FACCE SURPLUS

SUSTAINABLE AND RESILIENT AGRICULTURE FOR FOOD AND NON-FOOD SYSTEMS

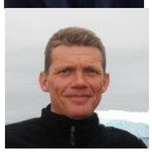
Intensify production, transform biomass to energy and novel goods and protect soils in Europe

INTENSE Newsletter #5

(April 2018)

INTENSE

Highlights

Summer school 2018 June 12th - 14th **Sustainable agricultural production on marginal soils within Europe** **CIEMAT, Madrid**		 
	**Joint pot experiments**	
 	**INTENSE Workshop in Hasselt** (January 2018)	CMK CENTRE FOR ENVIRONMENTAL SCIENCES UHASSELT
Special Issue of Frontiers: *Options for Transition of Land Towards Intensive and Sustainable Agricultural Systems*	frontiers in Plant Science	

Foreword

Welcome to the fifth newsletter of the EU INTENSE project. This newsletter series provides you with updated information on our project progress, achievements and important forthcoming activities related to the reconversion of poor, degraded, abandoned and polluted sites including grassland, set aside land, brownfields, and otherwise marginal lands into sustainable agricultural production across Europe. The improvement of soil status refers to improved water holding capacity, upgraded microbial diversity and functionality, improved nutrient status, and resilience against pollutants. This encompasses innovative systems-based tools for the development and implementation of integrated food and non-food production serving for intensified land management of these land areas. INTENSE sites are located throughout Europe from Spain in the South to Norway in the North, and cover a climatic gradient from cold/wet to warm/dry sites, and a soil quality regime from poor/rich in nutrients and organic matter as well as low/high in pollutants.

INTENSE ("*Intensify production, transform biomass to energy and novel goods and protect soils in Europe*") is a 36-month project (started on April 1, 2016; end in March 2019) funded by the ERA-NET JPI FACCE SURPLUS 2015 (Research Council of Norway, ANR-15-SUSF-0007-06). The main goals are to:

1. Determine and harmonize methodologies for identification and recuperation of degraded soils of specific degradation status,

2. Develop, and optimize novel cropping systems, using precision agriculture and modelling tools, which are capable of i) increasing productivity, ii) increasing soil life and functionality, and iii) making use of specific amendments, to suppress pathogens and fertilize soils.

3. Develop and implement suitable production systems applicable for land amelioration in complex degradation situations and finally

4. Develop and implement sustainable and financially attractive production alternatives for production on recovered farmland.

This 5th newsletter includes a brief report of the 5th meeting in Hasselt, Belgium (January, 2018), information on progress for work-packages and experiments, and the programme of the Summer school 2018 in early June (Madrid, Spain). More details can be found on our website https://www.nibio.no/en/projects/intense, which offers in-depth information about project results, publications related to the project, as well as INTENSE partners.

Enjoy reading,

Dr. Arne Saebo (project coordinator),
NIBIO, Norway

Dr. Michel Mench
INRA, France

■ INTENSE summer school 2018 - CIEMAT (Madrid, Spain)
June 12th - 14th, 2018
Sustainable agricultural production on marginal soils within Europe

This course aims to give an overview of applied research for a sustainable and ecologically compatible land use and approaches needed to restore degraded or marginal land.

Registration (Maximum 25 students):
To: Ana García Triviño (Course Secretary)
Formación en Energía y Medio Ambiente – CIEMAT
Avenida Complutense 40 – MADRID 28040 (Spain)
Phone: +34 91346 6486 / 6295, E-mail: er.ma.bt@ciemat.es
Fee: 75 € (includes coffee breaks and lunch at CIEMAT and bus transport to the field)

Materials provided: A pen drive with course presentations, field trip guide and certificate of attendance.
Course Directors: Dr. Rocío Millán, Dr. Thomas Schmid
CIEMAT coordination: Mirian Bravo Taranilla


Program:

June 12th:
9:00 – 9:30 Welcome
9:30 – 10:30 Dr. Arne Sæbø– "INTENSE and the circular bioeconomy"
10:30 – 11:00 Coffee break
11:00 – 12:00 Prof. Dr. Peter Schröder "Sustainable / precise agriculture - examples from a long term experiment in Germany and an ERANET project".
12:00 – 13:00 Prof. Dr. Nelson Marmiroli "Tools for improving soil quality and fertility".
13:00 – 14:30 Lunch
14:30 – 15:30 Dr. Tomasz Niedziński "Agronomical valorization of crops and residues".
15:30 – 16:30 Dr. Michel Mench "Phytomanagement of metal(loid)- contaminated soils and remediation of soil functions underlying ecosystem services".

Evening activity "Tapas and Science" Open forum conducted by Prof. Dr. Elena Maestri ("Healthy soils for a healthy life")

June 13th:
9:30 – 11:00 Dr. Francois Rineau "The role of microbial diversity and the contribution of mycorrhizas to ecosystem services: are they really involved, and is it relevant for our economy?"
11:00 – 11:30 Coffee break
11:30 – 12:30 Dr. Friederike Gnädinger "Use of drones and new technologies for mapping and monitoring agricultural areas".
12:30 – 13:30 Dr. Thomas Schmid "Soil degradation studies within semiarid regions using advanced remote sensing techniques".
13:30 – 15:00 Lunch
15:00 – 16:00 Mr. Christoph Poschenrieder "Ecological intensification of agricultural productivity. Case study Martlhof (Germany)".
16:00 – 17:00 Round Table / Open discussion

June, 14th:
Field trip Organizers: Dr. Rocío Millán, Dr. Manuel Rodríguez Rastrero and Dr. Thomas Schmid (CIEMAT)

9:00 Departure from CIEMAT
11:00 – 11:30 Arrival to Casasana area.
11:30 – 12:30 Study case of agricultural soil degradation.
12:30 – 14:30 Arrival to Buendía field plot. Explanation on the development of field experiments and training.
14:30 – 16:30 Lunch. Open forum on the agronomy of the future. Final remarks. Diploma of attendance.
17:00 Departure to CIEMAT

■ Special issue of Frontiers

The INTENSE project is involved in the edition of a special issue of Frontiers, which will appear in 2018. The title of the Research Topic is:
Options for Transition of Land Towards Intensive and Sustainable Agricultural Systems

Topic Editors:

Peter Schröder
Helmholtz Zentrum München - Deutsches Forschungszentrum für Gesundheit und Umwelt, Munich, Germany

Rocio Millán
Centro de Investigaciones Energéticas, Medioambientales y Tecnológicas, Madrid, Spain

Arne Sæbø
Norwegian Institute of Bioeconomy Research (NIBIO), Oslo, Norway

Among the "Great Challenges" for the 21st century, global food security, use of renewable raw materials and production of energy from biomass are important for the agricultural sector. Basic as well as applied science is required to reach sustainable increase in food production, novel products from agriculture and new perspectives for rural landscapes. Future land use must embrace efficient production and utilization of biomass for improved economic, environmental and social outcomes. At least 30 % of the agricultural soils worldwide need to be transformed to a state of higher quality.

Accordingly, reconverting poor, marginal or neglected soils and unlocking their potential for productivity are high on the agenda. Specifically, recovery of soils from pollution, drought or other reasons for low productivity requires research on (a) identification of crucial soil components and processes (b) identification and assessment of plant species producing high biomass on marginal and/or contaminated soil, (c) the optimum composition for compost and biogas production, (d) degradation and absorption of pollutants by selected species.

This Research Topic will combine cropping and soil amendment experiments, precision agricultural and crop modeling tools, experimental biomass conversion to energy, the assessment of greenhouse gas and nutrient emission and other environmental indicators, as well as socioeconomic models. Only a holistic approach will enable the identification of common traits and at the same time enable the development and dissemination of production chains for sustainable intensification which are adapted to the environmental and socio-economic diversity, and polluted sites including grassland, set aside land, brownfields, and otherwise marginal lands into sustainable agricultural production across the world is a major issue. Such an approach does not necessarily have to be in conflict with ecosystem conservation and the role of non-crop land for carbon sequestration. Innovative systems-based tools for the development and implementation of integrated food and non-food production have to be developed and discussed. Furthermore, utilizing and developing models characterizing fluxes of matter, productivity and socio-economy will be ever so important to implement sustainable intensification of integrated food and non-food systems of agriculture.

This special issue will gather interdisciplinary papers on novel crop production systems, carbon sequestration in arable land, modelling sustainability and socioeconomics, as well as soil improvement by amendments and crop rotation schemes and on the ecology of marginal soils.

This special issue is following the publication of a joint opinion paper:

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ELSEVIER

Opinion Paper

Intensify production, transform biomass to energy and novel goods and protect soils in Europe—A vision how to mobilize marginal lands

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HIGHLIGHTS

- Challenges for smart intensification of marginal land are manifold
- Tools for precise agriculture will aid to detect pollutant hotspots and poor soils
- Crop rotation and adapted crop choice will yield biomass
- Amendments will sequester carbon and release fertilizer when needed
- Potentials of marginal soils can be unlocked and lead to ecological and economical success

GRAPHICAL ABSTRACT

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ABSTRACT

The rapid increase of the world population constantly demands more food production from agricultural soils. This causes conflicts, since at the same time strong interest arises on novel bio-based products from agriculture, and new perspectives for rural landscapes with their valuable ecosystem services. Agriculture is in transition to fulfill these demands. In many countries, conventional farming, influenced by post-war food requirements, has largely been transformed into integrated and sustainable farming. However, since it is estimated that agricultural production systems will have to produce food for a global population that might amount to 9.1 billion by 2050 and over 10 billion by the end of the century, we will require an even smarter use of the available land, including fallow and derelict sites. One of the biggest challenges is to reverse non-sustainable management and land degradation. Innovative technologies and principles have to be applied to characterize marginal lands, explore options for remediation and re-establish productivity. With view to the heterogeneity of agricultural lands, it is more than logical to apply specific crop management and production practices according to soil conditions. Cross-fertilizing with conservation agriculture, such a novel approach will provide (1) increased resource use efficiency by producing more with less (ensuring food security), (2) improved product quality, (3) ameliorated

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INTENSE Meeting in Hasselt (Hasselt Universiteit), Belgium (January 2018).

■ After the kick-off meeting in Munich, Germany (April 27-28th, 2016), the WP1 meeting in Warsaw, Poland (June 14th 2016), the workshop meetings in Madrid, Spain (CIEMAT, April 3 – 5th 2017) and Parma, Italy (Univ. Parma, October 2017), INTENSE partners attended the 5th INTENSE meeting organized by the Belgian partners (Pr. F. Rineau, Dr. B. Beckers, Dr. N. Weyens, Dr. H. Olcay, Pr. J. Vangronsveld, Pr. S. Daniels) in Hasselt (Hasselt Universiteit, fig. 1, https://www.uhasselt.be/UH/CMK-en/CMK-eng-Research/Research-groups/Environmental-Biology.html). They were welcomed by the staff of the Environmental Biology Department, a research team working on Cellular toxicity of abiotic stress factors, Soil remediation, Role of plant-associated bacteria in growth and development of plants and in phytoremediation, Metal tolerance in mycorrhizal fungi, and Health effects of air pollution.

■ Attendees were: Dr. Arne Sæbø, Dr. Hans Martin Hanslin, Dr. Mats Höglind, Dr. Tomas Persson (Norwegian Institute of Bioeconomy Research); Prof. Peter Schröder, Dr. Friederike Gnädinger, Mr. Michael Obermeier (Helmholtz Zentrum München, Germany); Prof. Wiesław Szulc, Prof. Beata Rutkowska (Warsaw University of Life Sciences, Poland); Dr. Nele Witters, Dr. Nele Weyens, Dr. Bram Beckers, Pr. François Rineau, Dr. Hakan Olcay, Dr. Silvie Daniels, Pr. Jaco Vangronsveld (Hasselt University, Belgium); Prof. Elena Maestri, Dr. Davide Imperiale (University of Parma, Italy), Dr. Michel Mench, (INRA, University of Bordeaux, France); Mr. Christoph Poschenrieder (Martelhof am Tegernsee, Germany), Dr. Manuel Rodríguez-Rastrero (CIEMAT, Spain) (Fig. 1).

The agenda was:

- Short report from A. Sæbø and P. Schröder after the Facce surplus meeting in Paris and status for the cooperation with other FACCE SURPLUS projects.
- Minutes from the Parma-meeting
- Short presentations from each WP-leaders to update the status and plans for the 2018 season
- Plans for the greenhouse – experiments (the planning group)
- Stakeholder meeting (see page 21)
- Special issue of FRONTIERS – status (P. Schröder), Dissemination and publications
- New proposal initiatives and Meetings

Fig. 1. INTENSE Workshop at the Hasselt University, Belgium © Davide Imperiale

The agenda was dedicated to progress in WP milestones and deliverables of the project, including selection of plant species, soil amendments, tools for precise farming, sampling methods, valuation of ecosystem services, modelling of plant growth, etc., and preparation of forthcoming events.

Centre for Environmental Sciences: The Environmental Biology Department

CMK CENTRE FOR ENVIRONMENTAL SCIENCES UHASSELT

■ The CMK research aims at three core fields:

- **Effects of (a)biotic stress factors at various biological organization levels: from molecular to ecosystem level:** This includes the study of (a) physiological, biochemical and molecular effects; (b) cellular mechanisms; (c) biomarkers for effects and the use of it in (eco)toxicity tests and bioassays; (d) non-invasive technologies for the pre-symptomatic detection of abiotic and biotic stress factors and the follow-up of it; (e) symbioses between plants and plant-associated micro-organisms (mycorrhiza and bacteria) in contaminated ecosystems: importance for partners and nutrient cycles in terrestrial ecosystems; (f) effects of pollution of the aquatic environment on organisms and eco system level. Both depositions of nitrogen and of metal(loid)s influence the isotope proportions of these elements in the environmental compartments. Micro-organisms would have an impact on this natural isotope fractionation. It is examined in which way fractionation data can give information about pollution sources and about fluxes of C, N and metal(loid)s in terrestrial ecosystems.
- **Remediation and management of contaminated soils – Renewable energy production**: The CMK is a partner in many European research projects with regard to sustainable management, use and decontamination of polluted soils and (ground) water. An important strength are the possibilities to multidisciplinary approach (biological, chemical and economic/legal aspects) that exist within the CMK. The production and processing of biomass (whether or not contaminated with metal(loid)s and/or organic pollutants) requires an expertise. The integrated research from a chemical approach into the valorization of biomass as a green energy source and/or feedstock recycling via thermal treatment is important. This topic responds to the increased interest both from the energy point of view and the valorization possibilities of organic waste products from different sectors (among other things sewage sludge) in which there's a high need of efficient treatment techniques (recuperation of metal(loid)s).
- **Policy supporting environmental research**: This includes the following aspects:

(a) Study of the economic and legal aspects of pollution, decontamination and general environmental policy, with emphasis on the cost-benefit analysis. Measuring the benefits is in particular a field of study that many stakeholders look forward to. Within this field, the economic approach concentrates on the cost-benefit analysis of the environmental policy, in particular of these measures that are linked directly or indirectly to soil pollution. The economic-theoretical research includes the modelling of the welfare effects of soil pollution and soil decontamination. Concerning the application, special attention is given to the measuring of the total (private and social) benefits of a decontamination. With this, the hedonic price method is an important research instrument.

Decontamination techniques are also judged on their cost efficiency and with this, the possibilities to cost recovery play an important role. In particular for the 'soft' decontamination techniques, the research into the valorization of the biomass is crucial. The combination of phytoremediation and the extraction of renewable energy from biomass is economically very relevant for the Flemish, national and European environmental policy.

The economic approach is supported from the legal point of view, with which the implementation of decrees and regulations concerning polluted soils and sites is studied. Especially the brownfields get the necessary attention, concerning their decontamination, but also concerning re-use.

(b) Chemical characterization methods: The research into pollutants such as particulate matter and chlorinated hydrocarbons is carried out in an international context and in cooperation with companies (dioxin precursors). The growing interest in the toxicology of nano particles is important. It can be considered as a logical continuation on the PM10 and PM2.5 problems.

(c) Human use of freshwater fish and their relation to nature and health: The economic aspects (contingent valuation), the health aspects (PCBs) as well as the biological-ecological aspects (population dynamics, strength of the ecosystem) are examined. The economic impact of the use of public fishing grounds has been examined. The results are used to underpin the spatial structure in Flanders, the sustainable management of nature and the surface waters and also public health. From this research, a link can be made to the human dimensions of the problems.
Attention has been given recently to the impacts of the pollution of the aquatic environment (metal (loid)s, pesticides,…) on the organismal level (influence on defense mechanisms against oxidative stress, embryonic development, regeneration and the function of stem cells), the population level (influence on the reproductive success) and on ecosystem level (disruption of the food chain, habitat use and habitat suitability).
In 2003, this field was extended with the study of effects of contaminated underwater grounds and flood sediments in valley areas.

(d) Cleantech Economics: This core competence field also concerns the study of the biodiversity on all the levels of selected groups of organisms in different areas and habitats. Moreover, the study on the population level includes the study of (genetic) adaptations of certain populations to abiotic and biotic stress factors.
In the past few years, researchers have become aware that the decrease in biodiversity under the influence of anthropogenic factors is an acute and worldwide problem. That’s why major efforts are made on all levels (both national and international) to describe the biodiversity in detail. The CMK has a lot of experience in this field, including the freshwater and in the marine environments. Researches focus mainly on areas and ecosystems that are vulnerable and on areas that are threatened by anthropogenic activities (both chemical and physical harmful effects). The results are accessible for a very broad public because they end up in databases that can be consulted on the Internet. Data with regard to the marine environment are collected in a database. The CMK members are responsible for the content of this database, the Flanders Marine Institute takes care of the technical support. Data with regard to watercourses in Flanders can soon be consulted via the V.I.S. (Fish Information System). This research will get an additional dimension because of the study of the diversity within populations, in which the study of the genetic adaptation of populations to environmental stress is an important research component.

Integrated farming on marginal soils to raise productivity (WP1)

Aims: *Typical problems of agriculturally intensive used areas and generally of other soils impacted by anthropogenic activities (e.g. soils contaminated by either local or diffuse contamination sources) are: erosion, soil compaction, contamination of soil & groundwater, impoverishment of flora and fauna, marginal lands set aside without concept, only few hedges and fallow stripes, decoupling of energy and matter fluxes, and decreasing quality of life.*

The purpose is to include marginal land for food and energy crops which have the following characteristics: (1) dry (low water-holding capacity) - agricultural; (2) low organic matter content - agricultural; (3) contaminated - former industrial and agricultural. Due to such characteristics, these lands are left aside or at suboptimal production. Researches focuses on (1) improving soil characteristics, and (2) the use of agricultural residues for producing soil amendments and amelioration of soil properties. An increase in soil organic matter should improve soil reaction, microbial activity and water-holding capacity.

■ Joint pot experiments

A network of sites was created to support pot experiments and field trials for assessing various organic amendments (e.g. biochars, composts, manures, byproducts from biogas production, and organic granulated fertilizers) (fig. 2). This INTENSE network of field trials is covering various soil and climatic conditions, notably accounting for climate change, across Europe as well as various strategies regarding marginal soils, crops for the Bioeconomy, brownfields, set-aside and agricultural soils. Initial status and changes in soil properties are monitored along the project.

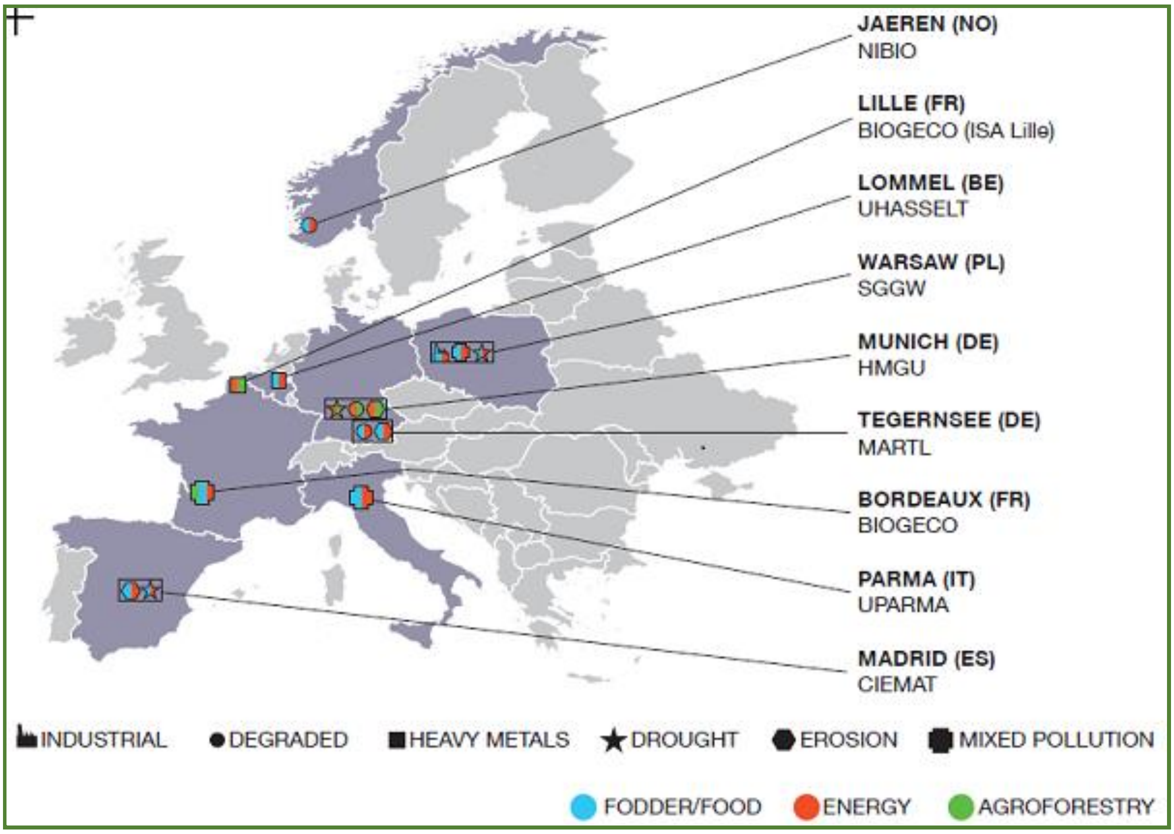


Fig. 2. Network of sites managed in the INTENSE project

It was agreed at the Parma workshop to jointly carry out pot experiments to assess the same organic amendments (provided by the SGGW partner) and various biochars using the untreated soils from the field network. The hypotheses to investigate were:

- How does the rate of biochar addition in organic amendments (especially compost pellets) affect plant performance? (the biochar addition may reduce the leaching of nutrients when the organic amendment starts to be mineralized)
- What is the influence of biochar characteristics on plant performances?
- How are the interactions between biochar and organic amendments influenced by soil characteristics (notably soil fertility, soil contamination)?
- Should biochar incorporation into the soil be supplemented with a minimal fertilization?

Pellets (made from spent mushroom substrate, pig and chicken manures, Fig. 3) and containing various doses biochar are assessed at least in triplicates (the Polish biochar being made from the pyrolysis of conifer wood). Unplanted- and planted- amended soils, and fertilized (uncontaminated) control soils are also included in the experiments. The addition rate of amendments into the soil is based on potential supply of mineral nitrogen.

	Dose g/kg of soil	Dose mineral N mg/kg of soil
pellet	5,0	0
Pellet + 10% biochar	4,5	10
Pellet + 20% biochar	3,5	30
Biochar*	2,0	55

Fig. 3. Production of compost pellets by the SGGW partner and pot experiment carried out by INRA © Wieslaw Szulc, Rafael Gomez

Expected data are: soil physico-chemical analysis (after harvest - full maturity); for grain and straw: fresh matter, dry matter, content N, P, K.
Roots measurements: fresh and dry weight yield, maximum root length
Phenological observations during growth of plants and yield components: number of spikes per pot, grain number per spike, 1000-grain weight, SPAD, chlorophyll fluorescence thousand kernel weight, tillers per plant, ears per tiller, ears per pot, grains per ear, mass per grain, and grain mass per plant.

■ Field trials for assessing organic amendments and raising crop production

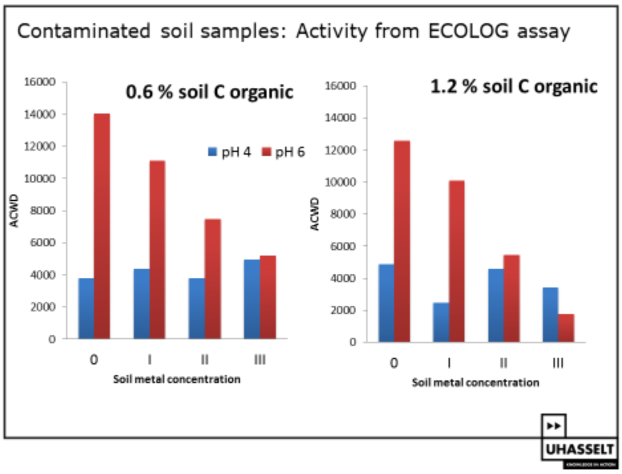
Several agricultural degraded soils and former industrial sites with soils contaminated by either local or diffuse anthropogenic sources are phytomanaged by growing energy and non-food crops (SGGW, INRA, YNCREA, UPARMA, HMGU, and CIEMAT) intended for the production of biomass (e.g. willow, poplar, *Miscanthus*, *Arundo donax,* kenaf) and biogas (e.g. maize, sugar beet, rape, barley).

Additional outcomes are scenarios for the valuation of ecosystem services (WP4, Dr N Witters)

The phytomanagement options assessed on degraded and contaminated soils included:

● Woody crops: poplar (*Populus nigra* L., *P. trichocarpa* x *deltoids* cv. Beaupré), willows (*Salix caprea* L and *Salix viminalis* L.) and false indigo bush (*Amorpha fruticosa* L.), *Pinus sylvestris* L.

Relationships between structural and functional diversity of soil microbial community and the phytomanagement: For the Skierniewice soils cultivated with *Salix* spp., all soil organic amendments have a positive effect on the microbial activity in both soil layers (Beckers et al, ECOLOG Assay, Community-level Physiological profiling, CLPP). However, functional diversity of the microbial communities remained highly stable and unaffected by the treatments.
Microbial activity decreased with the soil metal contamination, notably at soil pH 6. For this soil pH, the lower microbial activity is for both 0.6 % C organic and 1.2 % C organic. At soil pH 4, the relationship between total soil metal and microbial activity was not consistent for the various C levels. At 1.2 % C organic: slightly lower microbial activity with higher metal concentration. The functional diversity (based on ECOLOG assay) remained similar whatever the levels of soil metal contamination and soil C organic, except it decreased at soil pH 6 for the highest soil metal contamination and the 1.2% soil C organic level.



(Beckers et al, UHasselt)

Fig.4. Microbial activity (measured as average color per well development in ECOLOG plates) in the metal-spiked Skierniewice soils depending on total soil metal, soil pH and soil organic C

● Perennial grassy crops: *Agrostis capillaris, A. delicatula, A. gigantea, Deschampsia caespitosa, Sporobolus indicus*, *Vulpia myuros, Phleum pratense, Festuca arundinacea*

In the SGGW field experiments, the shoot yield peaked for Thimothy grass combined with Tall fescue (50%/50%), i.e. sum of 2 cuts: 192.2 Mg FW ha^{-1}, and the inorganic fertilization (Szluc et al, SGGW)

● High yielding crops: sunflower, tobacco and oilseeds, barley, maize

In the SGGW field experiments, grain yield of barley peaked (4.8 Mg ha^{-1}) for compost at 100 kg N/ha + 50 kg N mineral and shoot DW yield of maize (38.3 Mg ha^{-1}) for compost 200 kg N/ha + 50 kg N mineral; maize yield decreased as soil metal contamination increased notably at pH 4 (Szulc et al, SGGW).

At the Italian Site:
• biochar has no effect on maize yield but may cause a collateral decrease in GHG emissions.
• Pr. J. Vangronsveld informs all partners to be aware of the initial toxic effect of PAHs in biochar, which he observed in several studies. (Maestri et al, Univ. Parma)

At the German site:
• Beets on the German field grew very nice but the barley did not grow well
• As bad weather (storm) influenced the crop yield, the barley was pressed down on a very wet soil and suffered fungal infection.
• the field trial suffers from a weed invasion (space between the plots) (Poschenrieder et al)

At the Spanish sites (Millan et al, CIEMAT):
• Spanish sites experienced severe drought periods in 2017
• Biochar addition alone has no effect on plant yield whereas biochar with compost was effective

Table 1: Phytomanaged field trials in 2017-2018

Sites	Soil stress	Remediation option	Phytomanagement in 2017 - 2018
INRA, BIOGECO, FR	Cu, PAHs	Organic and mineral amendments, phytoextraction/rhizodegradation	Sunflower, tobacco, *Erucastrum incanum*, broad bean, hemp
INRA, BIOGECO, FR	Cu, PAHs	Organic and mineral amendments, phytostabilisation/ rhizodegradation	*Miscanthus*, vetiver, poplar, willows, false indigo bush, barley
INRA Parc aux angéliques, FR	Metal(loid)s, PAHs	Organic amendments, phytostabilisation/ rhizodegradation	Alfalfa, poplar, grassy crops
MetalEurop, YNCREA, FR	Cd, Pb, Zn, other metal(loid)s	Organic and mineral amendments, phytostabilisation	Energy crops: Miscanthus, kenaf
Roggenstein, Technical University of Munich, DE			Energy crops
Martl-Hof, DE	Low fertility	Organic fertilizer: pig and sheep manure	Broad bean (*Vicia faba*) as intercrop, maize fodder beet, barley Miscanthus
SGGW Skierniewice, PL	Low soil C Low soil WHC Sandy soil	Organic amendments ± irrigation Soil amendments: - Dry fraction from biogas-digested cattle manure + mineral fertilizer - Cattle manure dry fraction (not gasified) + inorganic fertilizer - inorganic fertilizer - Biochar+ inorganic fertilizer	- Timothy grass (*Phleum pratense*) - Tall fescue (*Festuca arundinacea*) - Thimothy grass and Tall fescue (50%/50%)
SGGW		1. Control	in Suliszew: maize/barley

Skierniewice and Suliszew, PL		2. Mineral fertilization 100 kg N/ha 3. Mineral fertilization 200 kg N/ha 4. Compost 100 kg N/ha 5. Compost 200 kg N/ha 6. Pellet 100 kg N/ha 7. Pellet 200 kg N/ha 8. Compost 100 kg N/ha + 50 kg N mineral 9. Compost 200 kg N/ha + 50 kg N mineral 10. Pellet 100 kg N/ha + 50 kg N mineral 11. Pellet 200 kg N/ha + 50 kg N mineral	(irrigation, no irrigation) in Skierniewice: Barley/maize
SGGW Skierniewice, PL	Soil spiked with Zn, Cu, Cd, and Pb pH 4 and 6	Zn: 48 to 300 mg/kg	Maize
SGGW Skierniewice, PL		Soil treatments: bio-rest from biogas production spent mushroom substrate fruit pomace sewage sludge control Doses 170 kg N ha^{-1} Plot size 4x5 m, 4 replicates	Salix
SGGW Miedniewice, PL	Low soil C Low soil WHC	Organic amendments ± irrigation	Maize
NIBIO, Særheim, NO	Low soil C Low soil WHC	Dry fraction from biogas-digested cattle manure, cattle manure dry fraction (not gasified), Biochar ± mineral fertilizer	Timothy grass (*P. pratense*), Tall fescue (*Festuca arundinacea)*
UParma	Agricultural soil	Mineral fertilization, compost, manure, with and without biochar from wood	Maize
CIEMAT	Agricultural soil	Compost pellets, biochar (pine and olive wood), mineral fertilizer (NSA / urea)	Barley, sunflower

Prof. Wiesław Szulc Prof. Beata Rutkowska
Warsaw University of Life Sciences, Poland.

☐ Effect of soil amendments (compost, dolomitic limestone), plant cover and associated microorganisms on the improvement of soil processes:

In long-term phytomanaged plots with Cu-contaminated soils, carried out by INRA BIOGECO, the ecological remediation options enhanced the recovery of several soil processes underlying ecosystem services. Best results (as compared to unmanaged soil) for Carbon sequestration, soil quality for plant species, plant nutrition and water supply, exposure to soil contaminants (Copper) and soil microorganisms, depending on soil amendments and plant assemblages, are listed in the following table (best option in bold for one soil function) (Mench et al). Work on insect community is ongoing:

Functions		high yielding crops	Grassland (*Agrostis*, spp.)	Short Rotation Coppice willows/poplars
Cycle regulation Medium for plants and soil microbes	Organic carbon sequestration	+40% - +150%	**+ 187** %	+ 64%
Cycle regulation Plant nutrition	Nitrogen cycle (Total soil N)	+ 128% - **+ 157%**	**+ 169** %	+ 66%
Cycle regulation Plant nutrition	Phosphorus cycle Available P	+ 14% - + 23%	+ 148 %	+ 71%
Cycle regulation contaminant	Labile Cu pool	- 193% - **-535**%	- 69 %	- 57%
Water cycle/supply regulation	Water holding capacity	+ 163% - **+347**%	+ 27%	+ 19%
Habitat, soil microbes	FDA activity	+ 46% - + 50%	**+ 71** %	+ 17 %


Dr M. Mench


Dr. N. Oustrière


Dr. L. Marchand


Dr. B. Castagneyrol

Strategies to improve soil biodiversity and ecosystem services: precise management (WP2)

Aims: *This work relates critical factors like degradation, contamination and management intensity to changes in soil biodiversity and studies the impact of strategies designed in WP1 to improve system functionality by applying precision farming. It then links soil biodiversity to the delivery of selected ecosystem services: C sequestration, nutrient cycling and water retention. INTENSE is combining farming-by-soils tools as an integrated part into the final aim of producing biomass and byproducts on degraded soils in the most efficient way, aiming at a strategy to deliver different sources of biomass according to inter-and intra-seasonal variation in cropping conditions. This WP utilizes maps, tools and data already existing for the sites, and apply the most suitable management strategy; the approach will be harmonized, but tailored to the different situations. Taking advantage of data collected by other WPs, the WP is validating inputs, as well as providing output data to other WPs, notably WP3 and WP4. Essential requirements are strong cooperation with stakeholders and territorial institutions.*

UPARMA is currently collecting information on precision farming using a questionnaire and templates in the countries contributing to the project in order to construct a database, with the help of INTENSE partners and potential readers of this newsletter (feel free to contribute! See the following page).

Thanks in advances for your help: Feel free to contribute to the questionnaire and return your answer to elena.maestri@unipr.it


Prof. E. Maestri

1. Please check if your “Ministry for Agriculture” has an official position on precision agriculture
   a. Provide us with the address of the web site(s) of reference
   b. Indicate if an English version exists
   c. Provide any official document on precision agriculture, even if they are in your National language

2. As far as possible, try to recover some information about the status of precision agriculture in your own region (or in the area where the INTENSE activities are taking place): useful information (not exhaustive list) could concern:
   a. Area affected by precision agriculture in general
   b. Main fields of intervention: e.g. fertilisation, irrigation, mapping, livestock management, etc.
   c. Main techniques or technologies applied: e.g. drones, tractors, etc.
   d. Research initiatives involving farmers or experimental farms

3. List any stakeholder, company, farmer in your region and/or country who might possibly be involved in INTENSE activities: If available, provide name of company/Institution, name of contact person, email, website
4. Any other possible document or information you consider of interest

Ecological indicators of land use changes: stresses & key factors of sustainability (WP3)

Aims: *Environmental indicators provide information on pressures on the environmental conditions of the selected agroecosystems and societal responses as proxies for measuring conditions that are so complex that currently there are limited possibilities for direct measurement. This WP is collecting information about the status of the selected field sites, soil improvement, biomass production, and the impact that the measures exert on resilience and productivity in these ecosystems to stakeholders, the public and to policy makers. Information on soil fertility, soil life, plant performance and yield, as well as on stress factors and on product quality and the ecological sustainability of the measures taken in INTENSE are provided to the other WPs. This will help prioritizing regions and systems for the adaptations and mitigation strategies to be applied. Agrochemical use are minimized, and irrigation avoided as far as possible. Sectoral policies concerning e.g. land use, nature and biodiversity conservation, water and irrigation, greenhouse gas emissions and soil quality (e.g. soil carbon sequestration) will also benefit from this approach.*

Current ongoing tasks are: the monitoring of vegetation at sites of concern (based on Ellenberg procedure); harmonization of sampling and assays and determination of plant stress due to drought, metal(loid) excess or organic pollution in lead species during growth.

- Dr. Friederike Gnädinger (Helmholtz Zentrum München) stresses the importance of the indicators and the difficulty of choosing the right ones. The MartlHof site can be the case study.
    - Pressure indicators
    - Response indicators
    - State indicators
- The ultimate aim is to create a simple decision tool
- What do we want from the decision tool?
    - To give advice to the farmers => money
    - How can we evaluate the monetary value? => WP4
    - How do we deal with the high uncertainty for WP4?
- Pr. Schroeder will do a study of the available literature and come up with a possible list of indicators with the advice of the partners and stakeholders.

Dr. F. Gnädinger

Economic valuation of biodiversity and ecosystem services: cost effective management (WP4)

Aims: *Farmers confronted with budget constraints are in need of supporting evidence of biodiversity benefits outweighing the opportunity costs incurred in order to strengthen the argument for biodiversity conservation at the farm level. WP4 contributes to this evidence in two ways: it aims (1) to reveal the economic value of soil biodiversity for agricultural production based on the functional role of microbial communities in delivering ecosystem services (determined in WP2), and (2) to perform a cost-effectiveness analysis of the management strategies accounting for the current shortcomings of the land (WP1) and impact on the delivery of ecosystem services (WP2), by assessing costs of these strategies and their benefits (e.g. increased biodiversity, ecosystem service delivery, etc.).*

Identification of data to describe ecosystem properties and evaluate ecosystem services, such as functional diversity, microbial diversity, soil quality, etc. is ongoing. A frame for collecting information is prepared by UHA (Dr. N. Witters et al), including climate conditions during the experiment, soil quality, biomass production, irrigation, herbicides/pesticides if they have been used. First data will come in autumn.

Partner	System in focus	Responsibility/Role	Specific contribution	Strategies developed
NIBIO Coordinator	Grassland pasture and bio-rest as fertilizer, northern climate	WP6. Management, nutrient cycling, grass yields, dissemination, crop model	Diversity, biomass, soil biology	Biomass, nutrient use from organic sources, climate adaptation
HMGU	Set aside land, Agroforestry, small plots	WP 3. Indicators, plant stress, maps, models (EXPERT-N, PLATHO)	Proteomics, N,P,C, yield model, water relations, indicators	Biomass, pellets, agroforest, precision farming
SGGW	Arable land, poor soils, set aside land	WP1. Agronomy, biofuels, energy budgets, GHG, teaching	Farming, yield . model, GHG emissions, nutrient availability,	Biomass, fibers, new varieties
UMR-BIOGECO	Brownfields, restoration sites, tailings	WP5. Industrial sites, pollutant uptake, phytoremediation	Soil restoration, organic pollutants, remediation	Biofuel, gentle remediation, mixed plantation
UHASSELT	Abandoned / arable land, plots	WP4. Heavy metals, socio-economy model	Models, Plant-microbe interaction, genomics	Agroforest, microbial inoculates
CIEMAT	Dryland, Innovative Greenhouses	Water reuse, biomass, socio-economy	Water use efficiency, soil biology, CO_2 cycling	Biomass, water reuse
MARTL	Small farm, erosion, pasture (SME)	Small scale productivity, dissemination, contact to local stakeholders	Marketable crops and fruits, biogas biomass, economy budgets	Biogas, alternative products, vegetables, alternative heating
UPAMA	Greenhouse, arable land, restoration sites	WP2. Heavy metal analysis, biofuel, biochar, teaching	Genomics, proteomics, life cycle analysis, fate of heavy metals	Biochar, LCA, ecotoxicology, teaching

Systems in focus and scenario/strategy developed within the framework of the INTENSE project

Hakan Olcay, Silvie Daniels, Nele Witters, Robert Malina et al have presented the 4 pillars of the WP4 tasks:


Dr. S. Daniels

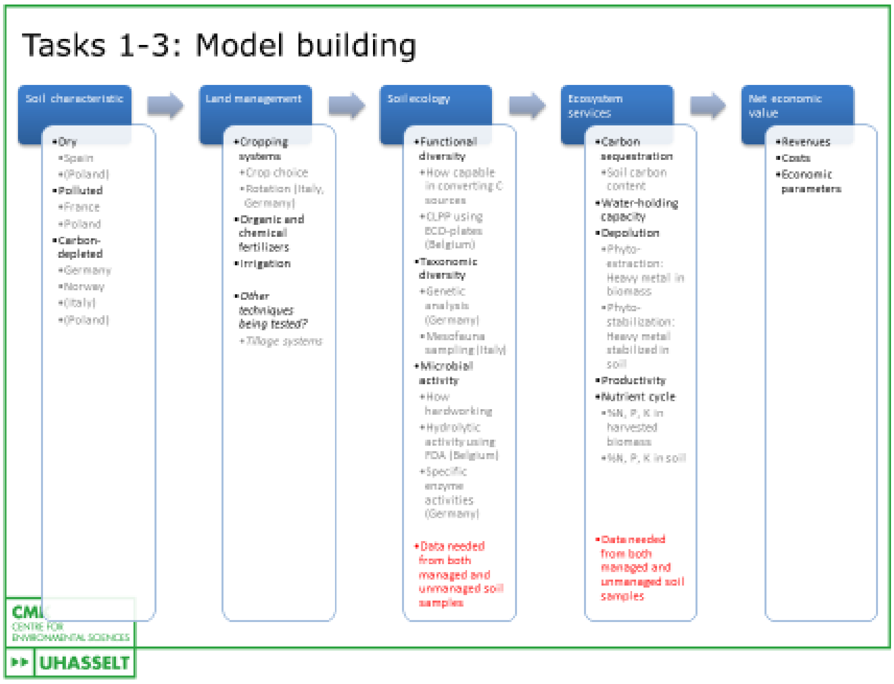

Dr. N. Witters


Dr. H. Olcay

● Create model(s) to relate net economic value of productivity to soil ecology for different land managements
● Include ecosystem services in the model. Determine effect of marginality
● Compare direct costs and revenues for different managements including the unmanaged case
● Include environmental benefits and disbenefits

Data have been already input from Norway, Poland and France.

- **Tasks 4.1 and 4.2** are about building a model that uses the relationships between soil characteristics, land management, soil ecology, ecosystem services and the net economic value of productivity. Establishing these relationships is a part of WP2 and WP3, and hence, should be done by all the partners involved. These relationships will be developed through regression analysis once data has been collected from the partners. Due to the complexity of establishing correlations between all the parameters, it is highly likely that these two tasks will generate more than one model on a case-by- case basis.
- **Task 3** is to compare the net economic value of productivity for different land managements as well as the unmanaged case, which will be assessed once the models have been set up.
- **Task 4** includes a cost-benefit analysis. In addition to the net value of productivity, environmental benefits such as sequestered carbon in soil, and disadvantages such as life cycle greenhouse gas emissions from managing previously unmanaged soils are to be monetized. This task will link different management practices to the net monetized benefits.



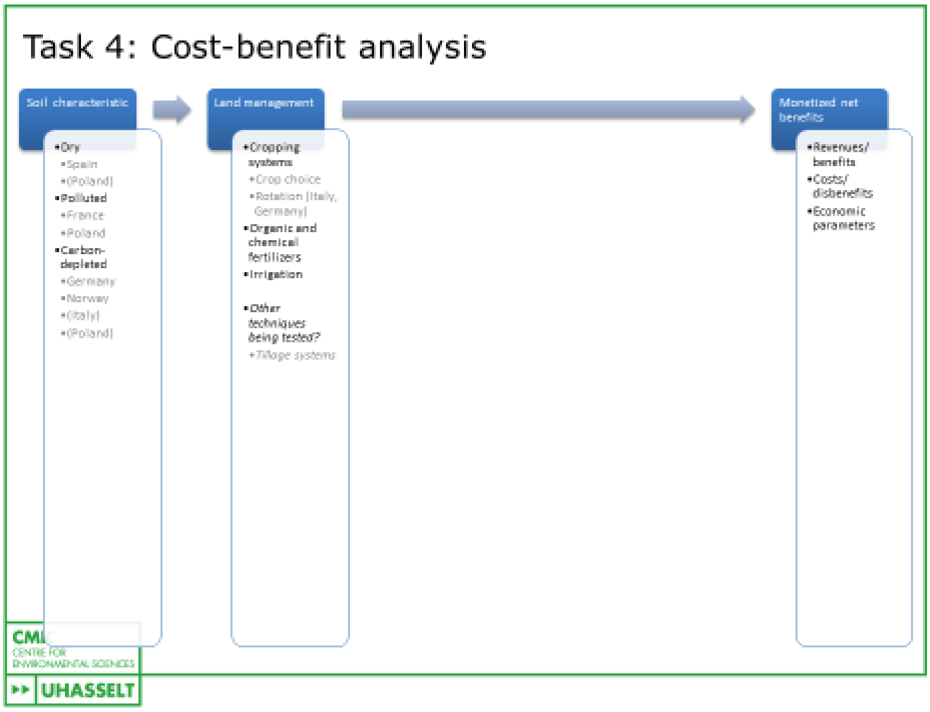


Fig. 5 Model for economic valuation of biodiversity and ecosystem services (Olcay et al UHasselt)

Implementing sustainability of marginal lands: outreach and demonstration (WP5)

Aim: *the purpose is to deliver remediation methods and management strategies for a number of marginal land situations, including various limiting factors and pollution scenarios, and a climate gradient across Europe. Besides providing practical experience from and tailor made solutions for special problem sites, it is essential to deliver a toolbox with a hierarchical set of methods to stabilize soils, improve soil life, maximize productivity, at high level of C sequestration, water retention, and nutrient cycling. This WP is integrating data from WPs 1-4 during the whole project and implement their results into an integrated management setup that mirrors best practices on a higher level of abstraction. The process of integration is accompanied by close stakeholder contact..*

■ Stakeholder's workshops

The stakeholder meeting (January 31, 2018) was welcoming INTENSE partners and the following stakeholders:

Stakeholders	Represented by:
Bio2clean	Dirk Dubin
Biobest	Soroya Franca
	Felix Wäckers
BiPa	Sandro Frati
DCM	Inge Hanssen
	Filip Coppens
	Hervé Dupré de Boulois
Sylva	Jan Coussement
Agropolis	Kristof Das
Sibelco	Milko Burkard
	Bartek Prusisz
	Spiro Fakiolas
Others : Bosgroep Zuid	Leon vandenberg, Bart Nyssen

(in green: oral communications)

Dr. N. Weyens

Pr. F. Rineau

Fig. 6. INTENSE Workshop at the Hasselt University: stakeholder meeting © Davide Imperiale

During this meeting all stakeholders provided a brief introduction to their companies and their interest in the INTENSE project where after feedback and discussion between stakeholders and INTENSE partners ensued. Pr. Schröder provided a comprehensive and informative overview of the activity, experiments and preliminary data from all the partners of INTENSE.

• The Sibelco stakeholder raises the point of the practical application of new fertilization/amendments strategies. In their experience, it remains a bottleneck to convince local farmers and agricultural workers of new strategies since they are mostly focussed on short-term revenue and not on the long-term quality and fertility of the soils they use. This aspect is enhanced by the fact that a lot of farmers do not own the land they use. Pr. Schröder acknowledges this point and explains that this is, at least in some part, a problem of the mind-set of the farmers and we have continue to provide useful and reliable data to convince them otherwise. Specifically future fertilization/amendment strategies will have to be introduced at some point because of stricter NPK regulations and possibly shortages of nutrients.
https://www.sibelco.com/
2) Leon van den Berg introduces Bosgroep Zuid and their main activities. Bosgroep Zuid is an organization that manages 37,000 ha of forestry in the south of the Netherlands. They have more than 400 members (land owners, cities, nature groups, etc.), which they work and help them develop and manage their forest sites. Their main problem is the occurrence of podzol soils, i.e. soils with a low pH, low nutrient content, shallow rooting zones (danger for unrooting trees during storms). In cooperation with Sibelco (which provides a large range of rock dust varieties) they are evaluating the effect of the addition of rock dust to the soil in order to (1) increase moisture-holding properties in the soil, (2) improve cation exchange capacity and (3) improve soil structure and drainage. Rock dust also provides calcium, iron, magnesium, phosphorus and potassium, plus micronutrients. They are also evaluating the amount of rock dust that is needed per ha.
https://bosgroepen.nl/bosgroep-zuid-nederland/medewerkers/

• Dr. Mench provides information about the UMR BIOGECO and ISPA research groups from INRA in the south of France with similar soil conditions (podzols) and research strategies and shares contact information with Bosgroep Zuid.

2) Spiro Fakiolas introduces Sibelco and describes their general activities. In addition to their main activity (mining), they are interested in all ecological aspects of their mining activities. This includes proper site management and development after mining but also having a look at agricultural application for their products. They produce a large range of rock dust products (different sizes and chemistry), which can used as soil amendments (see Bosgroep Zuid research). Their interest in the INTENSE project is mainly to evaluate whether some of the INTENSE partners are interested in applying some of their rock dust products and evaluating the efficiency of their products in field conditions.

3) Jan Coussement introduces SYLVA, one of the biggest tree nurseries in Western-Europe. He describes the long history of SYLVA (Van Hulle family, since 1750) and their evolution from 2 ha to 80 ha. They produce mostly forest and hedging plants, Christmas trees, poplars, understocks and export to about every country in Europe. Jan describes the production process from seeds to trees, how SYLVA collects a lot of the seeds themselves (and also purchase others) and how certain treatment of seeds (e.g. acid treatment enhance seed germination (because it mimics the passage through the stomach and gut of animals). Because of the climate in Waarschoot (location Sylva) and the mild sea climate they also receive a lot of seeds from different countries to germinate. They are also the pioneer in the use of ladybirds against the woolly beech aphid. Their interest in the INTENSE project is mainly to find solutions/strategies to maintain long-term quality and fertility of their soils and possibly receive new research info concerning the protection against certain pathogens.
http://www.sylva.be/page6_1.aspx?Language=EN

4) Soraya Franca describes the history and activities of Biobest (Westerlo). Biobest started in 1997 and were the first company to bring bumblebees to the marketplace. Today they still are actively involved in bumblebee production and pollination with bumblebees. Furthermore they are involved in biological control and crop protection advice as well as developing integrated crop protection strategy for each grower.
https://www.biobestgroup.com/nl/biologische-bestrijding-bestuiving-via-hommels
https://www.biobestgroup.com/fr/lutte-biologique-pollinisation-par-les-bourdons
https://www.biobestgroup.com/en/

• Dr. Saebo expresses his interest in the bumblebee production. The bumblebees in Norway often show low activity and raises the question whether Norwegian bumblebees can be produced in Belgium and then transported to Norway.
Their interest in the INTENSE project is mainly to evaluate whether some of the INTENSE partners are interested in using two of their products in experiments: (1) Glycine Betaine which helps plant against drought stress and (2) Trichoderma spray which helps plants against pathogens but also other stresses in the greenhouse (e.g. drought).

New available peer-reviewed papers

Schroeder P, Beckers B, Daniels S, Gnädinger F, Maestri E, Mench M, Millan Gomez R, Obermeier MM, Oustriere N, Persson T, Poschenrieder C, Rineau F, Rutkowska B, Schmid T, Szulc W, Witters N, Saebo A 2018. Intensify production, transform biomass to energy and novel goods and protect soils in Europe - a vision how to mobilize marginal lands. Science of the Total Environment 616–617, 1101-1123. doi 10.1016/j.scitotenv.2017.10.209

https://www.sciencedirect.com/science/article/pii/S0048969717329297?via%3Dihub

The rapid increase of the world population constantly demands more food production from agricultural soils. This causes conflicts, since at the same time strong interest arises on novel bio-based products from agriculture, and new perspectives for rural landscapes with their valuable ecosystem services. Agriculture is in transition to fulfill these demands. In many countries, conventional farming, influenced by post-war food requirements, has largely been transformed into integrated and sustainable farming. However, since it is estimated that agricultural production systems will have to produce food for a global population that might amount to 9.1 billion by 2050 and over 10 billion by the end of the century, we will require an even smarter use of the available land, including fallow and derelict sites. One of the biggest challenges is to reverse non-sustainable management and land degradation. Innovative technologies and principles have to be applied to characterize marginal lands, explore options for remediation and re-establish productivity. With view to the heterogeneity of agricultural lands, it is more than logical to apply specific crop management and production practices according to soil conditions. Cross-fertilizing with conservation agriculture, such a novel approach will provide (1) increased resource use efficiency by producing more with less (ensuring food security), (2) improved product quality, (3) ameliorated nutritional status in food and feed products, (4) increased sustainability, (5) product traceability and (6) minimized negative environmental impacts notably on biodiversity and ecological functions. A sustainable strategy for future agriculture should concentrate on production of food and fodder, before utilizing bulk fractions for emerging bio-based products and convert residual stage products to compost, biochar and bioenergy. This position paper discusses recent developments to indicate how to unlock the potentials of marginal land.

Sauvetre A, May R, Harpaintner R, Poschenrieder C, Schroeder P 2018. Metabolism of carbamazepine in plant roots and endophytic rhizobacteria isolated from Phragmites australis. Journal of Hazardous Materials 342, 85-95. Doi: 10.1016/j.jhazmat.2017.08.006

Carbamazepine (CBZ) is a pharmaceutical frequently categorized as a recalcitrant pollutant in the aquatic environment. Endophytic bacteria previously isolated from reed plants have shown the ability to promote growth of their host and to contribute to CBZ metabolism.

In this work, a horseradish (Armoracia rusticana) hairy root (HR) culture has been used as a plant model to study the interactions between roots and endophytic bacteria in response to CBZ exposure. HRs could remove up to 5% of the initial CBZ concentration when they were grown in spiked Murashige and Skoog (MS) medium. Higher removal rates were observed when HRs were inoculated with the endophytic bacteria Rhizobium radiobacter (21%) and Diaphorobacter nitroreducens (10%). Transformation products resulting from CBZ degradation were identified using liquid chromatography ultra high-resolution quadrupole time of flight mass spectrometry (LC-UHR-QTOF-MS). CBZ metabolism could be divided in four pathways. Metabolites involving GSH conjugation and 2,3-dihydroxylation, as well as acridine related compounds are described in plants for the first time.

This study presents strong evidence that xenobiotic metabolism and degradation pathways in plants can be modulated by the interaction with their endophytic community. Hence it points to plausible applications for the elimination of recalcitrant compounds such as CBZ from wastewater in CWs.

Kolbas A, Kolbas N, Marchand L, Herzig R, Mench M 2018. Morphological and functional responses of a metal-tolerant sunflower mutant line to a copper-contaminated soil series. Environmental Science and Pollution Research, doi: 10.1007/s11356-018-1837-1

https://link.springer.com/article/10.1007%2Fs11356-018-1837-1

The potential use of a metal-tolerant sunflower mutant line for biomonitoring Cu phytoavailability, Cu-induced soil phytotoxicity and Cu phytoextraction was assessed on a Cu-contaminated soil series (13-1020 mg Cu kg^{-1}) obtained by fading a sandy topsoil from a wood preservation site with a similar uncontaminated soil.

Morphological and functional plant responses as well as shoot, leaf and root ionomes were measured after a 1-month pot experiment. Hypocotyl length, shoot and root dry weight (DW) yields, and leaf area gradually decreased as soil Cu exposure rose. Their dose-response curves (DRC) plotted against indicators of Cu exposure were generally well fitted by sigmoidal curves. The half-maximal effective concentration (EC_{50}) of morphological parameters ranged between 203 and 333 mg Cu kg^{-1} soil, corresponding to 290-430 µg Cu L^{-1} in the soil pore water, and 20±5 mg Cu kg^{-1} DW in the shoots. The EC_{10} for shoot Cu concentration (13-15 mg Cu kg^{-1} DW) coincided to 166 mg Cu kg^{-1} soil. Total chlorophyll content and total antioxidant capacity (TAC) were early biomarkers (EC_{10}: 23 and 51 mg Cu kg^{-1} soil). Their DRC displayed a biphasic response. Photosynthetic pigment contents, e.g. carotenoids, correlated with TAC. Ionome was changed in Cu-stressed roots, shoots and leaves. Shoot Cu removal peaked roughly at 280 µg Cu L^{-1} in the soil pore water.

Ruotolo R, Maestri E, Pagano L, Marmiroli M, White JC, Marmiroli N 2018. Plant response to metal-containing engineered nanomaterials: An omics-based perspective. Environmental Science & Technology 52, 2451-2467. DOI: 10.1021/acs.est.7b04121

The increasing use of engineered nanomaterials (ENMs) raises questions regarding their environmental impact. Improving the level of understanding of the genetic and molecular basis of the response to ENM exposure in biota is necessary to accurately assess the true risk to sensitive receptors. The aim of this Review is to compare the plant response to several metal-based ENMs widely used, such as quantum dots, metal oxides, and silver nanoparticles (NPs), integrating available "omics" data (transcriptomics, miRNAs, and proteomics). Although there is evidence that ENMs can release their metal components into the environment, the mechanistic basis of both ENM toxicity and tolerance is often distinct from that of metal ions and bulk materials. We show that the mechanisms of plant defense against ENM stress include the modification of root architecture, involvement of specific phytohormone signaling pathways, and activation of antioxidant mechanisms. A critical meta-analysis allowed us to identify relevant genes, miRNAs, and proteins involved in the response to ENMs and will further allow a mechanistic understanding of plant-ENM interactions.

Murawska B, Spychaj-Fabisiak E, Kozera W, Knapowski T, Rozanski S, Rutkowska B, Szulc W 2017. Influence of sulphur and multi-component fertilizer application on the content of Cu, Zn and Mn in different types of soil under maize. Journal of Central European Agriculture 18, 571-583 DOI: 10.5513/JCEA01/18.3.1931

The aim of the study was to determine the influence of the soil type and differential sulphur rates used with or without Basfoliar 36 Extra on the soil pH as well as the amount of available forms of copper, zinc and manganese based on the micro plots field experiment. Moreover, the relationship between the studied microelements was examined. The experiment was performed in two-factor design; the first-order factor was the soil type (Typic Hapludolls, Typic Hapludalfs, Typic Haplorthods, Typic Endoaquolls), while the second-order factor - fertilization with sulphur and compound fertilizer - Basfoliar 36 Extra. The plant tested was Rota cultivar maize. The use of sulphur and sulphur combined with Basfoliar 36 Extra changed the classification of the soils in terms of their pH. In the soils under study, as a result of the 10-years application of sulphur and/or foliar fertiliser with NPK fertilization as well as growing maize in monoculture showing a high uptake of macro-and micro-nutrients, there was reported a clear decrease in the content of zinc, copper and manganese, as compared with the initial content. With that in mind, one shall assume that growing maize in a 10-year monoculture is connected with an intensive use of soils, which can result in a clear deficit of the elements studied in soil.

Rutkowska B, Szulc W, Szara E, Skowronska M, Jadczyszyn T 2017. Soil N_2O emissions under conventional and reduced tillage methods and maize cultivation Plant Soil and Environment 63, 342-347. DOI: 10.17221/291/2017-PSE

https://www.agriculturejournals.cz/publicFiles/224233.pdf

The study concerned the determination of nitrous oxide (N_2O) emissions under conventional and reduced tillage conditions. In the reduced cultivation, a soil cultivating seed drill was used for simultaneous sowing of seeds and subsurface application of fertilizer. The emission levels of the gas tested were dependent on the year of the study and the method of soil tillage, and were subject to considerable changes during the growing season. The use of reduced soil tillage significantly limited emissions of the analysed gas into the atmosphere. Depending on the year of the study, N_2O emission in the reduced tillage system was from 15% to 40% lower than in the conventional system. Low levels of easily mineralized components in soil could have been the cause of the reduction in N_2O emissions to the atmosphere.

Michels E, Annicaerta B, De Moor S, Van Nevel L, De Fraeye M, Meiresonne L, Vangronsveld J, Tack FMG, Ok YS, Meers E 2018. Limitations for phytoextraction management on metal-polluted soils with poplar short rotation coppice-evidence from a 6-year field trial. International Journal of Phytoremediation 20, 8-15 DOI: 10.1080/15226514.2016.1207595

Poplar clones were studied for their phytoextraction capacity in the second growth cycle (6-year growth) on a site in the Belgian Campine region, which is contaminated with Cd and Zn via historic atmospheric deposition of nearby zinc smelter activities. The field trial revealed regrowth problems for some clones that could not be predicted in the first growth cycle. Four allometric relations were assessed for their capacity to predict biomass yield in the second growth cycle. A power function based on the shoot diameter best estimates the biomass production of poplar with R-2 values between 0.94 and 0.98. The woody biomass yield ranged from 2.1 to 4.8 ton woody Dry Mass (DM) ha($^{-1}$) y($^{-1}$). The primary goal was to reduce soil concentrations of metals caused by phytoextraction. Nevertheless, increased metal concentrations were determined in the topsoil. This increase can partially be explained by the input of metals from deeper soil layers in the top soil through litterfall. The phytoextraction option with poplar short rotation coppice in this setup did not lead to the intended soil remediation in a reasonable time span. Therefore, harvest of the leaf biomass is put forward as a crucial part of the strategy for soil remediation through Cd/Zn phytoextraction.

Forthcoming events

More and updated details about events organized by the INTENSE consortium can be found under the `Meetings and Events´ section of the webpage (https://www.nibio.no/en/projects/intense)

INTENSE meeting and workshop

• A final FACCE SURPLUS project meeting will be held in November 2018 in Dusseldorf. Specific dates and venue are still to be defined. As soon as this information is available it will be posted on the website.

• A joint scientific workshop will be organized with three other FACCE projects. Date and location will follow later this year

Time	Place	Topics
October 2018	Bordeaux, France or Novi Sad, Serbia (IPS Conference)	Publication, stakeholder meeting, dissemination
February or April 2019	Stavanger, Norway	Final meeting

Contributions to forthcoming International Conferences

INTENSE project will be present at several forthcoming international conferences

► the 15th International Phytotechnologies Conference, which will take place in Novi Sad, Serbia from 1-5 October 2018 (http://phytosociety.org/events)

► Dr. M Mench will present a lecture in 2018 at the 3rd Summer Course of the PhytoSUDOE Project focusing on technologies for contaminated soils recovery, jointly organized by the University of the Basque Country (UPV / EHU) and the Environmental Studies Centre of the Vitoria-Gasteiz city council (CEA). It will take place on the 9th and 10th of October in Vitoria-Gasteiz.

http://www.phytosudoe.eu/en/dates-confirmed-for-the-remaining-events-of-phytosudoe-the-2nd-stakeholders-workshop-the-3rd-summer-course-and-our-final-conference-scheduled-for-2018/

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- https://www.nibio.no/en/projects/intense
- http://faccesurplus.org/research-projects-1st-call/intense/

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FACCE SURPLUS (Sustainable and Resilient agriculture for food and non-food systems) is committed to improve collaboration across the European Research Area in the range of diverse, but integrated, food and non-food biomass production and transformation systems, including biorefining.

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