, sugar beet is either not represented as a separate crop and/or not represented accurately enough. For this reason, BGD has developed its own GHG calculator for sugar beet. The BGD Carbon Tool meets international GHG requirements (IPCC), DIN ISO 14067 and the current state of art, and is TÜV validated. In the case of sugar beet, fertilisation accounts for approx. half of total emissions (mainly from nitrogen fertilization), beet leaves and diesel consumption each accounting for around one fifth. The quality of data collection has a significant impact on the GHG result. In cooperation with Sustainable AG, an app has been developed that can be used to collect primary data on beet cultivation in different languages and cultural areas in a uniform manner.