Referat af møde i Agroøkologi Foulums Laboratorieudvalg
Tors. d. 9. sep 2021
Kl. 11.00-12.00, udenfor Kirkesalen

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Afbud:, Poul Erik Lærke, Stig T. Rasmussen
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Dagsorden

1. Godkendelse af dagsorden
2. Opfølgning på referat fra 15. dec 2020
3. Investeringsønsker
4. Nyt fra LAMU
5. Evt.

Ad 2. Renovering af sandbokse er i gang. Der opsættes skilt på dør til afgrødelager (skal holdes lukket), TOC kommer på den nye investeringsplan, aluringe til iltdiffusion er indkøbt. Støjafskærmning i GC-rum: Det er svært at få en aftale med Bent Lorentzen. I mellemtiden anvendes personlige værnemidler. Desuden undersøges muligheden for instrument-intranet, så data kan tilgås fra kontorerne – det vil yderlige have den fordel at data ikke skal flyttes rundt.

Ad 3. Der er indkommet ønsker (og kommer måske flere fra KLIMA) – de fremgår af bilaget. Labudvalget har prioriteret dem indenfor to kategorier: 1) udskiftning af eksisterende nedslidt udstyr og 2) nyt apparatur.

Kategori	Prioritet	Apparatur	Ca pris.
Udskifning af eksisterende nedslidt apparatur	1	TOC	350.000 kr.
	2	GC 8890 + Pal3 autoanalyzer	650.000 kr.
	3	Sample oxidizer	850.000 kr.
	4	Bladarealmåler Licor	100.000 kr.
	5	Fasekontrast mikroskop med epifluorescence og kamera	300.000 kr.
	6	Ionchromatograf	175.000 kr.
Nyt apparatur	1	Fourier transform infrared sensor (FTIR)	600.000 kr.
	2	Scanningelektronmikroskop (SEM)	550.000 kr.
	3	CT-scanner	3.500.000 kr.

Dertil kommer en række mindre investeringer (laboratoriestole, dispensere, pipetter osv.) som samlet set løber op i 100-200.000 kr. Disse kan købes uden udbud.

Ad 4. Der er lavet test af belastningen af forsøgsmedarbejdere i forbindelse med sprøjtning. Retningslinjerne er indført og skal anvendes. Retningslinjerne findes på Intranettet (https://agro.medarbejdere.au.dk/fileadmin/DJF/Agro/Medarbejderportal_AGRO/Forsoegsplanlaegning/Re-entry_i_marker_ved_AGRO._LAMU_2021.pdf). Der skal ske en opfriskning af retningslinjerne for medarbejderne til foråret.

Ad 5. Der blev efterspurgt nyt omkring værkstedsfunktionen. Der blev udtrykt behov for fortsat dels at have adgang til et værksted tæt på laboratorier og dels at have bemanding, hvis ikke lokalt så i hvert fald en meget klar ordning, som fungerer i praksis. JER tager en videre til ledelsen.

JER 9/9 2021

Bilag: Indkomne ønsker til investeringer.

Apparatur	**Begrundelse**	**Ca pris.**
TOC	Mange ”beskidte” prøver slider hårdt på detektor og system. Behov for udstyr som tåler høje saltkoncentrationer	350.000 kr.
Sample oxidizer	Til bestemmelse af C-14 i faste prøver – nødvendigt for studier af rhizodepotion.	850.000 kr.
Bladarealmåler Licor	Anvendes i efterafgrødeforsøg. Gammel apparat slidt op og uddateret.	100.000 kr.
Fasekontrast mikroskop med epifluorescence og kamera	Studier af celler og cellulære processer. Erstatning af gammelt udstyr	300.000 kr.
GC 8890 + Pal3 autoanalyzer	Forøgelse af kapaciteten på GC-området	650.000 kr.
Fourier transform infrared sensor (FTIR)	Til bestemmelse af organiske og mineralske forbindelser. Specielt behov omkring mikroplast.	600.000 kr.
Scanningelektronmikroskop (SEM)	Forstørrelse op til 100.000 gange.	550.000 kr.
CT-scanner	Visualisering og kvantificering af jordstruktur	3.500.000 kr.
Ionchromatograf	Bestemmelse af anioner i vand	175.000 kr.

Equipment Justification - Scanning Electron Microscope, SEM

The research in the department will benefit immensely from the purchase of a scanning electron microscope. An SEM has numerous uses in the study of soils. It can be used to study soil aggregation (examining macro and micro aggregates, clay mineral bonding, soil surface structure analyses etc. The SEM has a large magnification range, allowing examination of solids with almost no magnification to imaging at well over 100,000 times. Another important feature is the large depth of field of SEM images, which appears three-dimensional and provides much more information about a specimen’s topography and surface structures than light microscopy at the same magnification.

The SEM will be relevant for quantifying the surface structure of the wide array of soils that exists in the water vapor sorption database we have built over the last 7 years. It will also be crucial for visualizing microplastics in soils, soil aggregation and soil structural changes in the long term fertilization experiments that are integral for Project 31574 (Soil Biophysical drivers as drivers of soil sequestration), and several other projects in the department that involves soil aggregation as well as several proposals in the pipeline (e.g., Sapere Aude, Villum experiment).

An SEM is also valuable for soil-biota studies for colleagues in Flakkebjerg that work with mycorrhiza fungi, as exemplified below.

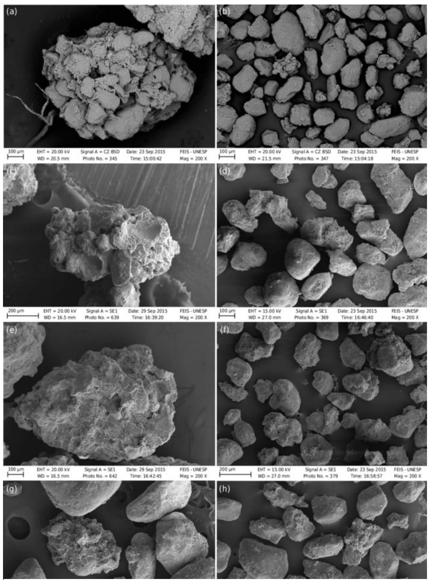

Figure 1 - SEM images of different aggregates sizes after long term organic matter management. Source: Sena et al. 2017. Revista Brasileira de Ciência do Solo 41

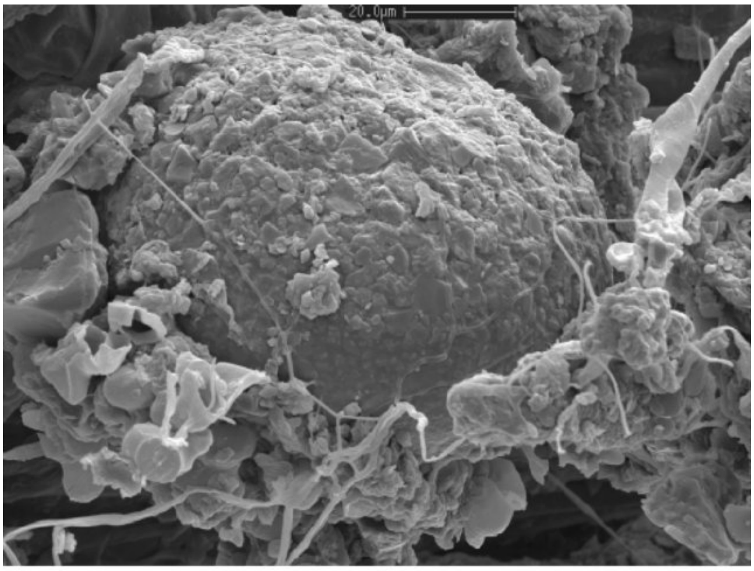

Figure 2 SEM of mycorrhizal fungi in the Acacia falciformis rhizosphere mining scarce mineral nutrients from soil aggregates, with silicon (Si) and iron (Fe) concretions accumulating around the fungal strands. Source: Little et al. 2004 R. Regolith 2004. CRC LEME, pp. 225-229.

Finally, the SEM will be an invaluable tool for teaching where students will be able to visualize all the above-described elements and phenomena during course demonstrations.

Example of Instrument and Quote

Hitachi TM4000Plus Tabletop Microscope; Manual Stage version. BSE and UVD detectors; PC with 24" Monitor; Installation and Training included

Approximately (☺) **557.000 DKK**

Fourier transform infrared (FTIR) sensor

We would like to upgrade our spectroscopy laboratory with a Fourier transform infrared (FTIR) sensor operating in the middle infrared range (2500-25000 nm). FTIR is a rapid and cost-effective method for characterisation and quantification of organic and mineral compounds, and due to its versatile instrumental setup can be used in different types of samples like solids (soils, sediments, plants, seeds, pollen) and liquids (water). In soil analysis, it provides a powerful means for a determination of a wide range of properties (physical, chemical, and biological: microbial biomass, microbial respiration, microbial groups).
It is crucial for us to obtain the FTIR sensor to develop a method for measuring microplastic in the soil in the already funded project ("Microplastic-SOIL") starting in January 2022. The system we would like to purchase has access to a reference polymer spectral library critical in the first phase of the project. FTIR analysis can also provide us with more insight and understanding of soil quality (detail characterisation of soil OM) and soil biodiversity indices which are of a great relevance in several projects and future applications. We would like to develop an FTIR soil spectral library which is compatible with a large and growing USDA library (ca. 80.0000 spectra to be freely available). It will supply qualitative and quantitative data for many projects and the possibilities of developing multi-sensor approach (fusion with other spectral techniques like NIRS and LIBS) to soil analysis. This will highly increase and broaden our competencies and possibilities to attract more funds within the field of spectroscopy but also allow extending its application to water and plant samples.

System specification
INVENIO-S Fourier Transform Infrared Spectrometer from Bruker, two measurement modes (transmission- for liquids and diffuse reflectance- for solids), autosampler microplate accessory with 96 sampling wells. Software, computer, polymer spectral library, sensor installation and on-site training. Total cost **DKK 583,417.19** (uden moms)

Application for X-ray micro-CT scanner

X-ray CT scanning is a powerful and unique tool for 3D visualization and quantification of soil structure (e.g., soil density and pore sizes, distribution, and connectivity), earthworm burrows, and root growth. Results of such studies are highly valuable. This technique can yield new fundamental insight into the complex interaction between soil structure and a large range of essential soil functions related to physical, chemical and biological processes.

In the last decade, the AGRO soil sections (Soil Physics and Hydropedology, and Soil Fertility) have developed many activities where CT images from X-ray CT scanners were used to better understand processes usually quantified by classical laboratory bulk measurements. The presentation of our results at conferences show that we are ahead with research in this area. Currently, we either use medical scanners at the Aarhus University Hospital (when it is available for use) or pay to use scanners in other institutions outside Denmark (e.g., SLU). The use medical scanners that are often not suitable for soils limits our capacity to study the complex interactions between bulk physical, chemical and biological processes and soil structure. When we have to use scanners in other institutions, the time spent on travelling and the cost of using the scanners significantly delay the progress of the work. During the last decade, high resolution micro-CT scanners have become cheaper and handier, and have been used more and more in soil science. We have gained high expertise with micro X-ray CT both from our own work and from international collaborations, but will benefit strongly from having our own system – as the first soil science laboratory in Denmark.

We will be able to;

- Work in much higher resolution.
- Modify the scanning system directly for our use.
- Save a lot of time and expenses travelling to labs in Europe who have scanners.
- Do specific research on the CT-scanning technique per see.
- Freedom to combine CT scanning with on-going dynamic measurements.
- Ability to develop and verify models of e.g. heterogeneous transport, soil compaction and root growth.
- Sampling quality control of large intact soil columns.

This represents a great opportunity for AGRO to acquire a full expertise in an advanced technology that can be used across the sections, and also by other departments in Technical Sciences.

To support our future research and of great benefit for present and future students enrolled in at the AGRO PhD programme, we request the department to acquire an X-ray micro-CT scanner.
Approximate price ~ ~3.500.000 Dkr.

Selected publications (last 3 years) related to the use of CT scanners at AGRO:

- Lamandé, M., Schjønning, P., Dal Ferro, N., & Morari, F. (2021). Soil pore system evaluated from gas measurements and CT images: A conceptual study using artificial, natural and 3D-printed soil cores. European Journal of Soil Science, 72(2), 769-781.
- Pulido-Moncada, M., Katuwal, S., Ren, L., Cornelis, W., & Munkholm, L.J. (2020). Impact of potential bio-subsoilers on pore network of a severely compacted subsoil. Geoderma, 363, 114154.
- Pulido-Moncada, M., Katuwal, S., Kristensen, J.B., & Munkholm, L.J. (2021). Effects of bio-subsoilers on subsoil pore-system functionality: Case study with intact soil columns. Geoderma, 385, 114897.
- Katuwal, S., Hermansen, C., Knadel, M., Moldrup, P., Greve, M.H. and de Jonge, L. (2018), Combining X-ray Computed Tomography and Visible Near-Infrared Spectroscopy for Prediction of Soil Structural Properties. Vadose Zone Journal, 17: 1-13 160054. https://doi.org/10.2136/vzj2016.06.0054

- Müller, K., Katuwal, S., Young, I., McLeod, M., Moldrup, P., de Jonge, L. W., & Clothier, B. (2018). Characterising and linking X-ray CT derived macroporosity parameters to infiltration in soils with contrasting structures. Geoderma, 313, 82-91.
- da Silva, T. S., Pulido-Moncada, M., Schmidt, M. R., Katuwal, S., Schlüter, S., Köhne, J. M., ... & Levien, R. (2021). Soil pore characteristics and gas transport properties of a no-tillage system in a subtropical climate. Geoderma, 401, 115222.
- Winstone, B. C., Heck, R. J., Munkholm, L. J., & Deen, B. (2019). Characterization of soil aggregate structure by virtual erosion of X-ray CT imagery. Soil and Tillage Research, 185, 70-76.
- Singh, N., Kumar, S., Udawatta, R. P., Anderson, S. H., de Jonge, L. W., & Katuwal, S. (2021). Grassland conversion to croplands impacted soil pore parameters measured via X-ray computed tomography. Soil Science Society of America Journal, 85(1), 73-84.