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Model and Demonstration Projects

Joint Project: Model and demonstration project: Reduction of peat use in the cultivation of young vegetable plants – Acronym: ToGeP

- **Subproject 1: Region west and coordination;**
- **Subproject 2: Region south and analytical support;**
- **Subproject 3: Economic evaluation;**
- **Subproject 4: Ecologic evaluation**

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Subproject 2:	University of Applied Sciences Weihenstephan-Triesdorf – Institute of Horticulture
Subproject 3:	Johann Heinrich von Thünen-Institut - Federal Research Institute for Rural Areas, Forestry and Fisheries – Institute of Farm Economics
Subproject 4:	University of Applied Sciences Erfurt
Contact (Coordinator)	Dr. Norbert Laun Tel.: + 49 6321 671-263 → Write E-Mail
Project ID	2222MT022A-D
Start	01.10.2023
End	30.09.2027
Work description	<p>The planned ToGeP model and demonstration project is intended to show that high-quality vegetable seedlings can be produced with reduced peat use. With this in mind, barriers at the farms are to be dismantled, peat-reduced substrates and peat-saving cultivation systems are to be gradually implemented in practice and acceptance is to be established in the specialised vegetable seedling farms and among their customers nationwide. Two approaches are conceivable for reducing the use of peat: Firstly, reducing the peat content in the substrates by using peat substitutes and secondly, reducing the substrate volumes of the cultivation systems. Both approaches can be combined. A total of six model farms will be involved in the project, representing as broad and representative a spectrum as possible of cultivation systems, production methods and focal crops. Intensive support in plant cultivation and substrate analysis (DLR Rheinpfalz, HSWT) will accompany the gradual reduction of peat use in order to ensure plant cultivation success. The aim is to reduce the peat input per individual plant by 50 % compared to pure peat substrates in the previous cultivation systems. The data to be collected on plant quality, cultivation risk, as well as labour and material costs, are to serve as a common basis for an economic (Thuenen Institute) and ecological evaluation (University of Applied Sciences Erfurt) of the new peat-reduced production systems. Possible effects in the young plant enterprise as well as in the vegetable producing companies are to be considered. For a quick and direct transfer of knowledge, there is a close cooperation with the German Vegetable Young Plant Farm Association (Verein Deutsche Gemüsejungpflanzenbetrieb e.V.). The horticultural information system hortigate, which has its own information area for the topic of peat substitution, is intended to serve as a central information hub.</p>

Project Database – “Peat reduction and peatland soil protection”- Details

Joint Project: Demonstration, discussion, realisation: the way to large-scale implementation of *Sphagnum* paludiculture as sustainable agricultural use of bog soils

– Acronym: MOOSland

- **Subproject 1: Field test under optimal hydrological conditions as well as ecological and economic studies, greenhouse gas balance, knowledge transfer;**
- **Subproject 2: Field test under suboptimal hydrological conditions;**
- **Subproject 3: Stakeholder management and transformation process;**
- **Subproject 4: Spatial and Agricultural structure;**
- **Subproject 5: Development and Testing of growing media based on *Sphagnum* biomass and initiation of further applications & continuation of the existing *Sphagnum* paludiculture sites in the peatland Hankhauser Moor for research on long-term effects;**
- **Subproject 6: Studies on biodiversity (focus on dragonflies)**
- **Subproject 7: Participation in the continuation and expansion of the demonstration areas while integrating local stakeholders in the district of Diepholz**
- **Subproject 8: Participation in the continuation and expansion of the demonstration areas in the district of Ammerland**

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Subproject 1:	- Institute of Botany and Landscape Ecology Soldmannstr. 15 17489 Greifswald
Subproject 2:	Stiftung Naturschutz im Landkreis Diepholz
Subproject 3:	University of Applied Sciences Osnabrück – Faculty of Cultural and Social Sciences
Subproject 4:	University of Vechta – Vechta Institute of Sustainability Transformation in Rural Areas (VISTRA)
Subproject 5:	Peat company Moorkultur Ramsloh GmbH & Co. KG
Subproject 6:	Carl von Ossietzky University of Oldenburg
Subproject 7:	District of Diepholz
Subproject 8:	District of Ammerland
Contact (Coordinator)	Dr. Greta Gaudig Tel.: +49 3834 420-4692 → Write E-Mail
Project ID	2222MT010A-H
Start	01.10.2023
End	31.12.2032
Work description	The cultivation of <i>Sphagnum</i> (peat moss) biomass in paludiculture on rewetted bogs and its use as an excellent peat substitute can contribute to achieve

climate protection goals. Lower Saxony plays a prominent role in this regard, as over 80% of the bog areas in Germany are located here. In order to achieve a large-scale implementation and real alternative for farmers as well as to ensure the raw material supply of renewable Sphagnum biomass in certified high quality for the substrate and horticulture industry, the continuation, expansion and further development of existing pilot sites in 2 bog regions representative for Lower Saxony with different site conditions as demonstration objects is of central importance. Thus, the transferability of project results to other regions is given. Combined with accompanying scientific studies on GHG balances, biodiversity, hydrology, nutrients, economics, socio-cultural and agro-structural research on the agricultural transformation process towards Sphagnum paludiculture, fundamental findings and integrated solution strategies for an ecologically, economically and socially compatible, regional implementation can be derived and facilitate the process. Moreover, it provides decisive impulses for a climate protection-oriented agriculture beyond the project regions. The numerous tools developed as a result of the project (manual as a guide for the implementation of Sphagnum paludiculture, information system for the identification of potential paludiculture areas, an interactive, participatory information and networking platform, consultations, practice-relevant assessment methods for Sphagnum growth, etc.) will make it easier for land users to learn how to implement Sphagnum paludiculture.

Project Database – “Peat reduction and peatland soil protection”- Details

Joint Project: Central coordination of the model and demonstration projects on peatland protection, including the use of renewable raw materials from paludiculture –

Acronym: PaludiZentrale

- **Subproject 1: Coordination, network setup, advice of the model and demonstration projects (“PaludiNetz”) and overarching ecological and socio-economic analyses;**
- **Subproject 2: Accompanying economic, ecological and establishment-related studies of the model and demonstration projects;**
- **Subproject 3: Communication and knowledge transfer;**

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Subproject 1:	Bundesallee 65 38116 Braunschweig
Subproject 2:	Universität Greifswald - Faculty of Mathematics and Natural Sciences - Biology - Institute of Botany and Landscape Ecology
Subproject 3:	Michael Succow Foundation
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(Coordinator)	Tel.: +49 531 596-2644 → Write E-Mail
Project ID	2222MT009A-C
Start	01.10.2023
End	31.12.2032
Work description	The model and demonstration (M&D) project for “Peat soil protection including the use of renewable resources from paludiculture” funded by the BMEL will prepare large scale transformation of drainagebased peatland agriculture to paludiculture and demonstrate the climate mitigation effects and further ecosystem services of paludicultures. The project “PaludiZentrale” will support the implementation of the M&D projects und provide overarching analyses of data from scientific monitoring conducted in all projects. Aims are the overarching coordination, the network setup and advice of the M&D projects (“PaludiNetz”), the harmonisation of measurement protocols and data, the data synthesis, the development of guidelines for economically viable paludicultures and their use in regional value chains as well as collaboration for knowledge transfer into practice. Further, it is envisaged to integrate the pilot projects for peat soil protection funded by the BMUV into the PaludiNetz. The project “PaludiZentrale” is organized in 11 work packages, which allow both working on specific subjects and networking within the project itself, with the paludiculture projects and external persons and institutions. Due to their comprehensive thematic scope and the project duration, both the PaludiZentrale and the paludiculture projects as a whole are of unprecedented complexity and ambition. Therefore, they offer the unique opportunity to answer numerous open questions regarding greenhouse mitigation by paludicultures, biodiversity, further ecosystem services and economic options not, as done so far, at the plot or parcel scale, but for regionally typical sizes of agricultural fields. The PaludiZentrale will bundle and disseminate knowledge and experience to improve peatland protection and paludiculture, to scale up and to enable more persons and institutions to implement large scale rewetting until 2050 and, therefore, to meet Germany’s climate protection goals.

Joint Project: Sustainable production and utilisation of cattail on fen sites in Lower Saxony – Acronym: RoNNi

- Subproject 1: Coordination, regional concepts, agricultural sites, public relations and knowledge transfer
- Subproject 2: Biodiversity
- Subproject 3: Economics and socioeconomics
- Subproject 4: Development, testing and production of *Typha*-based building products
- Subproject 5: Horticultural substrates
- Subproject 6: Utilization and marketing; model and demonstration objects; further training
- Subproject 7: Site support and accompanying scientific studies
- Subproject 8: *Typha*-based horticultural substrates in practice
- Subproject 9: Development of regional concepts; cultivation areas in the district of Cuxhaven
- Subproject 10: Support in the creation of polders, management of the cattail areas and accompanying public relations work
- Subproject 11: Life cycle assessment and building law aspects

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Subproject 2:	Carl von Ossietzky University of Oldenburg
Subproject 3:	Kiel University (CAU)
Subproject 4:	Fraunhofer-Gesellschaft zur Förderung der angewandten Forschung e. V.
Subproject 5	Osnabrück University of Applied Sciences
Subproject 6	Jade University of Applied Sciences
Subproject 7	Julius Kühn-Institut Federal Research Centre for Cultivated Plants
Subproject 8	Klasmann-Deilmann GmbH
Subproject 9	Nature Conservation Foundation of the district Cuxhaven
Subproject 10	Town of Geestland
Subproject 11	University of Applied Sciences and Arts Ostwestfalen-Lippe
Subproject 12	Johann Heinrich von Thünen-Institut – Federal Research Institute for Rural Areas, Forestry and Fisheries

Project Database – “Peat reduction and peatland soil protection”- Details

Contact (Coordinator)	Dr. Marie Luise Rottmann-Meyer Tel.: +49 5951 9893-0 → Write E-Mail
Project ID	2222MT006A-L
Start	01.10.2023
End	30.09.2032
Work description	<p>The aim of the project is the transformation of drained agriculturally used fen soils to a climate friendly peat soil conserving wet production through growing cattail. Therefore, in two model regions with different agricultural structures (Emsland/ Cuxhaven) the large-scale quality-optimised cultivation of cattail (<i>T. angustifolia</i>/<i>T. latifolia</i>) and the application of the biomass as construction material and horticultural substrate (peat substitute) will be developed, demonstrated and prepared for commercialization.</p> <p>Subproject 1: It is necessary to point out the chances but also the risks and limits of the wet cultivation. The establishment of a region-related water management and determination of regional area-potentials are important components in this context. Two <i>Typha</i>-polder (> 5 hectare each) will be established, maintained and scientifically monitored in order to achieve practically relevant data and to demonstrate the land use. The development of product chains will be supported through use-specific trials of harvesting methods and storage tests. A large-scale rewetting requires a continuous and intensive dialogue with diverse stakeholders. The establishment of two regional stakeholder networks to develop common solutions for the implementation of the wet cultivation and the promotion of acceptance of <i>Typha</i> growing will take place with the participation of all relevant stakeholders and the population. Knowledge transfer and public relations accompany the process. The overall coordination ensures an optimal interaction of the working packages.</p> <p>Subproject 2: Biodiversity of the <i>Typha</i> production areas will be recorded and evaluated by monitoring several groups of organisms (vascular plants, dragonflies and damselflies, and, if student assistants are available, birds, grasshoppers, and amphibians) and comparing them to the same organism groups in semi-natural cattail reed beds. Furthermore, vegetation development within the production plots will be studied to observe growth and vitality of <i>Typha</i> stands in interaction with other reeds. Based on the results, suggestions for the maintenance and development of the paludiculture will be developed. These suggestions aim to enable a high productivity while maintaining a high degree of biodiversity.</p> <p>Subproject 3: In the context of the "Economics" work package, both the process costs of the two <i>Typha</i> processing lines (peat substitutes and insulation materials) are to be examined and the willingness of the potential customers to purchase the respective <i>Typha</i> products is to be determined. The commercial cultivation of <i>Typha</i> and other paludicultures and the associated rewetting of drained peatlands have economic consequences for the actors involved and - in the case of large-scale cultivation - effects on the appearance of the landscape. In the work package "Socio-economics", the preferences of the regional actors (in particular farmers, local residents) for the transformation to wet peatland use with paludiculture are to be investigated. The analyses are carried out in an ex ante context, i.e. before a large-scale change of use is undertaken in a peatland-rich region.</p>

Subproject 4: The subproject includes all activities relating to the building material magnesite-bonded typhaboard. An essential part of this is the construction of a rationally operating plant in which the particles charged with binder are continuously compacted via a special conveyor belt and hot steam flows through the board material for rapid curing. The WKI is being supported in the development of new types of building products in which *Typha* particles are foamed, typha particle foam is used as a binder and a *Typha*/wood foam sandwich is produced. The company „typha technik Naturbaustoffe“ is also supported in the further development of *Typha* blow-in insulation. The determination of hygrothermal material properties and computational verification of functional suitability for various areas of application are used to check the suitability of the product of this plant and the newly developed building materials.

Subproject 5 & 8: The subproject "Horticultural Substrates" is being carried out jointly by the Osnabrück University of Applied Sciences and the Klasmann-Deilmann company. The objective is to determine how cattail (*Typha*) can be utilized as a peat substitute for growing media on an industrial scale and used in hobby and commercial horticulture. In addition to developing utilization options for *Typha*, the focus will be on economic feasibility analysis. This includes the determination and evaluation of the market potential for *Typha* in the horticultural sector and also presents the competitiveness with already existing alternative raw materials. To evaluate the suitability of *Typha* as a substrate constituent, the two *Typha* species *T. angustifolia* and *T. latifolia* will be considered in relation to planting location, growing conditions and harvest time. Experience has shown that pure *Typha* populations do not develop, but that areas are subject to natural succession. Therefore, mixtures with a proportion of typical accompanying vegetation will also be investigated. In order to improve the substrate properties, the materials will be subjected to suitable preparation. The knowledge gained in previous research projects on a model scale is to be advanced within the framework of the project up to the development of industrially implementable technologies and marketable products.

Subproject 6: The main focus of the activities of subproject 6 is the coordination of the working groups with a background in building materials. In addition, laboratory tests and planning and measurement of building physics data are recorded and evaluated on demonstration objects. Together with the partners, the data is evaluated and, if necessary, supplemented for approval as a building product.

Subproject 7: In subproject 7, agronomic parameters are monitored; stand development is documented over the establishment phase (years 1 to 3) and the development phase (years 4 to 6) and the long-term yield structure of the cattail species *Typha angustifolia* and *T. latifolia* is mapped. The monitoring is implemented over the entire period by means of visual bonitures of shoot formation, height growth, development stages and nutrient deficiency symptoms. Furthermore, the heterogeneity in the stand with regard to plant growth and maturity is recorded non-destructively by drone flight with RGB, hyperspectral and thermal cameras. These data are compared with images taken by a drone with an optical camera. Furthermore, biomass yields and qualities are investigated in relation to nutrient supply and harvest time. For this purpose, nutrient analyses (PCAL, KCAL, Nmin) and pH-value measurements of regularly taken soil samples are carried out. The analyses of the plant material with regard to nutrient content (N, P, K, C and trace elements) in summer and winter are intended to provide information on the nutrient supply coupled with biomass production. The biomass yields as well as the the cob and stem/leaf proportions and in this context, the carbon export associated with the harvest are determined. Maturation is documented by means of drone flights and visual bonitures. In the winter biomass, the nitrogen content, the C:N ratio and the content of skeletal substances (cellulose, hemicellulose, lignin) are also

analysed. This allows conclusions to be drawn about the fitness of the plant stand and the direction of utilisation, and possible optimisations to be implemented. Possible crop damage to the stand is recorded directly after harvesting and during the subsequent growing period with the help of drone overflights and visual bonitures. Nutrient balances are calculated in cooperation with the project partners.

Subproject 8: see subproject 5.

Subproject 9: In subproject 9, a regional concept is to be developed for an area in the district of Cuxhaven, and a polder is to be built and planted with cattails on an area of up to 10 ha.

Subproject 10: The town of Geestland will act as local contact person to assist the Nature Conservation Foundation as the land owner and the coordinator 3N Competence Center with the construction of the polder in the town area and also supervise the constructed cattail field from project phase two on. Supervising involves the maintenance of the polder and the technical facilities (e.g. regulation of water level) and also harvesting techniques, the development of product chains for subsequent commercialization. Furthermore, the municipality will accompany public relation works during the whole project duration.

Subproject 11: The main aim is the development of generic EPDs and their data basis for the spectrum of construction materials to be developed in the scope of this project. Furthermore TH-OWL will research and develop the legal basis for accreditations of the to be developed construction materials.

Subproject 12: The partial project addresses the greenhouse gas exchange and the water balance of the paludiculture sites and reference sites under intensive agricultural use. Green house gas exchange (CO_2 , CH_4 and N_2O) is measured with the eddy covariance method and/or manually with chambers. Further, environmental parameters such as the peat water level and the nutrient contents of the peat as well as changes in surface heights are measured. As this is the first time to measure greenhouse gas exchange at *Typha* paludicultures using the eddy covariance method, results will not only quantify the mitigation potential, but also help to improve our understanding of the much discussed CH_4 emissions of *Typha* paludicultures. Above-ground components of the water balance are measured, while groundwater inflow is determined by geohydrological modelling. Results will inform about the water demand of *Typha* paludicultures and will be used to calculate input and export of dissolved substances such as nutrients or dissolved organic carbon.

Project Database – “Peat reduction and peatland soil protection”- Details

Joint Project: Land management and biomass utilisation of wet fenlands: Network of model and demonstration projects in peatland regions of Brandenburg – Acronym: WetNetBB

- **Subproject 1: Coordination, technology and methods for management, biomass utilization, economic evaluation;**
- **Subproject 2: Field management;**
- **Subproject 3: Knowledge transfer and public relations, biodiversity monitoring;**
- **Subproject 4: Scientific support: hydrology, derivation of bio-indicators and socio-economy;**
- **Subproject 5: GHG flux monitoring using the eddy covariance method**

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Subproject 2:	State Office for Environment Brandenburg
Subproject 3:	Eberswalde University for Sustainable Development
Subproject 4	Leibniz-Zentrum für Agrarlandschaftsforschung (ZALF) e.V.
Subproject 5	Helmholtz-Zentrum Potsdam German Research Centre for Geosciences GFZ
Contact (Coordinator)	Prof. Dr. Annette Prochnow Tel.: +49 331 5699-210 →Write E-Mail
Project ID	2222MT005A-E
Start	01.09.2023
End	31.12.2032
Work description	In Brandenburg, there are extensive fenlands with a great diversity of habitats. However, almost all of them are drained and subject to progressive degradation. Groundwork has been done with rewetting in several peatland-rich regions of the state, many years of research activities for material and energy use of biomass and companies interested in biomass processing. The WetNetBB project is intended to act as a catalyst for large-scale transformation to sustainable peatland use by taking up these developments and bringing them together, implementing water levels that conserve peatlands at typical sites, developing processes for land management and biomass use, and thus having an impact beyond the project sites and regions. The overall objective of WetNetBB is the establishment of a network of model and demonstration projects for the use of wet fenlands with representative fields, biomass utilisation pathways and relevant actors in Brandenburg. The project areas reflects site conditions such as hydrogenetic peatland types, trophic levels, water regime types and vegetation as well as operational conditions for biomass utilisation in a representative way and includes the peatland-rich regions Rhinluch/Havelland, Mittlere Havel, Uckertal/Randowbruch and Spreewald. As a result of the WetNetBB project, the unique potential synergies of peatlands for climate, soil, water and biodiversity protection and regional value creation

are to be demonstrated in an exemplary manner, thus building acceptance and interest for sustainable peatland use in the selected regions and beyond.

Subproject 1: As part of subproject 1, investigations are carried out into the management of rewetted fenland areas and the utilization of biomass as a material and energy source. Adapted standard technology and special technology for land management will be tested on a large scale and transferable concepts and recommendations for action will be derived. Together with companies, processes for the material use of paludibiomass as peat substitutes and organic fertilizers, molded pulp/paper and bedding pellets, building and insulation materials and biochar as well as for energy use through anaerobic fermentation and combustion will be developed, demonstrated on a practical scale and introduced to the market. The effects of rewetting on the economic efficiency of land use and biomass utilization are being determined as part of the accompanying economic research.

Subproject 2: This subproject is responsible for module 1, in which demonstration areas will be rewetted and managed in cooperation with the local agricultural holdings, while active measurements to increase biodiversity as well as standard agricultural technology and special agricultural technology will be tested. Transferable concepts and recommendations will be derived from the project.

Subproject 3: HNEE is responsible for knowledge transfer and public relations, as well as biodiversity monitoring within the framework of the scientific monitoring. The module public relations and knowledge transfer controls the knowledge transfer internally and externally. The core of the module is the creation of an innovation forum for wetland use, which links all interested stakeholders in the long term and creates opportunities for knowledge transfer at eye level in various formats. In addition, the focus is on communication with the general public as well as politics and administration. The biodiversity monitoring will record site changes and their effects on the vegetation in the course of rewetting and management. The module will evaluate the management's site suitability and sustainability for stable biomass production, as well as record and evaluate the effects of the management changes on site biodiversity. Habitat suitability, the biotope connectivity, and landscape, including their influence through adaptation of management processes, are considered.

Subproject 4: The sub-project (TV) 4 "Accompanying Research: Hydrology, Delineation of Bioindicators and Socioeconomy" is part of the MuD project WetNetBB. TV4 comprises the activities in module 4 for scientific support in the work packages stand hydrological investigations (WP 4.1a), greenhouse gases including bioindicator development (WP 4.3a, b, c) and socioeconomic investigations (WP4.5a,b) within the framework of module 4. In addition, TV4 coordinates and communicates the entire accompanying research activities that Module 4 realizes, which additionally includes economic studies of the partner ATB (AP4.4) and biodiversity and soil studies on the part of the HNEE (AP4.2). The requested AP 4.1 and 4.3. will be realized at the intensive monitoring plots to be able to follow over 10 years how rewetting and changed biomass use affect ecological processes and properties, i.e. greenhouse gas fluxes and balances and biodiversity. The data collected will be made available in collaboration with the centrally coordinating project PaludiZentrale to contribute to the setup of a national database on rewetting of grasslands and peatland systems. In addition to the established method to assess greenhouse gas fluxes and budgets, a soil microbiome and vegetation-based bioindicator system will be developed to allow for greenhouse gas forecasting on an annual basis with an efficiently and cost-effectively tool to accompany rewetting projects in the future. The proposed WP 4.5. will use social network analyses to investigate actor constellations (e.g. landowners and farms) and their changes in terms of

behavior and acceptance, and thus, will make an important contribution to the realization of practical implementation and societal participation.

Subproject 5: The area setting represents local conditions such as hydrogenetic peatland types, trophic levels, water regime types and vegetation as well as operational conditions for biomass utilization in a representative manner and includes the peatland-rich regions Rhinluch/Havelland, Mittlere Havel, Uckertal/Randowbruch and Spreewald. The sub-project "GHG flux monitoring with eddy covariance" in the module "Scientific support" establishes a continuous monitoring of CO₂ and CH₄ fluxes using eddy covariance and quantifies the short-, medium- and long-term effects of the implemented measures on the greenhouse gas balances. It also investigates the factors influencing the emissions of the individual gases, derives optimization potentials and provides fully quality-controlled and gap-filled data sets.

Joint Project: Climate and nature protection-oriented grassland management on wet peat soils with innovative biomass utilization in the administrative district Osterholz– Acronym: Living Lab Teufelsmoor

- **Subproject 1: Coordination and knowledge transfer, land management, agronomic survey and economic evaluation;**
- **Subproject 2: Greenhouse gas exchange, hydrology, soil properties and nutrient retention;**
- **Subproject 3: Area management and water level rise, ecological investigation;**
- **Subproject 4: Utilization and marketing of existing wet meadow paludiculture;**
- **Subproject 5: Area selection and water level raising;**
- **Subproject 6 Development of process chains and products of regional paludicultures**

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Subproject 1:	
Subproject 2:	Thünen-Institute of Climate-Smart Agriculture
Subproject 3:	District of Osterholz
Subproject 4	Niedersächsisches Landvolk Kreisverband Osterholz e. V.
Subproject 5	Michael Succow Foundation
Subproject 6	Technische Universität Dresden
Contact (Coordinator)	Dr. Sarah Witte Tel.: +49 441 801-419 ➔ Write E-Mail
Project ID	2222MT002A-F

Project Database – “Peat reduction and peatland soil protection”- Details

Start	01.01.2024
End	31.12.2032
Work description	<p>The main objectives of the project are to establish an adapted land use of rewetted peatlands on a practically relevant scale (up to 200ha) and to develop an innovative and economically viable utilization of the biomass from wet grasslands in the Teufelsmoor region of Lower Saxony. Within the transdisciplinary and iterative process of the Living Lab process further suitable areas for paludiculture crops will be identified and established. Furthermore, with the participation of stakeholders from economic, scientific, ecological and social domains, opportunities of biomass production, processing and marketing should be tested and regional processing and marketing of the biomass should be established. The project will be supervised and evaluated scientifically through agro-economic, ecological and socioeconomic studies and measurements of greenhouse gas emissions and water quality.</p> <p>Subproject 1: The collaborative project is coordinated by the chamber of agriculture of Lower Saxony (LWK Niedersachsen). By applying the Living Lab concept local partners, practice partners and other stakeholders will be involved in the implementation of paludiculture and the initiation of an innovative and economically viable utilization of the biomass. Lastly, the LWK will support the optimization of grassland management by providing agricultural advice, collecting agronomic data and conducting an economic survey for the optimization of the grassland management.</p> <p>Subproject 2: The subproject of the Thünen-Institute aims at quantifying the greenhouse gas (GHG) balance for two wet grassland paludicultures and a reference site for 9 years. For one wet grassland and the reference site, nutrient export rates will be compared. Further, a hydrological monitoring network will be set up for both already rewetted areas used for biomass harvest and paludiculture sites implemented within the course of the project. Changes in surface elevation and soil properties will be monitored as well. Results of the GHG flux measurements will be scaled up to the whole project area and further wet peat soils in the district using data on peat water levels, ground elevation and vegetation. Furthermore, GIS analyses will be used to derive potential target areas for raising water levels and implementing paludiculture. The analyses will account for hydrological prospects, legal status, nature protection priorities and current agro-economic framework conditions of the whole district. Results will be fed into the Living Lab process to foster discussion.</p> <p>Subproject 3: the District of Osterholz (LK OHZ) will provide support in the selection of sites within protected areas and the raising of water levels to be carried out there, help develop the nature conservation framework conditions and ensure compliance with them. In addition, the LK OHZ is responsible for carrying out accompanying ecological studies (flora and fauna). To this end, tenders, evaluations and coordination of the flora and fauna surveys are to be carried out, nature conservation and legal requirements are to be taken into account and a practical guide is to be drawn up.</p> <p>Subproject 4: The main focus of the work of the Niedersächsische Landvolk Kreisverband Osterholz e.V. is the development of marketable products from wet meadow paludiculture.</p> <p>Subproject 5: In sub-project 5, suitable areas for raising water levels and establishing paludiculture are discussed and selected in an iterative process with regional stakeholders within the framework of a Living Lab. In order to be able to make well-founded decisions on the selection of areas, hydrological preliminary planning and external expert opinions are included in the process in addition to the results of the investigations of sub-project 2, which are developed</p>

through subcontracts. In sub-project 5, the water level is raised and a paludiculture is established on the selected area.

Subproject 6: In the sub-project, material processing paths are developed on the basis of the raw material properties to be determined. Product-specific demonstrators are manufactured and product properties are determined and optimised.

Model and demonstration project for the use of peat-reduced substrates in cemetery horticulture – Acronym: TorfFrie

Address	University of Applied Sciences Weihenstephan-Triesdorf - Institute of Horticulture Am Staudengarten 14 85354 Freising
Contact	Dr. Dieter Lohr Tel.: +49 8161 71-3349 → Write E-Mail
Project ID	2221MT002X
Start	01.10.2022
End	30.09.2025
Work description	<p>The model and demonstration project shall prove that in cemetery horticulture the use of peat can almost completely be avoided. Therefore, four cemetery nurseries will stepwise reduce the percentage of peat in their cemetery soils up to zero on exemplary graves. The four nurseries shall reflect the local differences across Germany. The effect of peat reduction on the aesthetic value of the exemplary graves will be rated and labour and material expenses are documented to assess the economic impact. The model and demonstration project primarily serves as proof-of-concept for maintaining graves and public flowerbeds on cemeteries with strongly peat reduced or even peat free cemetery soils to overcome reservations against such cemetery soils. Furthermore, based on the experiences of the four pilot nurseries a practical guide for choose of suitable cemetery soils will be written, in which the pros and cons of the different peat substitutes will be discussed. The guide might be also used by manufactures for the conception of more peat reduced or even peat free cemetery soils.</p>

Joint Project: Model and demonstration project "Hobby gardening with peat-reduced and peat-free substrates based on renewable raw materials" – Acronym: HOT

- Subproject 1: Target group investigation and media communication;
- Subproject 2: demonstration projects and specialized information;
- Subproject 3: Marketing recommendations;
- Subproject 4: Real laboratory and trainings

Address Subproject 1:	University of Applied Sciences für Wirtschaft und Umwelt Nürtingen-Geislingen Neckarsteige 6-10 72622 Nürtingen
Subproject 2:	University of Applied Sciences Weihenstephan-Triesdorf – Institute of Horticulture
Subproject 3:	University of Applied Sciences Weihenstephan-Triesdorf - Straubing Centre of Science - Professorship Marketing and Management of Biogenic Resources
Subproject 4:	GreenSurvey - Institut für Marktforschung Prof. Dr. Menrad GmbH
Contact (Coordinator)	Prof. Dr. Carsten Herbes Tel.: +49 7022 201-1057 → Write E-Mail
Project ID	2221MT018A-D
Start	01.04.2022
End	31.03.2025
Work description	<p>Potting soils for the hobby sector account for about two thirds of the potting soil produced for the German market. The share of peat substitutes is only about one third. In order to achieve the goals of the German Climate Protection Plan 2050, the amount of peat used today is to be halved by 2025 and reduced to almost zero by 2030. Possible peat substitutes in potting soils are, for example, wood fibre, compost, coconut fibre and biogas residues. In contrast to peat, the quality of many peat substitutes varies greatly and they have, among other problems, a lower water storage capacity. For hobby gardeners, this means that they have to water more often with smaller amounts and take the properties of the potting soil more into account when fertilising. Therefore, hobby gardeners must not only be convinced to buy substitute products, but they must also be informed about the special features of peat-reduced/free potting soils and their application. The aim of the project is to accelerate the replacement of peat products in hobby gardening with peat-reduced and peat-free substrates based on renewable raw materials. To this end, the following activities will be pursued:</p> <p>1) Preparing communication: Investigating the decision-making processes and the influencing factors for buying potting soil of different hobby gardener target groups, 2) Implementing communication and bringing about change: positively influencing the factors that strongly determine a decision in favour of peat alternatives and peat-reduced products and 3) Ensuring cultivation success with peat substitute products through application support: Preventively identifying possible application errors and providing hobby gardeners with assistance in their use of peat substitutes through training and a mobile app. Associations, manufacturers, retailers and other stakeholders are also involved in the project.</p>

Subproject 1: The main tasks in this subproject are divided into three work packages: WP1 On-site projects with gardeners, WP3 communication at large events and WP5 media communication.

In WP1, preparatory activities include qualitative interviews with hobby gardeners in three contexts (private and allotment gardens as well as urban gardening) on the decision-making process when purchasing substrates. These initial findings are to be deepened and quantified by means of a Q-sort survey and a discrete-choice experiment. Furthermore, the roll-out of the communication measures will be planned and prepared. These communication measures are to be implemented in the form of information booths in city centers throughout Germany as well as in the context of moor tours.

WP3 continues these communication measures at several garden shows (“Bundesgartenschau” as well as several “Landesgartenschauen”): Based on the results of WP1 and WP2, suitable materials as well as concepts will be developed. On the garden shows there will be information booths and lectures to sensitize the public to the topic.

Within WP5, channel-specific and partly region-specific communication materials will be created and placed in relevant media via local editorial offices, thus raising awareness for peat substitute products via local and regional media as well as social media. In addition, content will be provided for the FNR communication campaign.

Subproject 2: In subproject 2 a living lab with hobby gardeners from the different milieus (member of allotment associations and urban gardening projects as well as individual hobby gardeners) as citizen scientist will be run over three years. In the first two years, the participants document their experiences with peat reduced or peat free potting soils in a diary study. Based on these experiences, HSWT will create instructions for use of such potting soils, which the citizen scientists validate in the third year. Demonstration plantings at HSWT will accompany the living lab. Furthermore, these plantings are used for specific knowledge transfer and general public relations activities. In the last part of the project, the findings from the living lab and the demonstration plantings serve as basis for training course (face-to-face and online) as well as for the development of a browser based or mobile app. The app should help hobby gardeners avoid typical problems arising from peat reduced and peat free potting soils.

Subproject 3: The content of this subproject is divided in two work packages that deal with the following tasks: WP4 “On-site projects with manufacturers and trade” and WP6 “Application support via an app (or browser-based solution)”.

WP4 adapts the findings from interviews with hobby gardeners, choice experiments and real-life laboratory from WP1 in combination with insights from the botanical displays in WP2 into marketing recommendations. As part of this work package, seminars are organized with manufacturers to elaborate a deliberate marketing strategy. At the same time, the findings support the composition of training material in online form to provide sales personnel with practical knowledge and to make relevant information available for consumers as well.

In WP6, the knowledge from the real laboratory (WP1) and the demonstration projects (WP2) is applied to offer users a decision-making aid when working with peat-reduced or peat-free potting soil. The aim is to develop a digital interface (app or browser-based solution), which will be pretested in a practical test by the participants in the real-life laboratory and then made freely accessible to interested parties.

Subproject 4: The main tasks in this subproject are divided into two work packages: WP1 “On-site projects with gardeners”, WP4 “On-site projects with producers and distributors”.

In WP1, usage behaviour and plant growth will be investigated in real laboratories, in several cities and in all three contexts (private and small gardens as well as urban gardening). For this purpose, a daily log book will be designed and implemented for the study. In addition, training sessions for hobby gardeners will be conducted in the three contexts (online and face-to-face) to provide assistance in the use of peat-free or peat-reduced substrates in order to prevent application errors.

In WP4, the findings of WP 1 and WP 2 in the application of peat-free or peat-reduced substrates will be compiled. Based on this, training courses for sales staff in garden centers and DIY stores will be designed and carried out to support them in marketing and selling peat substitute products.

Peat Alternatives

Junior Research Group: Regionally accumulating residual materials and renewable raw materials as peat substitutes: preparation – use – assessment – Acronym: NWG-Torfersatz

- **Subproject 1: Assessment of suitability, quality and sustainability, method development peat proof;**
- **Subproject 2: Processing and process optimization**

Address Subproject 1:	University of Applied Sciences Weihenstephan-Triesdorf - Institute of Horticulture Am Staudengarten 14 85354 Freising
Subproject 2:	Technical - department of Research, Development and Transfer Rosenheim
Contact (Coordinator)	Dr. Dieter Lohr Tel.: +49 8161 71-3349 → Write E-Mail
Project ID	2222MT014A-B
Start	01.07.2023
End	30.06.2026
Work description	The junior research group follows an interdisciplinary approach to meet the challenges of reduction of peat use in horticulture and to train young scientists for different aspects of therefore. The core topic of the junior research group is the testing of new peat substitutes based on regionally accumulating residues and renewable raw materials as well as the expansion of possible uses for materials already in use. The work considers the production, supply and processing of peat substitutes as well as the production of peat-reduced or peat-free potting soils and growing media and their sustainability assessment in horticultural use. In addition to the use of regional accumulating residues (e.g. hop bines), the main focus will be on the use of material from (lowland) paludiculture and sustainably produced biomass (e.g. SRC wood, fiber hemp). This work will be accompanied by investigations into the quality and sustainability of the peat substitutes tested and the potting soils and growing media produced from them. An important aspect of quality testing is the development of a method based on near infrared spectroscopy (NIRS) for the quantitative detection of peat in potting soils and growing media, and the general use of NIRS as an innovative analytical tool for quality assessment.

Junior Research Group: Development of a sustainable raw material base for growing media in horticulture – Acronym: ENROK

Address	University of Applied Sciences Osnabrück Albrechtstraße 3 49076 Osnabrück
Contact	Prof. Dr. Diemo Daum Tel.: + 49 541 969-0 → Write E-Mail
Project ID	2222MT013X
Start	01.07.2023
End	30.06.2026
Work description	<p>The planned research and development project intends to set up and establish a junior research group at Osnabrück University of Applied Sciences that deals with the development and evaluation of horticultural growing media based on renewable domestic raw materials. One horticultural scientist with a PhD will be given the opportunity to further qualify for an appointment as professor through research and teaching activities. Two further scientific employees with a master's degree will complete a doctorate in the aforementioned subject area in cooperation with the University of Osnabrück. The members of the junior research team will each work on different raw material and process combinations for the production of sustainable substrate raw materials. In addition, they are specializing in certain methodological fields of competence and are working on the further development of analytical investigation procedures for the evaluation of substrate components and substrates. To reduce the proportion of peat in growing media, it is necessary to optimize the application potential of alternative raw materials. The research work planned here focuses in particular on wood fibers, green waste compost and cattail products. The aim is, on the one hand, to improve the properties of the materials by means of various process engineering approaches in preparation and production that enable them to be used to the greatest possible extent in substrate mixtures. In addition, cultivation strategies are to be developed that contribute to a better adaptation of the cultivation in strongly peat-reduced or peat-free substrates and thus increase the cultivation safety. Overall, the project serves to secure and expand academic expertise in order to advance new, sustainable approaches to solutions for substrate-based plant production and to implement them in horticultural practice.</p>

Joint Project: Production and evaluation of peat substitutes based on hydrothermal conversion from biogenic residues – Acronym: HYTORF II

- Subproject 1: Implementation of the hydrothermal conversion and physicochemical, techno-economic and ecological evaluation;
- Subproject 2: Evaluation of plant cultivation and hydrological properties of hydrothermally produced peat substitutes

Address Subproject 1:	DBFZ Deutsches Biomasseforschungszentrum gemeinnützige GmbH Torgauer Str. 116 04347 Leipzig
Subproject 2:	Mitscherlich Akademie für Bodenfruchtbarkeit GmbH
Contact	Lisa Röver Tel.: +49 341 2434-429 → Write E-Mail
Project ID	2221MT014A-B
Start	01.11.2022
End	31.10.2025
Work description	Peatlands are the most important long-term carbon storage in the terrestrial biosphere. Peat is a finite and overused resource. Peat extraction leads to a release of the stored CO ₂ and is of great relevance to the climate. The development of peat-free garden substrates is therefore becoming increasingly important. The aim of this project is to develop and test peat-free substrates for horticulture. Green waste with 4.2 million t/a and flowering strips are promising basic materials for the production of peat substitutes. Hydrothermal carbonization (HTC) can be used to convert these materials into peat-like materials that are resistant to microbial degradation. In the laboratory test, ten variants are hydrothermally carbonized from green waste at 150-190 °C for 30-60 minutes. The variants will be tested (chemically, biologically, hydro-physically) and evaluated, and the horticulturally best variant will be selected for a large-scale trial. Three aggregate mixtures i) wood wool, coconut fibre, perlite; ii) green waste compost, bark compost, wood wool; and iii) bark compost, green waste compost, wood fibre, coconut fibre will be prepared by a soil manufacturer and each will be mixed with two different admixture rates of hydrothermally treated material from the large-scale trials. In addition to extensive characterization, the storage behaviour of these substrate mixtures will be investigated and evaluated. Crop suitability and aging behaviour will be tested and evaluated in (long-term) growing trials. The aged substrates are repeatedly tested and evaluated chemically, biologically and hydro-physically. Based on the techno-economic and ecological evaluation of the peat substitute on the basis of HTC of green waste and the results from the tests, appropriate recommendations for action will be derived.

Evaluation of hydrothermal Carbonisation of waste from landscape management for the production of high-quality peat substitute – Acronym: HYTORF

Address	DBFZ Deutsches Biomasseforschungszentrum gemeinnützige GmbH Torgauer Str. 116 04347 Leipzig
Contact	Taina Lühmann Tel.: +49 341 2434 - 112 → Write E-Mail
Project ID	22009916
Start	01.11.2017
End	31.10.2018
Work description	<p>The central problem of the project arose out of the impact of peat use on the carbon balance of ecosystems and the landscape. As an alternative, peat-free material, organic residual material fractions from landscape conservation were identified as a potential application. Hydrothermal carbonisation (HTC) is a possible process for converting these residual fractions into a peat substitute. Against this background, it was the overriding objective of a research and development project to investigate the basics and implementation possibilities of the production of ecologically and economically valuable peat substitutes on the basis of hydrothermal conversion from landscape conservation material. The project comprised the characterisation of raw materials, the definition of product requirements for a peat substitute and carbonisation experiments on a laboratory and larger scale. Subsequently, the carbonized material was applied to 10, 20 and 30% with a pure peat substrate. These mixtures, the pure peat substrate and a peat substrate mixed with wood fibre were used in substrate hydraulic and phytotoxic experiments as well as mixing, storage and cultivation trials with various plants. In the end, a techno-economic evaluation for the dimension of a demonstration plant was prepared and concluded with the elaboration of recommendations for action.</p>

Project Database – “Peat reduction and peatland soil protection”- Details

Joint Project: Biomethane and peat substitute from poplar wood – Acronym: PapiGas2

- Subproject 1: Implementation and assessment of the anaerobic digestion tests;
- Subproject 2: Analysis of microbial communities in anaerobic digestion

Address Subproject 1	DBFZ Deutsches Biomasseforschungszentrum gemeinnützige GmbH Torgauer Str. 116 04347 Leipzig
Subproject 2	Helmholtz-Zentrum für Umweltforschung GmbH - UFZ – Research Unit Environmental Technology - Department of Environmental Microbiology
Contact (Coordinator)	Dr. Britt Schumacher Tel.: +49 341 2434-540 → Write E-Mail
Project ID	2221MT017A-B
Start	01.12.2021
End	30.11.2023
Work description	Poplar wood from short rotation plantations can be used as a renewable raw material for the production of renewable energies, e.g. for decentralized heat supply. However, the use of wood heating systems in urban areas faces many challenges, such as the space required for heating systems and fuel storage. The use of poplar wood for biomethane production via the biogas process within the framework of this project is an innovative approach to the energetic use. The degree of innovation is further increased by the combination with the material use of the wood fibre fraction as a peat substitute after separation of the digestate. The biogas process can be understood as an upstream conditioning step for the material use, which provides energy and exploits (with appropriate substrate conservation) the wood's potential of volatile substances too. The project PapiGas2 is based on the feasibility study of PapiGas.

Biomethane and peat substitute from poplar wood – Acronym: PapiGas

Address	DBFZ Deutsches Biomasseforschungszentrum gemeinnützige GmbH Torgauer Str. 116 04347 Leipzig
Contact	Dr. Britt Schumacher Tel.: +49 341 2434-540 → Write E-Mail
Project ID	22038318
Start	01.04.2019
End	30.06.2021
Work description	<p>Poplar wood from short rotation plantations (SRP) can be used as a renewable raw material for the production of renewable energies, e.g. for decentralized heat supply. However, the use of climate-friendly wood heating systems in urban areas faces many challenges, such as the space required for heating systems and fuel storage. The use of poplar wood for biomethane production via the biogas process within the framework of this project is an innovative approach to the energetic use. The degree of innovation is further increased by the combination with the material use of the wood fibre fraction as a peat substitute after separation of the fermentation residues. The biogas process can be understood as an upstream conditioning step for the material use, which provides energy and exploits (with appropriate substrate conservation) the wood's potential of volatile substances too. The following tasks were investigated: (1) identification of parameters for the optimal fiber length for dual function disintegration of poplar wood from SRP to gain biogas and peat substitute, (2) development of a process for a continuous stable and productive biogas (biomethane) digestion of poplar fibers in lab-scale, (3) development and assessment of horticultural utilization concepts for the solid fibrous fraction of the digestate (test as peat substitute) in full-scale and theoretical considerations about use options for the liquid fraction of the digestate as well as (4) economic and ecological assessment of the general concept (estimation).</p>

Joint Project: Harvesting and use of cattail biomass as an alternative raw material in growing media for vegetable cultivation – Acronym: Typha Substrat

- Subproject 1: Coordination and knowledge transfer; site-specific quality and productivity, optimal harvest and storage period for cattail; horticultural tests with cattail-containing growing media;
- Subproject 2: Development, design, testing, and demonstrating an effective solution for harvesting cattail by using machinery with low soil-pressure;
- Subproject 3: Development of a peat reduced blocking substrate

Address Subproject 1	Universität Greifswald - Faculty of Mathematics and Natural Sciences - Biology - Institute of Botany and Landscape Ecology Soldmannstr. 15 17489 Greifswald
Subproject 2	Wellink GmbH
Subproject 3	Forschungsring für Biologisch-Dynamische Wirtschaftsweise - Institut für Biologisch-Dynamische Forschung Darmstadt/Bad Vilbel
Contact (Coordinator)	Dr. John Couwenberg Tel.: +49 3834 420-4177 → Write E-Mail
Project ID	2220MT003A-C
Start	01.11.2021
End	31.10.2024
Work description	<p>The use of fossil peat for substrates in commercial horticulture contributes substantially to global warming (CO₂ emissions), leads to loss of biodiversity and other peatland ecosystem services, and to the loss of arable land. At the same time, conventional drainage-based peatland management contributes to enormous greenhouse gas emissions. By implementing paludiculture, emissions can be reduced considerably, further degradation of the peat body can be stopped and a significant contribution to climate protection can be made. TyphaSubstrat therefore combines the potential of Cattail cultivation in paludiculture with its use as a raw material in growing media for vegetable cultivation (alternative to peat). Cattail can be cultivated sustainably on rewetted, degraded fen peatland with a wide range of benefits and has the potential to ensure the long-term supply of a renewable raw material of consistently high quality for the substrate industry. The objectives of TyphaSubstrat are to assess the quality (structure, nutrients and pollutants) and productivity of Cattail from different locations, to develop a technique for large-scale biomass harvesting, to identify harvesting or storage times, to develop Cattail pressed pots and to test them in horticultural applications.</p> <p>Subproject 1: The subproject 1 includes the coordination, scientific support and knowledge transfer within the whole project, the support of horticultural tests for Cattail pressed pots, as well as the investigation of the quality and productivity of Cattail raw material depending on the location, harvest time and the identification of suitable storage times for Cattail biomass.</p> <p>Subproject 2: Development of a suitable, effective and soil-conserving concept for harvesting and processing into bales and/or chaffing of cattail, including salvage and removal.</p>

Subproject 3: In subproject 3 peat reduced blocking substrate for cultivation substrates for vegetables will be developed. For this suitable alternatives to peat (cattail, wood fibre, sphagnum) have to be identified and modified (by cutting, fiberizing, fermentation etc.) to optimize the property of substrate. Developed blocking substrates will be analysed on physical and chemical parameters and tested with cress test and primary cultivation tests, unless they will be proofed practically in AP 1. The storage stability of final substrates will be tested, too.

Joint Project: Development and evaluation of peat-reduced horticultural production systems - Acronym: ToPGa

- Subproject 1: Project-coordination and useful and harmful organisms;
- Subproject 2: Microbiology and human pathogens;
- Subproject 3: Mixing effects display and app programming;
- Subproject 4: Novel peat alternatives - Investigation and evaluation of growing media components;
- Subproject 5: Novel peat alternatives - Suitability of peat substitutes in tree nurseries and fruit cultivation and optimization of the method for assessing the N-balance in peat-reduced substrates;
- Subproject 6: Novel peat alternatives - Practical suitability for deciduous woody plants and roses;
- Subproject 7: Novel peat alternatives - Fiber nettle as peat substitute;
- Subproject 8: Downsizing press pots to reduce peat use in field vegetable production;
- Subproject 9: Economic evaluation and Life cycle assessment

Address Subproject 1:	Julius Kühn-Institut Federal Research Centre for Cultivated Plants (JKI) - Institute for Plant Protection in Horticulture and Urban Green Messeweg 11/12 38104 Braunschweig
Subproject 2:	Julius Kühn-Institut Federal Research Centre for Cultivated Plants (JKI) – Institute for Epidemiology and Pathogen Diagnostics
Subproject 3:	Leibniz Institute of Vegetable and Ornamental Crops Großbeeren/Erfurt e.V. (IGZ)
Subproject 4:	Leibniz Universität Hannover - Faculty of Natural Sciences - Institute of Soil Science
Subproject 5:	Landwirtschaftskammer Niedersachsen - Abt. Gartenbau
Subproject 6:	Landwirtschaftskammer Schleswig-Holstein - Abt. Gartenbau
Subproject 7:	Julius Kühn- Institut Federal Research Centre for Cultivated Plants (JKI) – Institute for Crop and Soil Science
Subproject 8:	Landesforschungsanstalt für Landwirtschaft und Fischerei Mecklenburg-Vorpommern - Gartenbaukompetenzzentrum
Subproject 9:	Johann Heinrich von Thünen-Institut - Federal Research Institute for Rural Areas, Forestry and Fisheries – Institute of Farm Economics
Contact (Coordinator)	Dr. Ute Vogler Tel.: +49 531 299-4400 → Write E-Mail
Project ID	2220MT006A-I
Start	01.11.2021
End	31.10.2024

Work description The horticultural sectors need professional solutions in order to master the ecologically necessary changeover to peat-reduced substrates. The focus of the proposed project is to investigate and evaluate the effects of using peat-reduced substrates as holistically as possible. The incorporation of organic peat substitutes in substrates does not only involve chemical and physical changes. The incorporated substances also significantly influence the composition and function of biological processes in the substrate. Only with the help of such a comprehensive assessment can recommendations be given to the practice for a changeover to peat-reduced substrates. The necessity of interdisciplinary studies results from the multiple interactions between individual problem areas, which are to be worked on in subprojects in this joint project. In the project proposed, researchers from different disciplines are working together with the aim of Addressing the various problem areas of the use of peat-reduced substrates and developing interdisciplinary, mutually reinforcing solution approaches in a mutual exchange of information in order to contribute to the necessary reduction of peat use. One part of the consortium will deal with the development of production systems and the effects of the use of peat-reduced substrates. Interactions of defined substrates and peat substitutes in horticultural crops will be investigated in order to solve hitherto unexplained interrelations and thus contribute to practical solutions in the use of substrates based on peat substitutes in horticultural crops. Another part of the consortium is concerned with the evaluation of production systems with regard to their economic, ecological and social influences. Thus, the different subprojects complement each other and form a network of complementary expertise and competences.

Subproject 1: Subproject 1 is coordinating the nine ToPGa subprojects. This includes consolidating progress reports, organizing regular meetings of the project members and the advisory board as well as public relations work.

Furthermore, subproject 1 is evaluating peat substitutes and production systems adapted to peat-reduced growing media from a plant protection perspective. The aim is to identify key influencing factors to promote biological and integrated pest management. The mycological part of this sub-project analyses the pre-contamination and the survival time of pathogens in peat-reduced substrates as well as infections of plants by pathogenic and beneficial organisms. The entomological part of this sub-project investigates interactions between peat-reduced growing media and pest insects regarding choice preferences, pre-contamination and biological control of pest insects.

Subproject 2: Subproject 2 aims to identify how different peat substitutes (e.g. solid residues from biogas plants) influence the microbial communities in the resulting peat-reduced substrate as well as their impact on the plant microbiome. Further, it assesses potential pre-contaminations of peat substitutes with human pathogens and the presence of antibiotic resistance genes (ARGs). The persistence of human pathogenic bacteria in different peat-reduced substrate-mixtures and their influence on present microbial communities is assessed in inoculation assays. The results will reveal potential risks of applications of peat substitutes for human health.

Subproject 3: The preparation of multi-component mixtures from the already known starting materials is a considerable challenge in terms of analysis effort and laboratory capacity. To make recommendations for peat-reduced mixtures, a systematic model approach is to be developed using effective experimental design methods (e.g. orthogonal arrays), which allow predictions of the physical and chemical properties of peat substitutes in mixtures. Special attention will be paid to the use of solid fermentation residues from biogas production and the fibre nettle. Based on the results, a model for the creation of mixtures will be developed and a web application for the prediction of mixture properties will be created.

Subproject 4: In this subproject, the new potential growing media components fibre nettle and solid digestates from biogas production are systematically examined for their suitability for plant cultivation in a test procedure adapted for this purpose. Besides material and substrate analytical investigations, plant trials are carried out in experimental stations and under practical conditions in companies of various horticultural sectors.

Subproject 5: Subproject 5 is divided into three work packages. Firstly, the aim is to screen locally available solid biogas digestates and determine whether they are feasible as a peat substitute for evergreen shrubs and conifers. The second work package aims at optimizing peat-reduced cultivation for berries. A new, innovative cultivation method will be evaluated focusing on the growing media composition to provide the required structural stability. The third work package focuses on the challenges of determining the stability of the nitrogen balance in peat-reduced or peat-free substrates. Based on a literature study, new approaches are being developed to optimize the national method in its reliability and reproducibility when assessing potential nitrogen release or immobilization.

Subproject 6: The goal of subproject 6 is to evaluate novel potential peat substitutes and to adapt and optimize a test procedure covering different criteria for the composition of growing media. In this subproject, the suitability of solid fermentation residues from biogas plants is assessed for deciduous woody plants and roses.

Subproject 7: The aim of the project is to investigate and evaluate the fibre nettle as a potential regional peat substitute. The sustainable cultivation as well as yield and quality of biomass of three fibre nettle clones are compared. Nitrogen fertilization trials will reveal the impact of N fertilization on the C:N ratio in the harvested crop and whether N immobilization in the resulting growing media is thereby reduced. Qualitative changes of the harvest material, and resulting growing medium, due to storage, composting and ensiling are investigated. A potential analysis of fibre nettle cultivation in Germany is carried out with regard to cultivation area conditions and requirements.

Subproject 8: The goal of the subproject is to contribute to the reduction of peat use in field vegetable production by downsizing press pots to a practical minimum. An initial vegetable transplant producer's survey will enlighten the status-quo of peat use in general as well as crop- and season-specific peat pot dimensions in particular. Different sets of field experiments with lettuce (*Lactuca sativa* var. *capitata*) as model crop will provide data for the agronomic and technical evaluation of volume-reduced press pots.

Subproject 9: Subproject 9 has two main objectives namely “Economic production system analysis” and “Life cycle analysis of the production system”. The economic analysis evaluates the effect of peat reduction at the producer's level by comparing the peat-reduced production system to the currently used typical production system of selected horticultural crops. The life cycle analysis assesses the environmental impact of peat reduction in horticultural operations through a comparison between peat-reduced and today's typical production systems. Both evaluation approaches are carried out in an integrated manner, allowing for a superordinate interpretation of the results.

Joint Project: Plant damages in organic production of potted herbs – Acronym: Biotopfkräuter

- Subproject 1: Analysis of causes and development of counteractive measures and avoidance strategies;
- Subproject 2: Identification of causal agents and development of analytical methods for quality assurance of growing media

Address Subproject 1:	University of Applied Sciences Weihenstephan-Triesdorf - Centre for Research and Continuing Education – Institute of Horticulture – Department Plant Nutrition Am Staudengarten 14 85354 Freising
Subproject 2:	Julius Kühn-Institut Federal Research Centre for Cultivated Plants (JKI) – Institute for Ecological Chemistry, Plant Analysis and Stored Product Protection
Contact (Coordinator)	Dr. Dieter Lohr Tel.: +49 8161 71-3349 → Write E-Mail
Project ID	2220MT007A-B
Start	01.10.2021
End	30.09.2024
Work description	<p>During the last two decades, German growers continuously extended the acreage of potted herbs. Already one third of them is cultivated according to the EU regulations on organic farming and guidelines of organic certification bodies, respectively. However, in the last years there was a growing number of reports on inhibition of germination, chlorotic or necrotic cotyledons and reduced further growth. These damages seem to be associated with the growing medium and the fertilizer, and most cases have one thing in common: high amounts of ammonium in the growing medium. However, the ammonium itself cannot be the trigger of the damages, but it seems to be an indicator for a complex cause, which probably is linked to microbial processes in the growing medium. For growers as well as for manufactures of peat reduced growing media the uncertainty about the exact cause of the problem bear a high risk and deter growers from the shift from conventional to organic production. To avoid complaints growing media manufactures limit the percentage of peat substitutes to the minimum demanded by legislation and guidelines. The main goals of the research project are: (a) the identification of the root of the problem, and based on this (b) the development of methods and the specification of guideline values for quality control of growing media as well as (c) the evaluation of mitigation strategies, which prevent plant damages at all, or at least reduce them, if the growing medium already contains risky components.</p> <p>Subproject 1: In the first phase, the HSWT systematically screens growing media for their phytotoxic properties. While some of these growing media are prepared at HSWT from different components and are subsequently stored under various conditions (e.g. moisture, temperature, air seal), other growing media are provided by manufacturers. In total, 50 growing media are selected for microbiome analysis at JKI. In the second phase, the HSWT aims to validate the phytotoxic effects microorganism and their potential metabolites, which were identified as potentially harmful by JKI in the first phase. In the last phase, the HSWT and the Klasmann-Deilmann GmbH will conceptualize mitigation strategies of plant damages and develop methods and guidelines which should be incorporated in the RAL-quality assurance. This is done in close cooperation with the JKI.</p>

Subproject 2: Samples of the growing media from subproject I will be send to JKI. After the extraction of fungal and bacterial DNA from growing media, the microbiome of the different growing media is deciphered by sequencing taxonomically informative loci of bacteria and fungi. Following bioinformatic processing, the obtained microbiome data will be merged with the data from the trials at HSWT to infer biological information regarding the role of the microbiome in the phytotoxic potential of growing media. In the second phase, the JKI supports the validation trials at HSWT (e.g. the incubation of non-phytotoxic growing media with the suspected causal agents). In the last part of the project, the JKI evaluates how the generated knowledge regarding the microbiome of growing media and its impact on plant health can be used for quality assurance and avoidance of plant damages by growers and growing medium manufacturers.

Joint Project: Development of peat-free casing soils for mushrooms and other cultivated fungi – Acronym: MykoDeck

- Subproject 1: Development of production processes for peat substitutes, selection of suitable biogenic residues and analytical support;
- Subproject 2: Development and production of peat substitutes for casing soils;
- Subproject 3: Development of different recipes for the casing soil variants and laboratory cultivation tests

Address Subproject 1:	Fraunhofer Institute for Ceramic Technologies and Systems (IKTS) Maria-Reiche-Str. 2 01109 Dresden
Subproject 2:	LAV Technische Dienste GmbH & Co. KG
Subproject 3:	Institut für Holztechnologie Dresden gemeinnützige GmbH
Contact (Coordinator)	Marc Lincke Tel.: +49 351 2553-7766 → Write E-Mail
Project ID	2220MT005A-C
Start	01.08.2021
End	31.07.2024
Work description	<p>Cultivated mushrooms are a highly appreciated part of human nutrition. Over the past decades, a growing interest from medical science and biotechnology can be recognised. Between 2014 and 2019, the global market for cultivated mushrooms showed an average growth rate of 9,5%. Today, the German mushroom production alone offers a market for 270,000 t of substrates and 50,000 t of cover materials made out of peat. MykoDeck aims to fully unlock the economic and ecologic potential of casing soils in commercial mushroom production by the development of peat-free casing soils. Main focus of the project is to explore the potential of residual materials (e.g. hemp shives, xylite, spend mushroom substrate) as well as the efficient use of underused raw materials (e.g. green wastes, waste wood) as they are considered to enable a sustainable and ecological viable mushroom production based on local supplies. To ensure equal or superior chemical, physical, and biological functionalities of the peat-free cover soils to be developed, deep investigation on manufacturing processes as well as conversion processes during the growth cycles in mushroom production will be of particular interest for development, benchmarking, and market entry.</p> <p>Subproject 1: In subproject 1, the selection and physical characterization (water storage, gas exchange, particle size distribution, pore volume, nutrient availability) of possible source materials and cover soils is carried out. Another focus lies on the targeted mixing of additives (mineral components and organic nutrients) in order to be able to specifically adjust the desired properties of the peat substitutes. Based on the evaluation of the defined guiding parameters, the development and testing of processes and methods for the targeted conversion of selected substrates and substrate mixtures is performed. A combination of pulping, homogenization and composting is currently regarded as the favoured process.</p>

Subproject 2: Based on a screening of potential groups of substances, the development and testing of mechanical and biological processes for the targeted conversion of the selected substrates is carried out together with subproject 2. A composting process (temperatures above 70 °C) is used to microbiologically break down and disinfect the substrate, so that all foreign pathogens are killed.

Subproject 3: The main goal of subproject 3 is the development of different recipes for the casing soil variants and laboratory cultivation tests.

Joint Project: From tree to peat substitute - Analysis and Optimization of the proceeding of wood fibre – Acronym: Holzfaserstoff

- Subproject 1: Wood fibre production;
- Subproject 2: Testing and assessment of the suitability for plant cultivation

Address Subproject 1:	Technical - department of Research, Development and Transfer Hochschulstr. 1 83024 Rosenheim
Subproject 2:	University of Applied Sciences Weihenstephan-Triesdorf - Zentrum für Forschung und Weiterbildung - Institut für Gartenbau
Contact (Coordinator)	Prof. Dr. Andreas Michanickl Tel.: +49 8031 805-2366 → Write E-Mail
Project ID	2220MT004A-B
Start	01.07.2021
End	30.06.2024
Work description	<p>The main goal of the research project is a better understanding of wood fibre processing as a whole and effects of each single step on the quality of the final product. Therefore, the entire production process starting with the possible wood resources, over chopping and defibration, up to the ready to use growing media is systematically analysed. The effect of the single production steps on chemical, biological and chemical properties of the wood fibres is analysed and their suitability as growing media constituent is evaluated in scientific and practical trials, respectively. Rosenheim Technical University of Applied Sciences (THRO) and Weihenstephan-Triesdorf University of Applied Sciences (HSWT) do the interdisciplinary project in close cooperation with Klasmann-Deilmann GmbH, the leading global growing media manufacturer. THRO contributes their sound knowledge in wood fibre processing techniques for diverse applications, HSWT assesses the suitability of the wood fibres as peat substitute and Klasmann-Deilmann support the work with their long-lasting experience in production of wood fibre and their use as growing media constituent. This interdisciplinary approach opens new possibilities for the optimization of the entire process chain with the final aim of a wood fibre with a minimized or at least predictable nitrogen immobilization.</p> <p>Subproject 1: The subproject I is divided in two main work packages:</p> <ul style="list-style-type: none"> ▪ WP A: Raw material procurement and pre-processing ▪ WP B: Defibration by extruder and refiner technology <p>At the beginning, various stocks of wood (spruce with and without bark beetle infestation), pine, beech as well as wood from short-rotation plantations) are procured and chopped (WP A). Hereinafter, the chopped wood material is defibred at well defined conditions by extruder and refiner technology, respectively (WP B). During both processing steps – chopping and defibration – process parameters (e.g. temperature of the material, energy consumption, and throughput) are recorded. Additionally, the effect of a thermal pre-treatment of the wood and a thermal post-treatment of the defibred material is tested. All produced wood fibres are characterized for their chemical, biological and physical properties in detail and forwarded to subproject II, where their suitability as growing medium constituent is evaluated. Based on the findings the process parameters are optimized continuously. At the end, all results from both subprojects are merged and assessed in relation to agronomic, technological</p>

and economic aspects. Furthermore, guidelines for wood and technology specific processing of wood fibres are developed.

Subproject 2: In the first part of subproject II new approaches to assess the stability of the N balance are tested, as the incubation test, which is currently used, is quite time and labor consuming and is only of limited usefulness. Thereby, in addition to nitrogen stability also analysis of carbon stability should be addressed. Subsequent all wood fibres from subproject I are assessed for stability of the N balance using the newly developed approach and their suitability for plant cultivation is tested. The results are feed back to subproject I for the optimization of the processing. In the beginning, suitability for plant cultivation of quite a big number of wood fibres is tested in small-scale plant response tests, but with progressive project progress the number of wood fibres decreases and the intensity of the trials increases up to field trials in cooperation with horticultural companies. At the end, all results from both subprojects are merged and assessed in relation to agronomic, technological and economic aspects. Furthermore, guidelines for wood and technology specific processing of wood fibres are developed.

Joint Project: Sustainable growing media based on domestic wood resources –

Acronym: NakuHo

- Subproject 1: Development of test methods and evaluation of substrates;
- Subproject 2: Thermal treatment of lignocelluloses for use as growing media

Address Subproject 1:	University of Applied Sciences Osnabrück - Faculty of Agricultural Sciences and Landscape Architecture Oldenburger Landstr. 24 49090 Osnabrück
Subproject 2:	University of Göttingen Faculty of Forest Sciences and Forest Ecology; Wood Biology and Wood Products
Contact (Coordinator)	Prof. Dr. Diemo Daum Tel.: +49 541 969-5030 → Write E-Mail
Project ID	2220MT001A-B
Start	01.04.2021
End	31.03.2024
Work description	<p>The research project intends to develop a new approach for the increased use of regional wood raw materials to produce horticultural growing media. The aim is to modify wood fibres by means of a thermal or thermo-hydrolytic process to increase their stability towards microbial conversion. This is expected to inhibit the immobilization of nitrogen (N), which has previously made the N-dynamics in wood-based growing media hard to predict. During the modification process, as little wood substance as possible should be lost (high yield) and potential by-products should be utilizable as valuable resources. The project aims to develop an energy- and cost-efficient process that also allows tapping new sources of raw materials, such as deciduous trees from short rotation plantations or waste from fibreboard and particleboard production. Thus, it will contribute to securing the supply and reducing the costs of raw materials in the production of peat-reduced substrates. In addition to the process and product development, the project will refine methodological approaches for a reliable assessment of biological, chemical, and physical properties of wood fibres and optimize irrigation control for substrates rich in wood fibres. The thermally stabilized wood fibres are supposed to be free of growth-inhibiting substances and they should make up a proportion of about 50 % (v/v) in the substrates. Consequently, the use of peat as a substrate raw material may be significantly reduced or completely avoided if other organic materials such as compost are added. The new wood fibre substrates are expected to be suitable for growing a wide range of pot and container crops.</p> <p>Subproject 1: At the Osnabrück University of Applied Sciences, the suitability of thermally and thermohydrolytically modified wood fibres for plant cultivation is investigated. A three-stage test procedure (incubation test, seedling tests and vegetation trials) is used for this purpose. In addition, methodological approaches for the characterization and evaluation of wood fibres are to be further developed. The focus is on methods for estimating N immobilization, modelling physical substrate properties and adaptation strategies for irrigation of wood fibre based growing media. Furthermore, ecological and economic aspects associated with the implementation of the new process technology in industrial substrate production will be evaluated.</p>

Subproject 2: The department Wood Biology and Wood Products of the University of Göttingen is developing and optimizing a process that increases the stability of wood fibres towards microbial decomposition. The process focuses on the thermal modification of wood fibres, partly in presence of mineral acids as hydrolysing agents. The influence of different process parameters on the properties of the treated fibres is investigated and based on the results, promising approaches are continuously optimized. The process will first be developed for residues from softwood processing and then transferred to other lignocellulosic raw material sources. Furthermore, analytical methods are conducted to detect changes in fibre morphology and wood polymer content. The sorption behaviour of the fibres and the content of easily accessible sugars are also assessed.

Joint Project: Use of hardwoods and woods from short rotation plantations as peat substitute for the development of plant substrates, grow bags and grow blocks –

Acronym: GrowBags-GrowBlocks

- Subproject 1: Planting trials and development of grow bags and grow blocks;
- Subproject 2: Decomposition of hardwoods with a short rotation period and wood from SRP for the development of plant substrates, grow bags and grow blocks

Address Subproject 1:	Georg-August-Universität Göttingen - Faculty of Forest Sciences and Forest Ecology - Büsgen-Institut - Section Molecular Wood Biotechnology and Technical Mycology Büsgenweg 2 37077 Göttingen
Subproject 2:	Kleeschulte Erden GmbH & Co. KG
Contact (Coordinator)	Prof. Dr. Kharazipour Tel.: +49 551 39-33488 → Write E-Mail
Project ID	22002118 (Subproject 1), 22027718 (Subproject 2)
Start	01.03.2019
End	28.02.2022
Work description	<p>Wood fibers as peat substitutes are an interesting alternative to the increasingly limited availability of peat, as they are available in certain annual quotas with sustainable forest management in practically unlimited quantities. The aim of this research project is to take account of the conversion of forestry and the preservation of peatland landscapes. For this purpose, plant substrates and substrate components for potting soil, as well as grow bags and grow blocks for vegetable production in greenhouses, are to be developed from hardwoods and evaluated under practical conditions in planting trials.</p> <p>Subproject 1: „Practical planting trials with substrates, grow bags and grow blocks made of hardwood fibers and development of protein-bound grow blocks (University of Göttingen)“</p> <p>Subproject 2: „Digestion of hardwoods with low rotation time and woods from short rotation plantations (SRP) for the development of planting substrates, grow-bags and grow-blocks (Kleeschulte Erden GmbH & Co. KG)“</p>

Production of wood fibres with special consideration of rotten spruce wood as a peat substitute through thermohydrolytic treatment - commissioning and optimization of a model plant – Acronym: Funktionsmusteranlage Torfersatz

Address	Kleeschulte Erden GmbH & Co. KG 59602 Rùthen Briloner Str. 14
Contact	Dr. agr. Wilfred Vrochte Tel.: +49 2952 9726 21 → Write E-Mail
Project ID	22023306
Start	01.07.2007
End	30.06.2009
Work description	The object of the project is the installation and optimization of a continuously operating functional pilot plant for the use of red rotten wood fibre as a horticultural substrate. The wood fibre must meet the criteria required for a RAL quality-assured wood fibre. Wood fibres as peat substitutes have the potential to reduce the natural and environmental damage caused by massive peat extraction in many countries. The energy required for fibre production of red rotten wood is significantly lower than for unaffected wood. Investigations were carried out on the following topics: analysis and optimization of substrate and potting soil mixtures with red rotten wood fibres, the fungal growth of wood fibres in storage and/or fungal growth of substrates with wood fibres, the influence of storage of wood fibres, its properties, the optimization of the transport suitability of wood fibres, nitrogen fixation, the proof of the different digestion influences on wood fibre by SEM images, on the nutrient supply by NPK fertilizers in the substrate.

Investigations of spruce wood biotechnologically degraded by the red rot fungus *Heterobasidion annosum* in vivo with the aim of value-adding utilization – Acronym: Rotfäulepilz / Fichtenholz

Address	Georg-August-Universität Göttingen - Faculty of Forest Sciences and Forest Ecology - Büsgen-Institut - Department of Forest Botany and Tree Physiology Büsgenweg 2 37077 Göttingen
Contact	Prof. Dr. Andrea Polle Tel.: +49 551 393482 → Write E-Mail
Project ID	22010403
Start	01.07.2004
End	30.09.2007
Work description	<p>The focus lied on the use of red-rotted wood for the manufacture of higher value-added products. The aim was to investigate to what extent the use of in vivo biotechnologically transformed wood can enable significant energy savings during pulping and a reduction in binding agents in the manufacture of wood-based panels.</p> <p>In addition, the following has been examined:</p> <ul style="list-style-type: none"> - The possibility of using red-rotted spruce wood as a raw material for the production of high quality substrates, which can serve as a peat substitution. - Characterization of the produced fibrous materials and wood chips (defibration of the wood in a refiner and chipping of the wood in a knife ring flaker). - Production, process engineering and practical investigations of the produced wood-based panels. - Implementation of the manufacturing processes from pilot to industrial scale. - Material testing and product analysis - Refining of red-rotted spruce wood as a plant substrate - The energy requirement for the defibration of the wood transformed by the white rot fungus should be significantly lower when defibrating in the refiner than when using unaffected wood.

Sphagnum

Development of an integrated overall process for cultivating sphagnum – Acronym: GesaSpAn

Address	mera Rabeler GmbH & Co. KG Lindenstr. 3 21435 Stelle
Contact	Christian Wentzien Tel.: +49 4174 5909369 → Write E-Mail
Project ID	2220MT002X
Start	01.03.2021
End	28.02.2023
Work description	Peat moss is among the best alternatives for peat in soil and substrates, as its chemical and physical properties are most similar to peat. It can be grown on agricultural raised bog areas. The necessary waterlogging of the sites significantly reduces the emission of climate-relevant gases from these soils. A weak point in the previous cultivation method is the application of the planting material to the cultivated areas. In addition, a full harvest with immediate re-application of the capitula (heads) of the peat moss might be the most effective type of harvest with further cultivation. For these two work steps, which are crucial in the overall process of peat moss cultivation, there are currently no adapted techniques. As part of the project, a technology is being developed for the uniformly dosed application of the propagation material, which is connected to a sphagnum harvesting vehicle currently under development. In the future, all essential processing steps can be carried out with a vehicle that is very gentle on the soil and culture. Furthermore, with the new components the probably most effective type of sphagnum cultivation is possible: During a harvest, the uppermost heads of the mosses are distributed over the area as seedlings. An alternative crop removal is also part of the project. For these tasks, already established Sphagnum cultivation areas in the Hankhauser Moor near Rastede are to be optimized and cared for, harvested and replanted for the experiments. Finally, the developed and successfully tested technical components of the overall process are brought to prototype maturity. They are optimized and sustainably documented with the help of various CAX techniques.

Multi-Layer-Production and standardization of physikochemical properties of Sphagnum biomass for developing Sphagnum based growing media – Acronym: EVA-BioKULT

Address	Humboldt-Universität zu Berlin - Faculty of Life Sciences - Thaer-Institute of Agricultural and Horticultural Sciences Invalidenstr. 42 10115 Berlin
Contact	Prof. Dr. Dr. Christian Ulrichs Tel.: +49 30 2093-46422 → Write E-Mail
Project ID	2220NR072X
Start	01.08.2020
End	31.07.2023
Work description	<p>The present project Addresses the production and use of Sphagnum biomass for growing media. The cultivation is to be implemented in a multi-layer system, a so-called MLSM (= Multi Layer Sphagnum Matrix). Within this system, Sphagnum species will be tested that have a high potential for good yield generation. Cultivation in several layers, adapted to the special physiology of Sphagnum, is expected to significantly improve the yield per area unit and profitability. The applicability of Sphagnum biomass has already been successfully demonstrated in numerous trials. Problems have been observed in individual cases. Initial investigations indicate a connection with the content of certain secondary metabolites from the group of phenolic acids. Plant assays will be used to test the effect of aqueous extracts of sphagnum biomass and single substances on plant growth. Based on these data, treshold values of plant-damaging contents will be derived. In addition to these biological parameters, physical properties of the Sphagnum species will also be investigated. This includes in particular the water capacity and the bulk density of the material. Here too, ranges of values for high-quality Sphagnum biomass are to be determined. Finally, the data obtained in the project will be used to carry out an economic analysis of the developed production process. The project forms an important basis for decisions on the further implementation of Sphagnum biomass as a raw material for horticultural growing media in Germany. Thus, the project significantly supports the goals of the German government's peat reduction strategy and the related efforts to make the production of growing media sustainable.</p>

Joint Project: Yield increase and upscaling of production and application of founder material as an initial for the cultivation of renewable Sphagnum biomass in paludiculture – Acronym: MOOSstart

- **Subproject 1: Increasing Sphagnum productivity at provenance and species level through field tests;**
- **Subproject 2: Increasing Sphagnum productivity at the molecular level;**
- **Subproject 3: development of a cost-effective bioreactor and economic evaluation;**
- **Subproject 4: Practical test of the low-cost bioreactor and spreading of Sphagnum founder material in the field**

Address Subproject 1	Universität Greifswald - Institute of Botany and Landscape Ecology Soldmannstr. 15 17489 Greifswald
Subproject 2	University of Freiburg – faculty of biology – Institute of biology II – plant biotechnology
Subproject 3	University of Applied Sciences Anhalt
Subproject 3	Niedersächsische Rasenkulturen NIRA GmbH & Co. KG
Contact (Coordinator)	Dr. Greta Gaudig Tel: +49 3834 420-4692 → Write E-Mail
Project ID	2221MT020A-D
Start	01.01.2023
End	31.12.2025
Work description	Sphagnum (peat moss) paludiculture offers the unique opportunity to reduce CO ₂ emissions from peat soils to zero through rewetting, stopping the use of fossil peat while ensuring the availability of high quality substrate raw materials for commercial horticulture. The first part in the production chain of peat moss cultivation is the production of founder material. In the previous project MOOSzucht, a method for axenic propagation of vegetative starting material in bioreactors was developed - a technological breakthrough. In the planned joint project MOOSsaat, the production process is to be established so that it can subsequently be commercialised. For this purpose, the development of a low-cost bioreactor is planned on the basis of previous experience. In the future, the production of founder material can take place decentrally in regions that are suitable for Sphagnum paludiculture (especially the bog areas of NW-DE and the foothills of the Alps). For this reason, the MOOSsaat joint project plans to set up a first low-cost bioreactor in a potential production facility in Lower Saxony and to carry out an initial test run here. Since the structure of the founder material produced in the bioreactor differs significantly from the chopped peat mosses used so far, an adaptation or new development of an application technique is necessary. Harvest yields are important for the profitability of Sphagnum paludiculture. Therefore, peat moss productivity is another focus of the planned project, which is to be increased or validated with proven and novel approaches. The intended project results should contribute to the transformation towards climate-neutral peatland use and substrate management and thus strengthen Germany's pioneering role with regard to Sphagnum paludiculture and the production of substrates.

Subproject 1: To increase the efficiency of bioreactors, transcriptome-based process analysis are used to analyse plant responses in the 5 L bubble column reactor to culture conditions and interventions in order to optimise culture management, harvest timing and to maximise the number of innovations. Simple measurement criteria for optimising growth conditions in decentralised low-cost bioreactors will be developed.

Subproject 2: The production of the inoculum is optimised in the 20 L bubble column reactor, and a low-cost bioreactor is being developed, tested and adapted to practice.

Subproject 3: The aim of the sub-project is the development of a cost-effective bioreactor that is suitable for the sustainable production of peat moss seeds under outdoor conditions on high moor areas. Based on previous knowledge of various reactor concepts from the laboratory scale, various pneumatically operated submersed reactor concepts are to be realized on a technical scale and subsequently characterized and compared with each other in terms of procedural characteristics and moss productivity. A high biomass productivity, a low energy input and the resulting morphology of the moss were defined as target criteria. As part of the up-scaling, culture volumes of 25...42 L per reactor unit are to be realized and the full use of the bioreactor volume will be assured by biomass retention set-ups. During cultivation, the kinetic description of the process variables (pH), important nutrient components (NO₃⁻ and NH₄⁺), the pigment content of the biomass (chlorophyll and carotenoids) and morphological criteria (number of innovations) should enable the establishment of an efficient production process for *Sphagnum* spp.. The focus of the bioreactor development is the combination of inexpensive materials, robust sensor technology and continuous operation in order to be able to convert an already established laboratory based, axenic process to a non-axenic production process in the field. This is to be proven in a bioreactor rated as effective in field trials at the project partner NIRA. The result of the sub-project should be a cost-effective bioreactor that will enable the effective, vegetative propagation of *Sphagnum* spp. in an optimized production process and which can produce peat moss seeds in relevant scales through Numbering Up.

Subproject 4: Practical test of the low-cost bioreactor and spreading of *Sphagnum* founder material in the field in Lower Saxony.

Highly productive peat moss in Sphagnum farming for sustainable supply with renewable raw material for horticultural growing media – Acronym: MOOSzucht

- Subproject 1: selection of highly productive provenances, propagation in the greenhouse, field test of selected, bred and mass propagated peatmosses;
- Subproject 2: Establishment of in vitro cultivation with sterile conditions and increased productivity through Smart Sphagnum Breeding;
- Subproject 3: Process optimization for growth of peatmoss in labscale, development and construction of a tricklebed-reactor for large scale mass production;
- Subproject 4: Developing peat-moss-culture as an in-house-culture and on-field-culture by optimizing the irrigation, illumination and fertilizing

Address Subproject 1	Universität Greifswald - Faculty of Mathematics and Natural Sciences - Biology - Institute of Botany and Landscape Ecology - Working group Peatland Studies and Palaeoecology Soldmannstr. 15 17489 Greifswald
Address Subproject 2	Albert-Ludwigs-Universität Freiburg - Faculty of Biology - Institute of Biology II
Address Subproject 3	Karlsruher Institut für Technologie (KIT) - Institute of Process Engineering in Life Sciences - Department III: Bioprocess Engineering
Address Subproject 4	Niedersächsische Rasenkulturen NIRA GmbH & Co. KG
Contact (Coordinator)	Prof. Dr. Dr. h. c. Hans Joosten Tel.: +49 3834 420 4177 → Write E-Mail
Project ID	22024915 (Subproject 1) 22007216 (Subproject 2) 22007316 (Subproject 3) 22007416 (Subproject 4)
Start	15.05.2017
End	31.12.2021 (Subproject 1), 14.05.2021 (Subproject 2-4)
Work description	The use of large amounts of slightly humified ('white') Sphagnum peat as a hitherto irreplaceable raw material for horticultural growing media leads to irreversible damage to climate, biodiversity and other peatland ecosystem services as well as loss of area available for agricultural use. The German growing- media industry, being the largest worldwide, depends on a peat resource that is nearly depleted in western and central Europe. The most promising alternative for this fossil peat is renewable Sphagnum biomass cultivated sustainably on rewetted degraded bogs (paludiculture). Whereas the agro-technical requirements are meanwhile well-established, large-scale implementation of Sphagnum farming for horticultural growing media is mainly hampered by: 1) Insufficient productivity of the hitherto used, randomly sampled wild parent material to make Sphagnum farming economically feasible; 2) Lack of appropriate volumes of high-quality moss propagules to kick-start large-scale cultivation. The interdisciplinary cooperative project 'MOOSzucht' aims at removing these bottlenecks by Increasing Sphagnum productivity in commercial-scale cultivation compared to currently used undifferentiated wild

parent material by selection of highly productive wild provenances and by smart breeding techniques. Increasing propagation rate of Sphagnum propagules by using optimized axenic conditions in a photobioreactor. Assessing performance of selected Sphagnum cultivars in lab and field cultivation.

Subproject 1: The Subproject 1 aims at the selection of highly productive provenances, propagation of peat moss in greenhouse conditions as well as field test of selected, bred and mass propagated peat mosses.

Subproject 2: The aim of this subproject is to produce axenic ("clean") peatmoss (Sphagnum) material and to accelerate its vegetative mass propagation in the photobioreactor for the purpose of producing "seeding" material. The biomass production of different Sphagnum species in the photobioreactor has to be optimized. Individuals of the best growing microprovenances (selected and propagated in AP 1) will be transferred into in vitro cultures. Therefore, the moss material is surface sterilized. The axenic clone is obtained from a single cell and then checked for absence of contamination. After ploidy determination, the most productive clones are further propagated in photobioreactor cultures, where the culture parameters are optimized towards biomass production. Polyploid species as well as hybrids often show improved growth characteristics, which will be investigated here for peat mosses. Protocols for protoplast isolation, regeneration and fusion will be established. Most productive clones will be polyploidized by breeding methods or hybridized with each other by protoplast fusion or chemically-induced polyploidization.

Subproject 3: Peat is an important substrate for horticulture. As part of the Paludi-culture, new moss is to be established on former peatland and then harvested. In this way, economic efficiency and environmental protection can be combined. Seeds must be provided in large quantities for recolonization. Within the framework of this project, the technical requirements for this were to be developed in the form of photobioreactors. Two approaches were investigated for this purpose. The first was to mimic natural conditions in a trickle-bed reactor. The moss plantlets themselves are fixed in place and irrigated from above as well as by the medium. Light is applied from above. CO₂ can be transferred both through the headspace and dissolved in the medium as well. In a second approach, the moss was propagated entirely in suspension culture. The CO₂ gas and mixing energy is realized by the airlift principle. Light can enter the reactor from the transparent reactor walls. Based on existing formulations, a medium was first developed which both enables (semi-) sterile operation even on a larger scale and supports continuous cultivation in perfusion mode. Above all, this medium does not require carbon sources, which would otherwise cause contamination. Furthermore, a purely phototrophic sustainable production of the seed is possible. Furthermore, the presentation of high nutrient salt concentrations in the medium as for the batch is no longer necessary. This also avoids pH effects.

Subproject 4: The subproject aimed at the further development of the cultivation of sphagnum mosses on non-axenic horizontal fleece culture in a shaded tunnel and outdoors as well as to achieve a relevant increase in yield, especially to produce seeds. For this purpose, variants of shading, nutrient supply and fleece layers were investigated. Harvesting and application techniques for peat moss capitula were tested.

Sphagnum farming for climatefriendly use of peatlands: cultivation and harvesting of peatmosses – Acronym: MOOSWEIT

Address	Universität Greifswald - Faculty of Mathematics and Natural Sciences - Biology - Institute of Botany and Landscape Ecology - Working group Peatland Studies and Palaeoecology Soldmannstr. 15 17489 Greifswald
Contact	Prof. Dr. Dr. h. c. Hans Joosten Tel.: +49 3834 420 4177 → Write E-Mail
Project ID	22007614
Start	01.02.2016
End	31.08.2019
Work description	The overall objective was the agricultural production of peat moss (Sphagnum) biomass on rewetted, degraded bog areas as a type of paludiculture to reduce greenhouse gas emissions and to produce a renewable raw material as peat substitute in horticultural substrates. The Sphagnum farming study site (5 ha) in the Hankhauser Moor, which was successfully established in the previous project MOOSGRÜN (FKZ: 22022308), and the well growing Sphagnum lawn allowed for the first time practice-relevant harvest and regeneration trials. The aim of the project was to go on with the development of Sphagnum farming on former bog grassland as a precondition for large-scale implementation. Only then the substrate and soil industry can be supplied with peat moss biomass - an excellent renewable alternative for peat - in sufficient quantity. In the project, the existing Sphagnum farming site was maintained and its area was tripled. Extensive accompanying research was also carried out to investigate the improvement of ecosystem services.

Project Database – “Peat reduction and peatland soil protection”- Details

Joint Project: Sphagnum farming on former bog grassland – Acronym: MOOSgrün

- Subproject 1: Implementation and optimisation of Sphagnum farming on former bog grassland;
- Subproject 2: Greenhouse gas balance of sphagnum moss cultivation on peat bog grassland

Address Subproject 1	Universität Greifswald - Faculty of Mathematics and Natural Sciences - Biology - Institute of Botany and Landscape Ecology Soldmannstr. 15 17489 Greifswald
Subproject 2	Universität Rostock - Faculty of Agricultural and Environmental Sciences - Institute of Management of Rural Areas (MLR)
Contact (Coordinator)	Prof. Dr. Dr. h. c. Hans Joosten Tel.: +49 3834 864-026 → Write E-Mail
Project ID	22022308 (Subproject 1), 22009910 (Subproject 2)
Start	01.10.2010
End	31.01.2015 (Subproject 1), 28.02.2014 (Subproject 2)
Work description	<p>Subproject 1: The main objective of the project is the sustainable cultivation of peatmosses (Sphagnum farming) to produce and harvest Sphagnum biomass. At the Ernst-Moritz-Arndt-University Greifswald the concept of paludiculture was developed. Paludiculture, from latin “palus- swamp, mire” is the cultivation of wet peatlands, while preserving the peat body and simultaneously combining utilisation and conservation. Sphagnum farming is paludiculture on degraded bogs with year-round high water tables. The project addressed a wide research range of issues, including peatmoss ecology, large scale field application, climate impact, hydrology, biodiversity, horticultural trials, and economic evaluation of Sphagnum farming. A 4ha large pilot site was established in the Hankhauser Moor (53° 15.80' N, 08° 16' E, Lower Saxony).</p> <p>Subproject 2: Cultivation of Sphagnum mosses serves to substitute peat extraction and the subsequent degradation of pristine bogs. In this way, emissions of the greenhouse gas (GHG) carbon dioxide (CO₂) can be avoided that would be released during the utilization of fossil peat, e.g. in horticulture. In addition, the conversion of drained bog grassland to Sphagnum farming also reduces GHG emissions. In order to evaluate whether the goal of GHG emission reduction can be reached by Sphagnum farming, measurements of net CO₂ exchange and methane (CH₄)- and nitrous oxide (N₂O)-emissions were conducted to accompany the cultivation experiments in the project. Emissions of the two cultivated Sphagnum species <i>S. palustre</i> L. and <i>S. papillosum</i> Lind. were compared to those of a moss-free treatment (with cover of vascular plants). Before this project, no data existed regarding the GHG exchange of Sphagnum cultivation during the establishment phase. For this reason, first field measurements of the GHG exchange of a Sphagnum cultivation site from field installation to the establishment of a closed moss lawn were conducted in subproject 4. Furthermore, the GHG emission potential of the Sphagnum mosses in relation to chemistry of the irrigation water and water table was studied in greenhouse experiments. In this way, the effects of different cultivation techniques on GHG emissions can be estimated with regard to the maintained water levels and different nutrient conditions and the climatic relevance of this new method of cultivation can be optimized.</p>

Sphagnum as a renewable resource: establishment and optimization of growth conditions – Acronym: Torfmoos

Address	Universität Greifswald - Faculty of Mathematics and Natural Sciences - Biology - Institute of Botany Grimmer Str. 88 17489 Greifswald
Contact	Prof. Dr. Dr. h. c. Hans Joosten Tel.: +49 3834 864-026 → Write E-Mail
Project ID	22005902
Start	01.04.2004
End	30.11.2007
Work description	<p>The subject of the project was research into the feasibility of cultivating peat mosses as a renewable raw material on agriculturally used high and lowland peatland sites. Peat is an ideal substrate for commercial and hobby horticulture. Three million cubic meters of peat are consumed in Germany every year (2004). Twice that amount is exported, and the demand is rising. The research focus in the project included the identification of peat moss (Sphagnum) species that combine optimal cultivability in Germany with the highest possible peat formation or primary production rates and good properties for substrate production. Furthermore, the clarification of the applicability of peat moss fresh material in growing media, namely in further areas than the already common fields of application (special crops: e.g. orchids) and the determination of the potential for peat moss cultivation areas was evaluated. The questions raised in the result of a literature study were addressed in container experiments, mainly concerning nutrient balance, water level and regime, using different peat moss species. In a second phase, the applicability of the results from phase 1 (laboratory experiments) were tested in the field and with the aim of a large-scale implementation.</p>

Certification of Peat Alternatives

Development and implementation of an international certification system for peat substitutes – Acronym: Zertifi-Torfersatz

Address	Meo Carbon Solutions GmbH Hohenzollernring 72 50672 Köln
Contact	Dr. Norbert Schmitz Tel.: +49 221 9727232 → Write E-Mail
Project ID	2221MT019X
Start	10.11.2021
End	09.11.2025
Work description	<p>To promote suitable and sustainable peat alternatives, BMEL has commissioned Meo Carbon Solutions GmbH (MCS) via the Agency of Renewable Resources (FNR) to develop and implement an international certification system for peat substitutes. The project started in November 2021 and is divided into three work packages (WP) with a total duration of 48 months. The involvement of stakeholders from e.g., the growing media industry, trade and consumers, NGOs and scientific institutions is crucial during the entire process.</p> <p>WP 1 (9 months) included the preparation of a report covering typical origins, supply chains and sustainability risks of peat substitutes. Additionally, initiatives and certification systems promoting peat reduction were analysed. Based on the report results, the certification concept was developed. It includes social, environmental and economic sustainability criteria, a GHG accounting methodology for peat and peat substitutes, a concept for the traceability of supply chains as well as the system structure.</p> <p>In WP 2 (15 months), the certification concept will now be tested through pilot audits for different national and international peat substitute supply chains. Based on the pilot results, the certification concept will be concretised and optimised. Furthermore, a website and a certificate database as well as system documents will be developed.</p> <p>In WP 3 (24 months), the certification system will be transitioned to regular implementation, including registration of system users, audits conducted by certification bodies and issuing of certificates. Further, accreditation as well as national and international recognition of the system are to be achieved.</p>

Expert Information

Joint Project: Expert information for horticultural companies on the conversion to peat-reduced substrates – Acronym: FiniTo

- **Subproject 1: Project coordination and regional competence center west;**
- **Subproject 2: Regional competence center north;**
- **Subproject 3: Regional competence center south and cross-sectional task growing media;**
- **Subproject 4: Regional competence center south-west and cross-sectional task knowledge transfer;**
- **Subproject 5: Regional competence center east;**
- **Subproject 6: Cross-sectional task business management**

Address	Landwirtschaftskammer Nordrhein-Westfalen
Subproject 1:	Nevinghoff 40 48147 Münster
Subproject 2:	Landwirtschaftskammer Niedersachsen
Subproject 3:	University of Applied Sciences Weihenstephan-Triesdorf – The Centre for Research and Knowledge Transfer - Institute of Horticulture – Department Plant Nutrition
Subproject 4:	Staatliche Lehr- und Versuchsanstalt für Gartenbau
Subproject 5:	Sächsisches Landesamt für Umwelt, Landwirtschaft und Geologie
Subproject 6:	University of Applied Sciences Weihenstephan-Triesdorf - Institute of Horticulture, ASC Smart Indoor Farming
Contact (Coordinator)	Dipl.-Ing.agr. Gabriele Hack Tel.: +49 221 5340 557 → Write E-Mail
Project ID	2221MT016A-F
Start	01.11.2022
End	31.10.2026

Work description The aim of the project is to support horticultural companies of all disciplines on the reduction of peat in growing media. The two main aspects thereby are: individual expert advice and the target-specific preparation of expert information. Across Germany, five regional competence centers are therefore established. They are supported by three cross-consortiums competence centers for digital knowledge transfer, growing media and economics, respectively. The professional information produced during the project in various media formats reflects the current state of expert knowledge and practical experience in cultivating in peat-reduced and peat-free growing media. In addition to the direct transfer of knowledge into horticultural practice, also serves as a basis for seminars and workshops as well as courses at technical colleges and universities of applied sciences. Thus find a lasting entry into horticultural training and further education.

Subproject 1: The subproject 1 includes the overall management of the project with networking and management of publications at one side and on the other side the regional competence center west, which supports horticultural companies in North Rhine-Westphalia and in the northern part of Rhineland-Palatinate. In cooperation with the four other regional competence centers, target-group specific information material for each horticultural discipline (ornamentals, vegetables, nursery, perennials, potted herbs, cemetery horticulture) is prepared. This work is done within eight coordination groups whereof two – for outside ornamental plant production and for fruit berry production – are managed by the staff of the competence center west.

Subproject 2: The subproject 2 includes the regional competence center north, which supports companies of all horticultural sectors in the north and north-east of Germany (Schleswig-Holstein, Lower Saxony, Mecklenburg-Western Pomerania). In cooperation with the four other regional competence centers target-group specific information material for each horticultural discipline (ornamentals, vegetables, nursery, perennials, potted herbs, cemetery horticulture) is prepared. The regional competence center north is managing two of the eight coordination groups, for greenhouse ornamental plants and for nursery plants.

Subproject 3: The subproject 3 includes the regional competence center south, which supports horticultural companies in Bavaria, and the cross-consortiums competence center growing media, which provides specialized information on properties of growing media constituents, adjustment on fertilization strategies on peat reduced growing media or implementation and interpretation of growing medium analysis. The cross-consortiums competence center focuses on general information on various aspects of peat reductions and supports the work of the eight coordination groups. Furthermore, it assists the five regional competence centers with detailed information e.g. on fertilization management or interpretation of results of growing medium analysis and is consulted in case of severe plant damages.

In cooperation with the four other regional competence centers target-group specific information material for each horticultural discipline (ornamentals, vegetables, nursery, perennials, potted herbs, cemetery horticulture) is prepared. This work is done within eight coordination groups, whereof two – for vegetable young plants and for cemetery horticulture – are managed by the staff of the competence center south.

Subproject 4: The subproject 4 includes the regional competence center south-west, which supports horticultural companies in Baden-Wuerttemberg, Rhineland-Palatinate and in Saarland, and the cross-consortiums competence for knowledge transfer. This helps the five regional competence centers in publishing and using digital media for the information material. Furthermore it sets up and maintains the homepage of the project and provides the online platform for the cross-sectional knowledge transfer interface.

In addition of the direct advice of the companies the staff of the regional competence center south-west prepares in cooperation with the four other regional competence centers target-group specific information material for each horticultural discipline (ornamentals, vegetables, nursery, perennials, potted herbs, cemetery horticulture) and is managing one the eight coordination groups, the one for potted herbs.

Subproject 5: The subproject 5 includes the regional competence center east, which supports horticultural companies in the eastern countries of Germany (Saxony, Saxony-Anhalt, Brandenburg, Thuringia). In cooperation with the four other regional competence centers target-group specific information material for each horticultural discipline (ornamentals, vegetables, nursery, perennials, potted herbs, cemetery horticulture) is prepared. One of the eight coordination groups - for perennials– is managed by the staff of the competence center east.

Subproject 6: Within the project the cross-section “Business Management” is responsible for providing professional business information and practical illustrative material in connection with the use of/conversion to peat-reduced/peat-free growing media (= task of Subproject 6). On the one hand, the focus is on specialist information on the use of business management tools in farm management and corporate management, On the other hand, basic and generally valid information on business management issues in the context of peat reduction is planned in different design, dedicated to the following three main topics: Current research results, sample calculations and digitalization of business management tasks.

In addition to the continuous information on business management topics within the project consortium, the cross-consortium specialist information of the cross-sectional business management interface mainly takes place via the online platform ("Digital Guide") of the cross-sectional knowledge transfer interface and also makes use of the trade press, specialist events and cross-regional networking within the horticultural sector, in particular with business management advice in horticulture. This also includes direct contact and intensive exchange with companies from all horticultural sectors on business management topics, in order to make an important contribution to reducing the economic risk of converting to peat-reduced or peat-free growing media.

Peatland Protection

Joint Project: Sustainability of Paludicultures with particular consideration of the matter balance – Acronym: NAPALU

- **Subproject 1: Project coordination, cultivation and biodiversity evaluation on pilot sites in Lower Saxony, establishment of regional value chains;**
- **Subproject 2: Greenhouse gas emissions on a bavarian pilot site and evaluation of the effects of fertilization on productivity and environment;**
- **Subproject 3: Greenhouse gas emissions on a pilot site in Lower Saxony and modeling of the site conditions on plant growth;**
- **Subproject 4: Nutrition of paludicultures;**
- **Subproject 5: Nutrient dynamics in peat and water quality;**
- **Subproject 6: Economic evaluation of paludicultures;**
- **Subproject 7: Fibre injection moulding, mechanical properties and paper moulding investigations**

Address Subproject 1	3N Kompetenzzentrum Niedersachsen Netzwerk Nachwachsende Rohstoffe und Bioökonomie e.V. Kompaniestr. 1 48757 Werlte
Subproject 2	University of Applied Sciences Weihenstephan-Triesdorf - Centre for Research and Continuing Education – Specialist area of landscape planning, landscape ecology and environmental safety
Subproject 3	Johann Heinrich von Thünen Institute; Federal Research Institute for Rural Areas, Forestry and Fisheries - Institute of Climate-Smart Agriculture
Subproject 4	Julius Kühn Institute; Federal Research Centre for Cultivated Plants - Institute for Crop and Soil Science
Subproject 5	University Trier; Spatial and Environmental Sciences - Department of Soil Science
Subproject 6	University Kiel – Department of Agricultural Economics
Subproject 7	University of Applied Sciences Bremen; School of Nature and Engineering
Contact (Coordinator)	Dr. Marie-Luise Rottmann-Meyer Tel: +49 5951 9893-12 → Write E-Mail
Project ID	2221MT010A-G
Start	15.11.2022
End	15.11.2025

Work description The aim of this project is to investigate and optimize cultivation methods of established fen paludicultures in Bavaria and Lower Saxony and develop sustainable products. The aim is to assess long-term development of biomass yield and quality of Typha, Phragmites, Phalaris and Carex at the six pilot sites differing in nutrient availability and other relevant parameters. The impact of nutrient availability and a potential fertilization on quantity and quality of biomass, matter balances (GHG exchange and nutrient dynamics) and biodiversity will be determined. The cultivation methods will be evaluated concerning their profitability. Another unique feature is the development of a crop growth simulation model. The project partners provide the infrastructure and pilot sites in South and North Germany. These include large areas, small intensive measurement sites and in total 36 mesocosms.

Main focus is the sustainability comprising the whole product chain from cultivation to utilization. Practical tests will evaluate concepts for producing materials (bioraffination, biobased materials). The interdisciplinary project consortium will advance the concept of paludiculture together with stakeholders. Due to a close partnership with entrepreneurs practical results can be discussed on a short term and realised on a mid-term.

This project aims to assess the sustainability of fen paludicultures on a long term, regarding productivity, exploitation strategies and profitability as well as nutrient dynamics, biodiversity and GHG mitigation potential. The generated data and results will contribute significantly to knowledge transfer, e.g. in the field of emission reduction of the sectors Agriculture and Land Use.

Project Database – “Peat reduction and peatland soil protection”- Details

Joint Project: Refining wet grassland biomass into Platform chemicals, packaging, Fibre casting and paper– Acronym: EDELNASS

- **Subproject 1: Coordination, knowledge transfer, public relations & ecological and economic evaluation**
- **Subproject 2: Development and exemplary realization of processes for the extraction and preparation of fiber raw materials for use in the pulp & paper sector**
- **Subproject 3: Platform chemicals from wet grassland biomass;**
- **Subproject 4: PEF-packaging**

Address	Universität Greifswald - Faculty of Mathematics and Natural Sciences - Biology - Institute of Botany and Landscape Ecology
Subproject 1:	Soldmannstr. 15 17489 Greifswald
Subproject 2:	Leibniz-Institut für Agrartechnik und Bioökonomie e. V. (ATB)
Subproject 3:	University of Hohenheim
Subproject 4	Albstadt-Sigmaringen University
Contact (Coordinator)	Prof. Dr. Gerald Jurasinski Tel.: +49 3834 420-4170 → Write E-Mail
Project ID	2222MT001A-D
Start	01.07.2023
End	30.06.2026
Work description	<p>EDELNASS focuses on the material utilisation of regrowth from rewetted peatland meadows, which are heterogeneous in species composition and often subject to management restrictions (e.g. harvest time). Biomass and its site parameters from 5 peatland sites in Germany will be analysed, tested and evaluated with regard to their applicability in two utilisation processes:</p> <p>(i) Conversion in biorefineries to the bio-based, high-value basic chemicals HMF and furfural and optimisation of the processes at the University of Hohenheim. Lignin is also produced as a by-product. The HMF can be further processed into the recyclable, bio-based high-performance plastic PEF, from which the Albstadt-Sigmaringen University develops sustainable packaging solutions.</p> <p>(ii) The Leibniz Institute of Agricultural Engineering and Bioeconomy, together with its partners, produces fibres from the biomass and further processes them into paper and fibre mouldings. Coupling potentials of material flows of the raw material fractions between the processes will be investigated by feeding intermediate and by-products of one process into the respective other process. The aim of the research is to develop new value chains based on the management of wet grasslands that combine the productive use of wet grasslands with the achievement of nature conservation and climate protection goals. Data bases for the future remuneration of the ecosystem services of the wet grasslands and peatlands will be compiled: CO₂ balance of processes and possible products (including soil-borne emissions), development of biodiversity and water quality. The costs from raw material supply to final product will be analysed in order to derive appropriate operating models for the individual processes and to project them in peatland regions as examples.</p>

Joint Project: Sundew and cloudberry as medicinal plants in paludiculture – Acronym: SoMoMed

Address	Universität Greifswald Domstr. 11 17489 Greifswald
Contact	Prof. Dr. Martin Schnittler Tel.: +49 3834-420 4123 → Write E-Mail
Project ID	2221MT012X
Start	01.01.2023
End	31.12.2025
Work description	<p>The project focuses on research of sustainable production of sundew and cloudberry production on peat mosses in paludiculture. The raw material demand for sundew and cloudberry in Europe is mainly covered by wild collections. However, wild collections as a raw material source are not sustainable and endanger the natural stocks in the long term. Sundew and cloudberry are typical for wet, nutrient-poor raised bogs and can therefore be grown in combination with peat mosses on rewetted bogs. Genetic characterization of selected European spp. with respect to medically active ingredients and productivity will provide a basis for breeding selection. Varieties with high active ingredient content and high productivity can thus be selected for further cultivation tests. By optimizing the cultivation conditions, active ingredient contents and biomass yields can be further improved. For research on sustainable cultivation, an economic and ecological analysis is essential. Therefore, first the market potential of cultivated crops will be analysed, second the costs of cultivation will be determined, third ecological effects will be estimated and fourth sustainable business models along the value chain will be developed.</p>

Joint Project: Paludiculture in practice: Optimisation of cattail and reed cultures – Acronym: Paludi-PROGRESS

- **Subproject 1: Establishment by seed, water and nutrient balance, biomass build-up and degradation, plant population development, biomass quality, management and harvest of the pilot case, profitability (coordination and knowledge transfer);**
- **Subproject 2: Working time studies on cattail and reed cultivation and lease of the practice trial area**

Address Subproject 1	Universität Greifswald - Institute of Botany and Landscape Ecology Soldmannstr. 15 17489 Greifswald
Subproject 2	Landesforschungsanstalt für Landwirtschaft und Fischerei Mecklenburg-Vorpommern
Contact (Coordinator)	Prof. Dr. Jürgen Kreyling Tel.: +49 3834 420-4131 → Write E-Mail
Project ID	2221MT009A;C
Start	01.09.2022
End	31.08.2025
Work description	<p>Paludiculture combines the productive use of peatlands with the preservation of the peat body and thus minimizes subsidence, soil degradation and CO2 emissions. In the joint project Paludi-PROGRESS, the cultivation of cattail (<i>Typha</i> spp.) and reeds (<i>Phragmites australis</i>) is being tested and further developed as new permanent crops for wet peatlands. The ecological and economic research focuses on a ~ 10 ha practical cultivation trial with cattail, which is located near Neukalen/ Mecklenburg-Western Pomerania and was established by the Paludi-PRIMA project in 2019. For reed, traditional reed harvesting sites will be investigated to derive recommendations for the targeted cultivation of reed on peatlands. The existing paludiculture sites are the basis of the economic evaluation by collecting real practice data on stand establishment, management, harvest, productivity, and biomass quality. A quantification of ecosystem services is done for the cattail cultivation trial in terms of carbon, water and nutrient budgets, as well as for biodiversity. For a process-based and quantitative understanding, the influence of water level fluctuations on biomass growth and decomposition will be investigated under controlled conditions (mesocosm experiments). Knowledge exchange with other pilot sites and knowledge transfer for the implementation of paludiculture e.g. via field trips, field days and workshops is a central concern of the project.</p> <p>Subproject 1: Traditional reed harvesting sites are investigated to derive recommendations for the targeted cultivation of reed on peatlands. The existing paludiculture sites are the basis of the economic evaluation by collecting real practice data on establishment, management, harvest, productivity, and biomass quality. A quantification of ecosystem services is done for the cattail cultivation trial in terms of carbon, water and nutrient budgets, as well as for biodiversity. For a process-based and quantitative understanding, the influence of water level fluctuations on biomass growth and decomposition are evaluated under controlled conditions (mesocosm experiments). Knowledge exchange with other pilot sites and knowledge transfer for the implementation of paludiculture e.g. via field trips, field days and workshops is a central concern of the project. The GHG exchange on the <i>Typha</i> paludiculture plot and in the</p>

mesocosm experiment at the University of Greifswald are measured and the laboratory analyses of the collected water samples are realized. In order to determine the large-scale carbon and climate balance on the spatial scale of the Typha cultivation system, Eddy Covariance (EC) measurements will be combined with focused chamber measurements (e.g. on the embankments, influence of high vs. low summer water levels). Measurements at the mesocosm site are performed using an existing automated closed dynamic chamber.

Subproject 2: Subproject 2 includes the lease of the practice trial area and the related administrative responsibilities. The focus of subproject 3 lies on the implementation and evaluation of working time studies. At present, no reliable planning and modelling data are available for the working methods of reeds and cattails. The aim of the working time studies in Paludi-PROGRESS is to make the working methods of cattails and reeds plannable and optimisable especially for economic reasons. In a first step, detailed working time studies for the cultivation of cattails and reeds are carried out and planned times are calculated on the basis of these results. The planned times for these paludiculture methods are used: - for publications as a modelling and planning basis for actors from agricultural policy, administration, science and agricultural practice, - for the calculation of labour costs, - to evaluate the economic efficiency of different paludiculture methods, - for optimising the work processes and conditions of the individual paludiculture methods. Recommendations for actors from agricultural policy and administration, science and agricultural practice are to be derived on the basis of the results generated. A further objective is the establishment of a reference farm network (eight farms) in order to determine procedural and economic data. On the basis of the labour costs, the management costs of cattail and reed cultivation are to be modelled. Thereby, the focus is on the optimization of the work processes and conditions of the cattail and reed cultivation.

Project Database – “Peat reduction and peatland soil protection”- Details

Joint Project: Putting paludiculture into practice - integration - management – cultivation – Acronym: Paludi-PRIMA

- Subproject 1: Cultivation, management and harvesting of Typha and Phragmites, biomass quality, economic assessment, transferability & knowledge transfer;
- Subproject 2: Working time studies and integration of paludiculture into practice

Address Subproject 1	Universität Greifswald - Faculty of Mathematics and Natural Sciences - Biology - Institute of Botany and Landscape Ecology Soldmannstr. 15 17489 Greifswald
Subproject 2	State Research Institute for Agriculture and Fisheries Mecklenburg-Vorpommern
Contact (Coordinator)	Prof. Dr. Dr. h.c. Hans Joosten Tel.: +49 3834 420 4177 → Write E-Mail
Project ID	22026017 (Subproject 1) 22032718 (Subproject 2)
Start	01.05.2019 (Subproject 1) 01.06.2019 (Subproject 2)
End	31.08.2022 (Subproject 1) 31.05.2022 (Subproject 2)
Work description	<p>Subproject 1: Paludi-PRIMA intended to contribute to putting paludiculture into practice on degraded fen sites. To this end, the project task was to close knowledge gaps regarding achievable biomass quality depending on site conditions, area and harvest management for the plant species common reed (<i>Phragmites australis</i>) and cattail (<i>Typha angustifolia</i>, <i>T. latifolia</i>). Different genotypes were investigated for reed. The project focused further on economics with a cost calculation for stand establishment, stand management and harvesting a cattail field site. The economic viability of paludiculture was assessed depending on biomass quality and utilisation options. The integration of paludiculture into practice focused on knowledge transfer, transferability, and integration into agricultural policy and planning processes.</p> <p>Subproject 2: The state Research Institute for Agriculture and Fisheries Mecklenburg-Vorpommern (LFA MV) and the University of Greifswald have investigated the cultivation of reeds and cattails in the joint project "Putting Paludiculture into practice: Integration - Management - Cultivation (Paludi-PRIMA)". The focus of Paludi-PRIMA was the 10 ha practical trial in which cattail cultivation was tested. The LFA MV was responsible for sub-project 2: "Working time studies and integration of paludiculture in practice" of the joint project Paludi-PRIMA. This includes work package 1 (WP 1) "Coordination, knowledge transfer and transferability" and work package 6 (WP 6) "Working time studies". In WP1, the LFA MV, together with the University of Greifswald, dealt with project coordination, public relations work and the development of proposals for the integration of paludiculture in agricultural law and policy. The LFA MV participated in events with representatives from nature conservation, politics and research, invited to discussions and prepared various statements. In WP6, working time studies on the working methods of reed and cattail cultivation were carried out in order to generate data for the planning of working procedures and the calculation of the costs of paludiculture methods. To realise the working time studies and to collect procedural data, the first step was to record the working</p>

steps in the field with a video camera (GOPRO). Subsequently, the working time studies were carried out and evaluated with two recognised programmes from the working time management of the company DRIGUS (MEZA, PLAZET). Working time studies were carried out on the establishment of cattails, the summer duck of reeds and the winter duck of cattails.

Joint Project: Optimising biomass production on wet peatlands and thermal utilisation – Acronym: BOnaMoor

- Subproject 1: Biomass production, life cycle assessment and economic assessment ;
- Subproject 2: Combustion aspects

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Project ID	22400518 (Subproject 1), 22404418 (Subproject 2)
Start	01.11.2018
End	31.03.2022 (Subproject 1), 31.01.2022 (Subproject 2)
Work description	<p>Subproject 1: The BonaMoor project aims to optimise and further develop energy biomass production on rewetted fen peatland sites. In addition to the development of sustainable and economically viable cultivation systems and value chains for biomass from wet fen sites, the goals of the project are to optimise the production of renewable raw materials in paludiculture and their thermal utilisation.</p> <p>To achieve these goals, field studies were carried out on rewetted fens on productivity and yields, biomass quality and vegetation composition. In addition, economic analyses and life cycle assessments were done. The scientific investigations were brought closer to the public through various activities to disseminate the results (publications, field days, workshops).</p> <p>Subproject 2: As part of the BOnaMoor joint project funded by the Federal Ministry of Food and Agriculture, investigations are being carried out into the energetic use of fen biomass in small-scale combustion plants and in an 800 kW biomass heating plant in Malchin (Mecklenburg-Western Pomerania). Sedge, reed and reed canary grass in pelletised form and in bale form are used as fuels. In particular, the effects of critical constituents on the combustion process are being investigated as a function of the fuel pre-treatment and the harvesting time of the biomasses. The aim of the investigations is to optimise combustion and improve management recommendations for the provision of raw materials. In the 2019/2020 heating period, measurement campaigns with loose stalk material were carried out at the Malchin heating plant and compared with measurement campaigns from the previous heating period (2018/2019), in which pelletised biomasses of the same stalk materials were used. As a further comparative fuel, a measurement campaign was carried out with wheat straw. The effects of various parameters on the emission values were investigated, as well as possible effects on the combustion process due to internals in the combustion chamber. It was found that the emission values for the combustion of pelletised fuels are significantly lower than for loose straw, but that pelletised biomass results in an increased risk of slagging in the boiler. As expected, the emission values when using lowland biomass are higher compared to woody fuels. Compared to the combustion tests with straw, the lowland biomass</p>

proved to be better suited to safely comply with the limit values specified in the TA Luft.

The potentials of heat and energy generation from straw material are well known (Prochnow et al. 2009). The fuel costs are lower compared to fossil fuels or even wood, but the investment and operating costs of combustion plants for pulp goods are higher. It is therefore all the more important to minimise costs in maintenance and operation. In the project, the practical trials at the Malchin heating plant are being scientifically accompanied and recommendations for practical application are being developed. In addition, laboratory tests will be carried out systematically and recommendations for transferability will be worked out. In this way, potentials for the utilisation of new energy crops from wet moorland sites can be developed.

Wise use of drained peatlands in a bio-based economy: Development of improved assessment practices and sustainable techniques for mitigation of greenhouse gases – Acronym: PEATWISE

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Project ID	22408917
Start	15.11.2017
End	31.05.2021
Work description	Approximately one third of the total global carbon stocks stored in soils are found in natural peatlands. Drained peatland soils are considered hotspots of GHG emissions. EU Member States are the second largest emitters worldwide. Drainage is a prerequisite for "classical" biomass production, such as agriculture and forestry. GHG emission rates (fluxes) depend on a number of different factors, such as soil and water management, nutrient status and carbon availability, as well as climate and hydrology. PEATWISE focuses on methods to measure and record GHG fluxes and emissions from different peatland uses (agriculture, forestry, paludiculture). In addition, soil and water management measures are (further) developed with which GHG emissions can be reduced despite use. The creation of incentive structures to support such management measures through public policy instruments and private sector initiatives will be essential for a climate policy that aims to integrate the land use sector more strongly into the European and international climate protection regime. PEATWISE will therefore analyse existing public incentive-based policy instruments in Europe, involving key stakeholders, in order to contribute to a coherent strategy for promoting these measures.