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EDITORIAL

Dr. Marta Pogrzeba,
Project Coordinator, Institute for Ecology of Industrial Areas, Poland

Dear Readers,

Welcome to issue no. 2 of our newsletter. As a Coordinator of the MISCOMAR project under the flag of the Era-Net Cofound FACCE SURPLUS - Joint Programming Initiative on Agriculture, Food Security and Climate Change (FACCE-JPI), together with my colleagues from Great Britain and Germany, I would like to present our work results and accomplishments in 2017.

We are a consortium of three organisations representing research from Poland (Institute for Ecology of Industrial Areas), Germany (University of Hohenheim) and Great Britain (Aberystwyth University) who committed to work jointly for 36 months. the focus of our research is the technical potential of novel Miscanthus hybrids to deliver biomass production options on marginal land in Europe and to quantify any changes in soil health and structure under these crops.

In addition to the three scientific institutions, we have two commercial partners from Great Britain on the MISCOMAR board: Terravesta as an associated partner and Physis Data Management LTD. These small enterprise companies are working with us to build knowledge of how to grow Miscanthus on marginal lands and how to manage the data collected during our field studies.

During the 18 months of activity so far we have established three field trial locations: heavy metal contaminated arable land in Bytom (Poland); high clay content, waterlogged soil in Unterer Lindenhof (Germany); and nutrient depleted soil intensively cultivated in the past Lincolnshire, (Great Britain). These trials are all testing new seed-based Miscanthus hybrids and M x giganteus (the standard commercial clone) as a control.

Repeated samples are being collected from across the trial sites, (both soil and plant sampling, 2 campaigns so far) to understand the different growing conditions and their inpacts on plant composition. In addition,

the biomass produced is being tested to understand how agricultural marginality can influence its quality for anaerobic digestion and combustion.

The consortium work in 2017 wasn't limited to just the in scientific tasks, early results were shared during international conferences and stakeholders' meetings.

Our colleague from IBERS - Prof. John Clifton-Brown and Dr. Jon Paul McCalmont presented the first MISCOMAR results on the International Bioenergy Conference held in Manchester on 22-23 March 2017.

Anja Mangold from Hohenheim University presented the first results of a cutting trial from Miscanthus on the 2nd International Bioeconomy Congress, Baden-Württemberg, organised in Stuttgart-Hohenheim on 12-13 September 2017.

More than 100 farmers, industry representatives and scientists listened to Andreas Kiesel's presentation (UHOH) on „Novel Miscanthus-based Value Chains" delivered on the 9th International MEG e.V. Conference: „Bioeconomic Application and Research Areas for Miscanthus" organised in Rheinbach (DE) on 20 - 21 November 2017.

A general poster about MISCOMAR's goals and achievements entitled: „Developing Miscanthus for Low-quality Land" was presented by Dr. Moritz Wagner (UHOH) on the 25th European Biomass Conference and Exhibition, held in Stockholm on 2-5 June 2017.

Also my team from IETU was very active in the dissemination area.

Our junior researcher Szymon Rusinowski prepared a poster "Acclimation of New Miscanthus Hybrids on Heavy Metal Contaminated Arable Land" for the VIII International Scientific Conference „Toxic Substances in the Environment" organised in Cracow, Poland on 14-15 September 2017.

My colleague Dr. Jacek Krzyżak presented MISCOMAR results on the III International

Conference „Environmental Engineering and Design" held in Zielona Góra, Poland (12-13 October 2017). On this basis we published a paper entitled: „Heavy Metal Uptake by Novel Miscanthus Seed-based Hybrids Cultivated in Heavy Metal Contaminated Soil" in the Civil and Environmental Engineering Reports 26 (3), 121-132.

As a coordinator I had the pleasure of presenting the MISCOMAR results during my visit to Bucharest, Romania at the Institute for Studies and Power Engineering (ISPE) - 8 February 2017. Further presentations took place on open seminars organised by the Institute for Ecology of Industrial Areas in Katowice (18 May 2017), as well as during such important events as: the 14th International Phytotechnologies Conference in Montreal (25-29 September, 2017) with the audience of more than 50 scientists from all over the world; and CHE 650 Hazardous Waste Engineering Seminar in Kansas State University, Manhattan, Kansas, USA (7-14 January 2018).

Project results were received with great interest not only among scientists, but also farmers and biomass producers. This interest allows us to think that the novel seed-based Miscanthus hybrids may well become a competitive alternatice to existing species of energy plants in the near future.

I cordially welcome you to read our newsletter, visit our website at www.miscomar.eu, and observe us via ResearchGate https://www.researchgate.net/project/MISCOMAR or LinkedIn https://pl.linkedin.com/in/miscomar-project-460a3a128 to see our advancements.

I encourage you to learn from the articles in this newsletter what we have achieved in the first half of the project and to contact us if you find something of special interest to you by visiting our project website or directly by e-mail.

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First results of biogas and combustion quality

Anja Mangold
Department of Biobased Products and Energy Crops, University of Hohenheim, Germany

Currently Miscanthus is primarily used for simple combustion to provide energy, either directly for heat or for the production of electricity. For this purpose, Miscanthus is harvested after winter, when moisture contents are low. This lower moisture content at harvest is particularly important, as less energy is required to dry the biomass prior to combustion. Delayed harvest in spring further helps to improve the combustion quality of the biomass, by reducing ash content and content of critical elements, such as chloride.

Anaerobic digestion is another energetic utilization option for Miscanthus. Perennial Miscanthus has lower environmental impacts than annual energy crops (e.g. maize) and requires lower agricultural inputs while producing comparable high biomass yields. For these reasons, Miscanthus can help to improve environmental and economic sustainability of the biogas sector. However, to date Miscanthus has needed to be green-harvested in autumn to achieve sufficient biomass yield and digestibility for anaerobic digestion. Harvests yields decrease over winter due to leaf fall and the increasing lignin content correlates negatively with digestibility.

In summary, it can be stated that the energetic pathways combustion and anaerobic digestion require different if not contrasting biomass qualities, which can be only achieved at distinct harvest dates. The MISCOMAR project aims to assess the suitability of novel Miscanthus genotypes for anaerobic digestion and combustion at two harvest dates (October and March) and compare them with the standard cultivar *Miscanthus* x *giganteus* (*Mxg*).

MATERIAL AND METHODS

The biomass was harvested in autumn 2016 and spring 2017 by the respective partners at each site and the biomass quality for biogas and combustion was analysed.

The assessment of the combustion samples included dry matter-, ash-, fiber-, mineral-, chloride- and silicon-content (according to VDLUFA methods). Additionally, the ash melting behaviour was evaluated by classifying the ash at different temperatures into ash fusion classes. For this purpose, the ash was heated up to four different temperatures (800°C, 900°C, 1,000°C and 1,100°C) and was analyzed after cooling via microscope. The samples were classified into four different ash fusion classes based on their macroscopic structure. The ash fusion classes 1 and 2 mean no or very little sintering of the ash, classes 2 and 3 partial ash-sintering, classes 3 and 4 high levels of ash-sintering and class 5 means completely molten ash.

The biomass quality for anaerobic digestion was assessed by a biogas batch test according to VDI 4630. The substrate-specific biogas and methane yield and the methane content of the biogas were determined. In the batch test, 200 mg of the dried and milled biomass was mixed with 30 g of inoculum from a commercial biogas plant and digested in gas tight fermentation flasks. The biogas batch test was carried out in a water bath with a temperature of 39°C (mesophilic conditions) for a duration of 35 days. The biogas volume was determined by measuring the pressure increase within the fermentation flasks. When necessary, the produced biogas was collected and stored in a gas storage flask. From this stored biogas, the methane content was analysed by using a gas chromatograph.

BIOMASS QUALITY FOR COMBUSTION

The average ash content of all genotypes at all locations was 4.13% of DM. The biomass from the site in Germany (UHOH) had the lowest ash content (3.25%), while those from the UK site (IBERS) had the highest ash content (4.91% of DM). The biomass from Poland (IETU) showed an ash content (4.18% of DM) close to the average. *Mxg* had at each location the lowest ash content and over all three locations about 2.55% of DM. The higher ash content from the IBERS site was influenced by the harvest in early February.

The average lignin content of all three locations was 9.27% DM, the average cellulose content 46.35% DM and the average hemicellulose content 26.59% DM from the biomass harvested in spring 2017. The biomass from UHOH site had the highest lignin contents, those from IBERS the lowest. Cellulose content, however, was highest at IETU and lowest at UHOH, while hemicellulose content was highest at IBERS and again lowest for UHOH. At each location, *Mxg* had the highest lignin content (11.5% of DM). The high lignin and low ash contents at all locations are a first indicator that *Mxg* is suitable for combustion.

The assessment of the ash melting behaviour showed that the biomass from UHOH location had on average the highest and from IETU location the lowest ash fusion classes at each temperature. The results showed that the increased heavy metal concentrations in the biomass had no negative effects on the ash melting behaviour. At the UHOH site, the novel genotypes tended to have lower ash fusion classes than the standard genotype *Mxg* and therefore an improved combustion quality. In Katowice (IETU), GNT41 is the most suitable and GNT14 the worst suitable genotype for combustion concerning the ash melting behaviour. In Aberystwyth (IBERS), GNT3 had poorest results in ash fusion classes, *Mxg* was the most suitable genotype for combustion.

University of Hohenheim - biogas batch test

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BIOMASS QUALITY FOR ANAEROBIC DIGESTION

The biogas batch test demonstrated that the biomass harvested in autumn had a slightly higher substrate specific methane yield (SMY) than the biomass harvested in spring (+8.5 ml CH4 (g oDM)-1), which shows that a harvest before winter is favourable for anaerobic digestion.

The results assume a negative correlation between lignin content and SMY: the higher the lignin content in the biomass the lower the SMY. Therefore, at UHOH and IETU, the novel genotypes had a higher SMY than the standard cultivar *Mxg* in autumn and spring biomass, due to lower lignin contents. At Aberystwyth, however, *Mxg* had the highest SMY in autumn biomass but the lowest when biomass was harvested in spring, which can also be reduced to the lignin contents.

These results show that higher heavy metal contents in biomass did not negatively affect anaerobic digestion. The results demonstrate that the novel genotypes tended to be more suitable for anaerobic digestion than the standard cultivar *Mxg*; however, these results are still preliminary, we will need to wait for the results from the second harvest year to confirm them.

Miscanthus x *giganteus* at Unterer Lindenhof

Miscanthus sinensis at Unterer Lindenhof

The analysis of chloride content showed that the average chloride content from all locations and all genotypes was 0.04 % of DM. The genotypes at Katowice had the lowest chloride contents, the genotypes at Aberystwyth had the highest with UHOH found between the two. At each location *Mxg* had the lowest or was near to the genotype with the lowest chloride content.

To conclude the results of the first year, no negative effects of contaminated soils on combustion quality were found. Depending on location, the novel genotypes seem to be more suitable for combustion than the standard cultivar *Mxg*.

Michal Mos,
PhysisData Ltd.,
Great Britain

Data management is as crucial as the data

"The world's most valuable resource is no longer oil, but data."

This statement from The Economist in 2016 highlights the rising power of accurate data.

MISCOMAR in its essence is centred on successful data management.

The project compiles data from three different organisations, from three different field trial locations in three different countries.

The challenge of successfully recording the data which will inform vital conclusions, is always present.

But it hasn't been an issue for MISCOMAR, due to a pioneering data management system which has streamlined the process of recording, organising, and compiling results.

PHYSIS is a new system allowing organisations to 'collect, manage and collaborate' scientific data which is properly stored and analysed, with no room for error.

"The system has been designed by scientists, for scientists," says Michal Mos from Terravesta, a key contributor to PHYSIS.

"I've been involved in numerous scientific trials for most of my life, and the challenge of collecting data from different sources which are not labelled clearly, or not contextualised, can halt the process of data analysis. This is a problem across the industry.

"With PHYSIS what you have is a dedicated, secure online management system which allows data to be expertly organised at different levels, and provides fast data visualisation in the form of graphs," says Michal.

"The data belongs to MISCOMAR, but is faultlessly managed by PHYSIS," he says.

At the heart of MISCOMAR there are measurements that are made on the plants at three field trial locations: a heavy metal contaminated arable land in Bytom, Poland, land with high clay content and waterlogged soils in Unterer Lindenhof, Germany, and nutrient depleted soil, intensively used in the past in Lincolnshire, Great Britain.

The task of compiling the data from different locations is not new, but the ultimate aim

of the project is being streamlined with the help of PHYSIS. "This is the first time we have successfully trialled the system and is has been a real triumph so far." - says Michal.

"PHYSIS has been invaluable in this scenario. We are hoping to roll it out for use on bigger projects and we're extremely excited about the potential to change the way data is managed for the better" adds Michal.

If you would like to find out more about PHYSIS then please e-mail:

info@physisdata.com

PHYSIS
Collect. Manage. Collaborate.

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Progress so far

German test site

The year 2017 can be considered as a good year for Miscanthus at the location Unterer Lindenhof, as all the trial genotypes were able to complete their establishment successfully; even *Sin55*, which suffered from poor plantlet quality in 2016, was able to catch up. To support the establishment of Miscanthus a herbicide treatment was required in spring 2017. As in the year before, no fertilizer was applied to either the green-harvested (autumn) or the spring-harvested plots and for plots of both harvest regimes very few plant losses were recorded in spring 2017.

The green harvest was taken in October 2017 and the spring harvest will take place in March 2018. The dry matter yield (DMY) of the genotype *Miscanthus* x *giganteus* (*Mxg*) was 19 t DM in autumn 2017 and therefore equal to the yield in autumn 2016. GNT1 and GNT3 had a slightly lower yield in 2017 than in 2016 (GNT1: -2.1 t DM; GNT3: -1.5 t DM), while the yield of Sin55 increased from 2016 to 2017 (+5.7 t DM), due to ongoing establishment. The average yield in autumn over all genotypes was in 2017 15.5 t DM ha*a^{-1} (2016: 15.0 t DM ha*a^{-1}), while the average dry matter content (34.4%) was lower in 2017 than in 2016.

hybrids are now significantly outperforming giganteus. However, it is the spring harvest that counts, when we see what's left after the winter leaf fall, but results are not yet in for this year. Marginality is particularly evident at the moment with the site resembling a lake more than a field; spring harvest of the 2017 growing season's crop is going to be delayed by a few weeks at least.

Flooded field in Lincolnshire, March 2018

Unterer Lindenhof site - overview

Great Britain test site

Despite the IBERS' soils being extremely nutrient depleted, as revealed in the baseline soil report; growth of some of the Miscanthus hybrids has been remarkable here! Harvest from spring 2017 showed that the commercial standard *M.* x *giganteus* was still the clear winner in the growing season of

2016, producing 11 tonnes per hectare in the spring harvest, around twice the biomass of the other three novel hybrids. However, this may just be the newcomers getting off to a slow start, peak yield harvesting in autumn 2017 showed that their average yields had doubled in this new growing season whereas the *M.* x *giganteus* had only increased by 3%. For the autumn yields at least, two of the new

Lincolnshire site - Harvesting the biomass, Spring 2017

Lincolnshire site - phenotyping, Autumn 2017

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Polish test site

Work carried out at the Polish test site focused on the assessment of plant growth and biomass productivity in the second growing season. Two new hybrids, which replaced those which had not survived the

Bytom site - plant pigments content measurements, July 2017

first winter, were growing well, showing good acclimatisation to environmental and climatic conditions. Biomass production and heavy metal uptake were determined twice, at autumn and spring harvests.

The main finding of the performed analyses was that seed-based hybrids after the second growing season showed biomass production comparable to that of *M.* x *giganteus*. It was also confirmed that seed-based hybrids were characterised by lower heavy metal uptake to aboveground parts than commercial *M.* x *giganteus*, showing phytostabilisation abilities and giving the opportunity for safe biomass production on contaminated soil. As the next step, the collected biomass will be analysed by the Hohenheim University for energy production through combustion and anaerobic digestion.

Bytom site - winter harvest, March 2018

Bytom site - waiting for the next growing season, March 2018

MISCOMAR WORKSHOP

Marginal land can be useful

Cultivation of energy crops on poor quality and heavy metal contaminated soils

Why it is worth trying?

26 SEPTEMBER 2018, KATOWICE, INSTITUTE FOR ECOLOGY OF INDUSTRIAL AREAS, POLAND

Farmers and biomass producers, companies processing agricultural biomass for energy, energy suppliers, scientists, representatives of local governments and state administration are kindly invited to a workshop and trip to the testing site of the Institute for Ecology of Industrial Areas.

We hope you will join us and take part in the discussion on remediation of heavy metal contaminated soils and improvement of poor soil quality by cultivation of new seed genotypes of Miscanthus for energy purposes.

Detailed information and agenda will appear soon.

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Project Facts Sheet

Project acronym:	MISCOMAR
Project full title:	Miscanthus biomass options for contaminated and marginal land: quality, quantity and soil interactions
Project start date:	1st of May 2016
Duration of the project:	36 months
Project website:	www.miscomar.eu

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