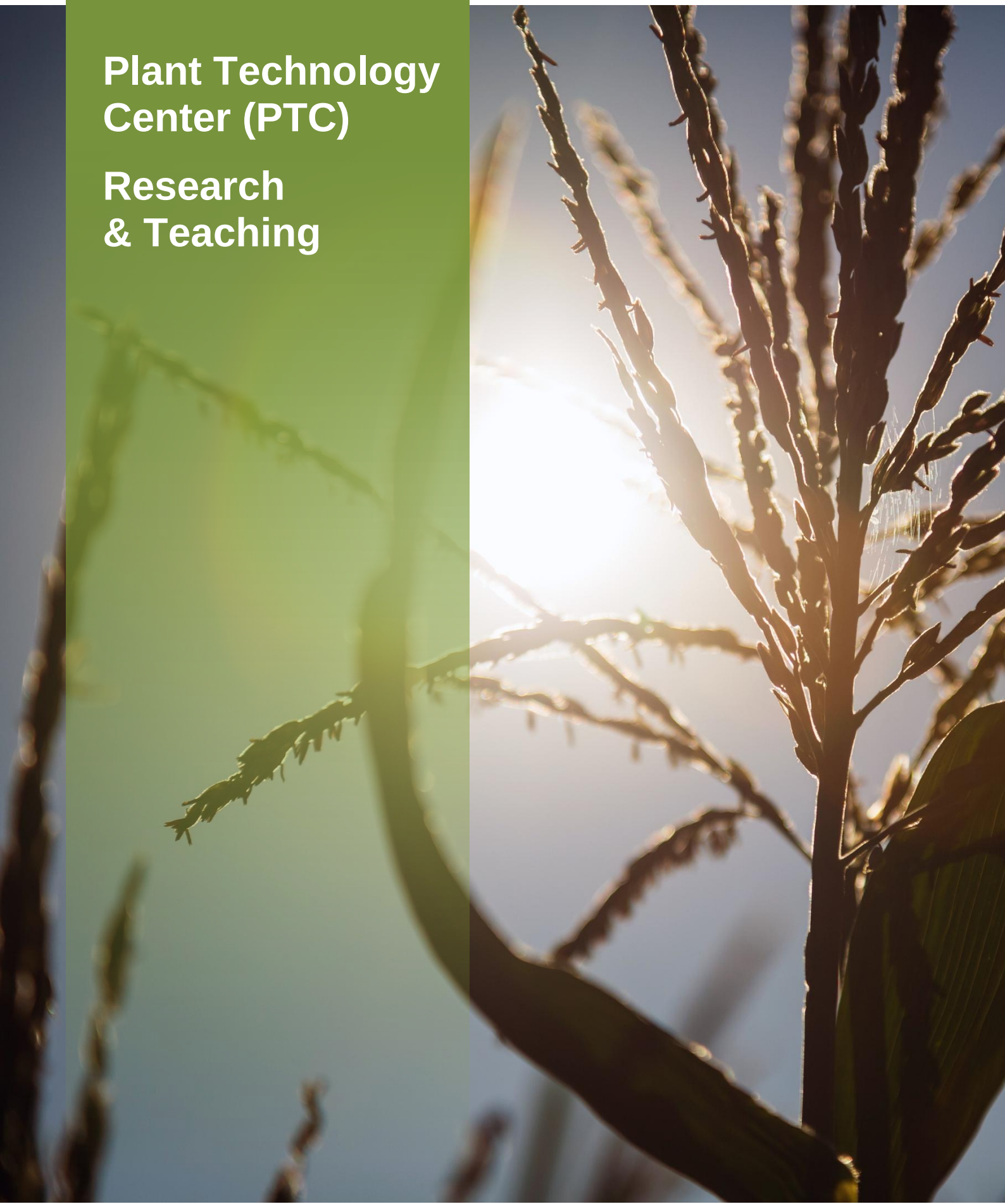
Annual Report

2023

Plant Technology Center (PTC)

Research & Teaching

Plant Technology Center
School of Life Sciences
Technical University of Munich



PTC Management

Director	Prof. Dr. Chris-Carolin Schön Chair of Plant Breeding
Deputy Director	Prof. Dr. Gerd Patrick Bienert Chair of Crop Physiology
Managing Director	Dr. Sonja Alexandra Dames

Field Crops Unit (FCU):

Managing Director	Dr. Harald Amon
Deputy Managing Director	Stefan Kimmelmann

Greenhouses and Phytochambers Unit (GPU):

Managing Director	Dr. Johann Hausladen
Deputy Managing Director	Dr. Susanne Steger
Scientific Coordinator TUMmesa	Dr. Bálint Georg Jákli

TUM Experimental Farm Roggenstein (Unterroggenstein). Foto: FCU.

Title picture: Fotograph of maize grown for the project network BayKimaFit.
Foto: Tom Freudenberg/pict-images. Kindly provided by the Chair of Plant Breeding, Prof. Schön.

Contents

TUM Experimental Farm Viehhausen. Foto: FCU.

1. Managing Director's Message

Welcome to the Plant Technology Center (PTC) annual report for 2023!

A lot has happened since the foundation of the PTC in the spring of 2020. Right from the beginning, Director Prof. Chris-Carolin Schön and the Managing Directors of the Field Crops Unit, Dr. Harald Amon, and the Greenhouses and Phytochambers Unit, Dr. Hans Hausladen and Dr. Susanne Steger, faced the challenge of establishing a technology core facility for plant and agricultural sciences during a once-in-a-lifetime pandemic. From 2021, they were supported by Deputy Director, Prof. Patrick Bienert and a Scientific Advisory Board (SAB) providing strategic advice. The SAB is composed of the Senior Vice President for Research and Innovation, Prof. Gerhard Kramer, the Director of the Animal Research Center, Prof. Benjamin Schusser, and three professors of the School of Life Sciences, Prof. Senthold Asseng, Prof. Ralph Hückelhoven, and Prof. Johannes Kollmann. Since the PTC is part of the School of Life Sciences, also Dean Prof. Ingrid Kögel-Knabner and Managing Director Dr. Tobias Bidon actively supported setting up a functional institutional structure. The commitment and collaborative spirit of all have set the stage for a promising future for the PTC.

I transitioned to the position of the PTC Managing Director in April 2024. I am very honored to have the opportunity to manage and further develop the PTC with its exceptional staff to its best. Collecting the information about the work conducted in 2023, I was very impressed by the broad scope of highly innovative plant and agricultural research projects they are supporting. I hope you will enjoy reading the report as much as I did writing it.

If you are interested in finding out more, please contact me at sonja.dames@tum.de or my wonderful colleagues managing the PTC subunits and visit our website: https://www.tcf.tum.de/ptc/.

Sonja A. Dames
Managing Director

TUM Experimental Farm Dürnast & GPU Dürnast. Foto: FCU.

2. PTC Corporate Year 2023 – Summary of Key Points

- PTC made a major contribution to research in the areas of plant breeding and nutrition, organic farming, precision and digital agriculture, plant disease and fertilization management, ecosystem research, indoor farming, and related fields by conducting 157 trials (55 Field Crops Unit (FCU), 102 Greenhouses and Phytochambers Unit (GPU)) for 23 TUM chairs, two other TUM institutions, three external organizations, and two companies.
- More than 27 publications, ten conference talks, and 24 theses (two PhD, eleven Master, ten Bachelor) could be published using data generated within PTC trials.
- The ecotron TUM Model EcoSystem Analyser (TUMmesa) has been successfully integrated into the GPU.
- The PTC implemented a new large agroforestry trial at TUM Experimental Farm Roggenstein (31 ha) and a smaller one that is used as a showcase in Dürnast (1,5 ha) by planting about 8000 trees and shrubs in preparation of a major grant proposal.

3. Overview of the PTC

The TUM Plant Technology Center (PTC) provides low-threshold, regulated access to excellent research infrastructure and expertise in the field of plant science research.

With its many years of experience, the PTC with its three sub-units offers an excellent environment for scientific experiments in the research areas of plant research, ecology, forestry, and agriculture under controlled conditions and in the field.

Field Crops Unit (FCU) – For field trials, the TUM experimental farms Dürnast (including the field areas in Thalhausen), Roggenstein, and Viehhausen provide around 550 ha of arable land and grassland – including the latest agricultural and plot technology, measurement sensors, weather stations, rolling houses, and technical and plant cultivation expertise. In addition, the FCU conducts field trials on commercial farms (on-farm research). Up to 200 ha are suitable for field experiments, which require experimental plots that are as homogeneous as possible. Heterogeneous soils are used to analyze the spatial variability of soil properties and plant stands using modern digital methods, e.g., in the digisens project (see p. 6). In addition to annual and multi-year field experiments, long-term field experiments with durations of 20 years and more are carried out. Accordingly, the entire field area is needed for experiments. The FCU supports the trial design and implements it in the field, with the option of setting up field trials in integrated and organic farming systems. Moreover, the FCU ensures the methodological development of field trials with regard to long-term needs.

Greenhouses and Phytochambers Unit (GPU) – For controlled environment plant experiments, the GPU in Dürnast, formerly Greenhouse Laboratory Center (GHL), offers table and ground greenhouses covering an area of 5,000 m^2, as well as vegetation halls, culture cabins, climate chambers, plant cooling rooms and culture cabinets. The TUM Model EcoSystem Analyzer (TUMmesa) research facility and decentralized climate chambers and greenhouses complement the scientific infrastructure.

Forest Research Unit (FRU) – The integration of the forestry research plots is under development.

4. Overview of Experimental Activities in 2023

Field Crops Unit (FCU)

In 2023, 55 field experiments were set up and supervised on around 80 ha. Of these, 16, covering about 42 ha, had been newly installed, and 39 had been continued. The scientific supervision was carried out by nine TUM chairs and one external scientist (table 1 & list of individual experiments in table A1 in the appendix). Overall, the focus in Dürnast is more on precision farming, the one in Roggenstein is on plant breeding and crop production as well as agroforestry systems, and the one in Viehhausen is on organic farming and agroecosystems. Among other things, experiments were set up on innovative fertilization approaches, crop rotations, the use of robotics and newly bred crops and energy plants, and to study plant diseases and drought stress. In the following, projects examining the use of biochar, digitalization in agriculture, and newly bred maize varieties will be exemplified.

Table 1: Quantitative overview of the FCU field trials for 2023

Experimental farm	Number of trials	TUM project leader	External project leader	Total trial area [ha]
Dürnast	21	10	0	18.25
Viehhausen	9	2	1	12.25
Roggenstein	20	5	0	42.89
External sites	5	2	0	6.33
Sum	**55**	**19**	**1**	**79.72**

For example, the FCU carried out trials for the **joint project AmAIzed** https://www.hef.tum.de/hef/agro-missionhub-weihenstephan/amaized/; joint project leader: Prof. Kang Yu, duration: 1 October 2023 - 30 September 2025). The main goal of AmAIzed is to develop an AI-supported multitasking robot system for individualized management of crops and weeds. To achieve this, experts in different disciplines such as agricultural- and bioengineering, crop and horticultural sciences, crop protection, and agricultural economics of TUM, the University of Applied Sciences Weihenstephan-Triesdorf (HSWT), and the Bavarian State Institute of Agriculture (LfL) cooperated. The data can be used, e.g., to significantly reduce the use of pesticides. AmAIzed and generally projects with the LfL and the HSWT are based on a cooperation agreement between the FCU, the LfL, and the HSWT.

Spreading of cattle manure containing biochar in the Thalhausen long-term field trial for the TerraBayt project. Foto: FCU.

In the **digisens project** (Title: Reduction of nitrate leaching through digital nitrogen management and sensor-based fertilization, scientific contact: Dr. Martin Mittermayer, project leader: Prof. Dr. Kurt-Jürgen Hülsbergen, project partners: TUM, HSWT, LfL, commercial farms, funding: Bavarian State Ministry of Food, Agriculture and Forestry (StMELF), city of Burghausen, municipality of Burgkirchen a. d. Alz), satellite- and sensor-based systems are used to investigate the spatial variability of soil properties and plant stands. Using methods of artificial intelligence,

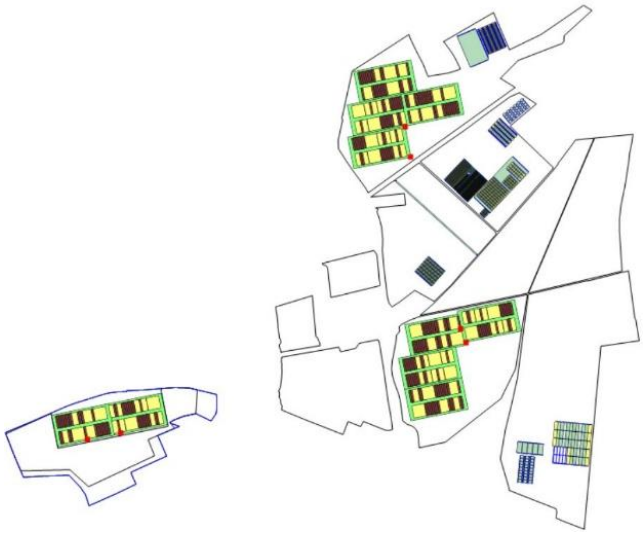
yield and fertilization algorithms are derived and validated. The new digital methods are extensively tested in field trials at the FCU.

In the **TerraBayt project** (Title: Potential of biochar and terra preta in Bavarian agriculture – contribution to climate protection and adaptation, scientific contact: Emanuel Jaufmann, project leader: Prof. Dr. Kurt-Jürgen Hülsbergen, project partners: TUM, Bayerischer Maschinenring, LfL, C.A.R.M.E.N., funding: StMELF) the long-term effects of biochar in combination with organic and mineral fertilizers on soils, plants and the environment are being investigated. The FCU is conducting complex long-term field experiments in Roggenstein and Thalhausen.

The project **MAZE** (https://www.europeanmaize.net/) that is funded by the Federal Ministry of Education and Research (BMBF) aims to improve quantitative traits of maize by assessing its genomic and functional diversity (funding period phase 3: 1 February 2023 to 31 January 2026). The FCU cultivated various maize varieties for this project on around 4 ha of field area (Table A1). Complementary, various experiments were carried out in the GPU Dürnast (Table A2).

With regard to the available infrastructure, **BayWa AG** is sponsoring the **DigiCrop Farm Dürnast Project** with digitally upgraded, highly intelligent agricultural technology (Fendt tractor 314 Vario, Pöttinger seed drill combination, Gaspardo field sprayer, Rauch fertiliser distributor and web-based field card index NextFarming Life). This allows processing operations to be planned on the computer and carried out automatically in the field. The management is fully documented and automatically archived in the field card index. The devices are currently used on around 100 ha of arable land. As part of the application for a research training group and research projects studying **agroforestry systems** (contact: Prof. Knoke) to the German Research Foundation (DFG), an experiment was set up in December 2023 on 31 ha of arable land, spread over three fields at the Roggenstein experimental farm. About 8,000 trees and shrubs were planted for this purpose.

A small test area was set up at the Dürnast experimental farm. The information board on the cycle path next to it offers an overview of the project for interested experts and laypeople.



Overview of the agroforestry trial areas at the Roggenstein experimental farm:

field area (yellow,11.2 ha), tree area (brown, 7.2 ha), trail (green) & wrap-around (small edge areas near the contour lines, 16.8 ha), total 35.2 ha.

Greenhouses and Phytochambers Unit (GPU)

GPU Dürnast

In 2023, 92 research projects were carried out at the GPU in Dürnast. A total of 20 TUM chairs and research groups from the LfL, the LMU and the Leibniz Institute for Food Systems Biology at TUM and two companies used the resource. A list of all experiments can be found in Table A2 in the appendix. Using molecular biological methods, breeding successes can be achieved more quickly in order to obtain plants that are better suited to meeting the increasing demand for agricultural products and coping with changing climatic factors. These are first planted on a small scale in the greenhouse (Table A2). If a new breed is suitable for outdoor cultivation,

this can be realized on a larger scale in the FCU (Table A1).

Growth of potato plants at the GPU Dürnast for the Chair of Phytopathology. Foto: GPU.

For the project network **BayKlimaFit 2 – *Strong Plants Mitigating the Impact of Climate Change*** (duration: 2021 to 2024, https://www.bayklimafit.de/), funded by the **Bavarian State Ministry for the Environment and Consumer Protection** and coordinated by the Chair of Plant Breeding (Prof. Schön), several experiments were carried out in the GPU Dürnast (Table A2) as well as in the FCU (Table A1) and in TUMmesa (Table 2). In addition to maize, also barley for the Weihenstephan Research Center for Brewing and Food Quality (Prof. Gastl) and the research group of Prof. Hückelhoven (Phytopathology), as well as rapeseed for the research groups of Prof. Bienert (Crop Physiology), rapeseed and strawberries for the research group of Prof. Leonhardt (Plant-Insect Interaction), and potatoes for the LfL had been cultivated.

For the **CRC 924 *molecular mechanisms regulating yield and yield stability in plants***, spokesperson Prof. Schwechheimer, numerous experiments were also carried out in 2023. Maize, barley, wheat, tomatoes and lotus were planted for this purpose. The final symposium of the CRC 924 took place in April 2023. Maize, the most harvested cereal crop in terms of quantity, is not only the focus of the BMBF project MAZE (see above), but also, as in CRC 924 and BayKlimaFit 2, in subprojects of the DFG-funded **priority program 2089** (P7, Prof. Bienert, https://www.ufz.de/spp-rhizosphere/) and the BMBF-funded project **InnoSoilPhos** (https://www.innosoil-phos.de/). In addition to maize, the research group of Prof. Bienert is also studying pak choi as part of the latter.

The research group of Prof. Hückelhoven is investigating, among other things, the interaction of potatoes with pathogens as part of the **Ecosol** project of the SusCrop – ERA-NET (https://www.suscrop.eu/), which is funded by the EU Horizon2020 program, and a project supported by the QS Science Fund (https://www.q-s.de/qs-system/qs-wissenschaftsfonds.html).

Growth of maize plants at the GPU Dürnast for the Chair of Plant Breeding. Foto: GPU.

Plant-parasite interactions in wild tomatoes are being investigated in several DFG-funded projects of Prof. Tellier (TE809/1-1 & 4, TE809/7-1).

To further explore the potential of indoor farming, lettuce and herbs (Chair of Agricultural Systems Engineering, Prof. Bernhardt) were planted alongside wheat varieties from NASA (Chair of Digital Agriculture, Prof. Asseng, supported by the Werner Siemens Foundation).

Experiments with trees, flowering plants, grasses and ferns were carried out in the GPU in Dürnast and partly also in TUMmesa for projects in the field of ecology, such as the DFG **Research Training Group 2679 'Urban Green Infrastructure'** (Prof. Kollmann/Restoration Ecology and Prof. Egerer/Urban Productive Ecosystems), the project **'BlühDiv'** (Prof. Kollmann) supported by the State Ministry for the Environment and Consumer Protection and the HEF, and DFG projects of the research group of Prof. Weisser (WE3081/40-1, WE3081/25-2, SPP 1374, Terrestrial Ecology).

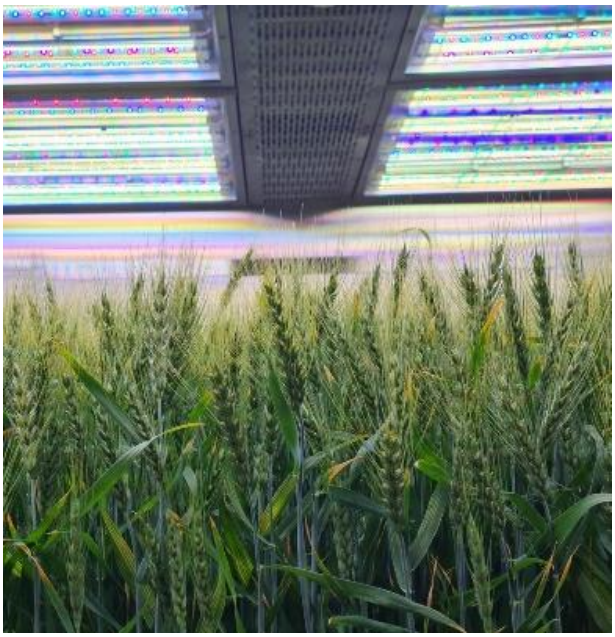
As part of collaborative projects, Indian curry leaf was planted for the Leibniz Institute for Food Systems Biology at TUM (Leibniz-LSB@TUM), lotus for a research group at LMU and winter barley for the LfL. Experiments were carried out with biocement for the start-up Dust BioSolutions GmbH and mushroom mycelium was grown for new foods for Walding Foods GmbH.

TUMmesa

The TUMmesa facility provides climate chambers with the latest technology and correspondingly fine regulation options for various environmentally relevant growth parameters. The research projects listed in Table 4 were carried out there.

Growth of thale cress (*Arabidopsis thaliana*) at TUMmesa for the Chair of Biotechnology of Natural Products. Foto: Moritz Kruse

As part of these experiments, for example, parameters for the cultivation of wheat indoors and the influence of various stress factors on the growth and adaptation to these for various crops and forest plants were investigated.



Growth of dwarf wheat at TUMmesa for the Chair of Digital Agriculture.

Since TUMmesa can be used to carry out complex dynamic climate simulations and other precisely regulated plant experiments, it has been and continues to be involved in TUM research projects with various cooperation partners, such as the Institute of Network Biology (INET) at Helmholtz Munich and the Plant Ecology Department of the Justus Liebig University of Giessen.

Table 2: Detailed List of Experimental Activities in TUMmesa .

Nr.	Chair/Institution	Project Management/Supervision	Project/Plant
1	Digital Agriculture	Prof. Asseng & M.Sc. Eichelsbacher	With Support by the **Werner Siemens Foundation** for vertical farming projects: *Indoor-Wheat – Limits of Production* (since 2023)
2	Botany	Prof. Grill, Dr. Yang	*Molecular basis of efficient water use of plants under moderate water deficit* (since 2022, publication in 2024)
3	Root-Soil Interactions	Prof. Ahmed, Dr. Abdalla	**DFG project:** *emerging effects of root hairs on plant scale soil water relations: Root-soil biophysical processes impacting plant water status in different crops during soil drying* (since 2023)
4	Biotechnology of Natural Products	Prof. Assaad, M.Sc. Wiese	**DFG project:** *characterization of a core module required for allocation decisions and adaptive responses in Arabidopsis (*AS110/8-1) *- Effects of the TRAPPII phosphorylation state on plant adaptive responses and resilience to future climate scenarios* (2023 started)
5	Plant-Insect Interactions & Restoration Ecology	Prof. Leonhardt, M.Sc. Nebauer, M.Sc. Prucker & Prof. Kollmann	**BayKlimaFit 2 FruKlimaBest:** *investigating the effect of warming (and pesticide stress) on activity and pollination service of three flower-visiting insect species on strawberry plants* (2023 terminated)
6	Population Genetics	Prof. Tellier, Dr. Silva-Arias, M.Sc. Muntaha	**DFG project** and preparation of new proposal: *revealing adaptive divergence among populations of Solanum chilense using hybrid individuals growing under controlled conditions* (2023 terminated)
7	Restoration Ecology	Prof. Kollmann, M.Sc. Berger	**DFG Research Training Group 2679:** *plant trait responses in grasses to infiltration-swale-like conditions* (2023 started/terminated)
8	Ecosystem Dynamics and Forest Management in Mountain Landscapes	Prof. Seidl, Dr. Muñoz Mazón	**ERC project: FORWARD**, 2021-2026 *- causes and consequences of forest reorganization: towards understanding of forest change* (2023 terminated)
9	Brewing and Beverage Technology	Prof. Becker, Prof. Gastl	**BayKlimaFit 2:** *influence of heat stress during growth on the synthesis of starch in brewing barley* (2023 terminated)
10	Terrestrial Ecology	Prof. Weisser, Dr. Heinen	*Artificial Light At Night (ALAN) - effects on wild herbaceous plant communities and the interactions with insect communities* (2023 terminated)

5. Teaching

PTC executive personnel (Dr. Amon, Dr. Hausladen, Dr. Steger, Dr. Jakli) have participated in over 30 semester hours (SH) teaching at TUM by giving lectures and supervising exercises and excursions:

- B.Sc. Agricultural and Horticultural Sciences: Farm and Production Systems (4 SH, Amon)
- B.Sc. Agricultural and Horticultural Sciences: Applied Statistics (2 SH, Amon)
- M.Sc. Agricultural and Horticultural Sciences: Applied Statistics (2 SH, Amon)
- One- and multi-day specialist excursions (0.5 SH, Amon)
- Agrobiosciences: research internship (4 SH, Hausladen)
- Agricultural Systems Science: practical course and training (3.8 SH, Hausladen)
- Epidemiology and management of plant diseases: lectures, seminars and exercises (4 SH, Hausladen)
- Plant protection: lecture (1.6 SH, Hausladen)
- Organismic phytopathology: lecture and exercise (0.7 SH, Hausladen)
- Special phytopathology: lecture and exercise (0.7 SH, Hausladen)
- One- and multi-day specialist excursions (0.8 SH, Hausladen)
- PhD student supervision (Hausladen)
- Plant protection/measurement technology: practical course (1.1 SH, Steger)
- Plant propagation in horticulture: practical course (2.1 SH, Steger)
- Technological basics of horticultural production: lecture and excursion (3.6 SH, Steger)
- Agricultural/horticultural excursion (0.42 SH, Steger)
- Plant protection/measurement technology: practical course (1.1 SH, Jakli)

Wheat growing in greenhouse compartments at the GPU. GPU Dürnast has 8 eight such cabins. Besides the usual greenhouse climate options, they can be cooled. Foto: GPU.

6. Publications and Theses

The following lists publications, lectures, and theses that were created using data from experiments conducted at the PTC and published, held, or submitted in the current corporate year, as far as this was queried by the sub-units or communicated by the users. In the future, the recording will be expanded and carried out systematically.

Publications in scientific journals

FCU

1. Argens, L., Brophy, C., Weisser, W. W., & Meyer, S. (2023). Functional group richness increases multifunctionality in intensively managed grasslands. Grassland Research, 1–16. https://doi.org/10.1002/glr2.12060.

   Just C., Armbruster M., Barkusky D., Baumecker M., Diepolder M., Döring T.F., Heigl L., Honermeier, B., Jate M., Merbach I., Rusch C., Schubert D., Schulz F., Schweitzer K., Seidel S., Sommer M., Spiegel H., Thumm U., Urbatzka P., Zimmer J., Kögel-Knabner I., Wiesmeier M. (2023). Soil organic carbon sequestration in agricultural long-term field experiments as derived from particulate and mineral-associated organic matter. Geoderma 434, June 2023, 116472.

2. Hagn L., Schuster J., Mittermayer M., Hülsbergen K.-J. (2023). Satellite-supported analysis of the spatial variability for the derivation of yield zones and its causes. Lecture Notes in Informatics, pp. 327 – 332.

3. Götz, K., Soitinaho, R. and Oksanen, T. (2023). Ploughing Furrow Recognition for Onland Ploughing using a 3D-LiDAR sensor. Computers and Electronics in Agriculture, Elsevier. Vol. 203, 107941.

4. Levin K.S., Winkhart F., Hülsbergen K.-J., Reents H.J., Auerswald K. (2023). Artefacts in Field Trial Research—Lateral Ammonia Fluxes Confound Fertiliser Plot Experiments. Agriculture, 13 (8), art. no. 1617, DOI: 10.3390/agriculture13081617.

5. Poyda A., Levin K.S., Hülsbergen K.-J., Auerswald K. (2023). Perennial Crops Can Compensate for Low Soil Carbon Inputs from Maize in Ley-Arable Systems. Plants, 12 (1), art. no. 29, DOI: 10.3390/plants12010029.

6. Urbatzka P., Salzeder G., Castell A. (2023). Welche Leguminose vor Backweizen? Differenzierung zwischen Ertrag und Qualität. Bioland 9, 22-23.

7. Urbatzka P., Heuwinkel H., von Tucher S. (2023). Einfluss von P-Recyclingdüngern auf Ertrag und P-Gehalt von Silomais im ökologischen Landbau. VDLUFA-Schriftenreihe 80, 179-183.

8. Urbatzka P., Salzeder G. (2023). Einfluss von Saatzeitpunkt und Art verschiedener Futterleguminosen auf den Besatz mit Ampfer im ökologischen Landbau. Mitt. Ges. Pfl. 33, 365-366.

9. Urbatzka P., Salzeder G., Castell A. (2023). Ansprüche von Backweizen nach verschiedenen legumen Vorfrüchten im ökologischen Landbau. Mitt. Ges. Pfl. 33, 327-328.

10. Schuster J., Hagn L., Mittermayer M., Maidl F.-X., Hülsbergen K.-J. (2023). Using Remote and Proximal Sensing in Organic Agriculture to Assess Yield and Environmental Performance. Agronomy, 13 (7), art. no. 1868, DOI: 10.3390/agronomy13071868.

11. Schuster J., Mittermayer M., Maidl F.-X., Nätscher L., Hülsbergen K.-J. (2023). Spatial variability of soil properties, nitrogen balance and nitrate leaching using digital methods on heterogeneous arable fields in southern Germany. Precision Agriculture, 24 (2), pp. 647 - 676, DOI: 10.1007/s11119-022-09967-3.

12. Strenner M., Chmelíková L., Hülsbergen K.-J. (2023). Compost fertilization in organic agriculture—A comparison of the impact on corn plants using field spectroscopy. Applied Sciences 13 (6), art. no. 3676. DOI: 10.3390/app13063676.

GPU

1. Hoheneder F.* & Steidele C.E.*, Messerer M., Mayer K., Köhler N., Wurmser C., Heß M., Gigl M., Dawid C., Stam R., Hückelhoven R. (2023). Barley shows reduced Fusarium Head Blight under drought and modular expression of differential expressed genes under combined stress, J. Exp. Bot. 74: 6820-6835, https://doi.org/10.1093/jxb/erad348. *equal contributions

2. Kahlon P.S., Förner A., Muser M., Oubounyt M., Gigl M., Hammerl R., Baumbach J., Hückelhoven R., Dawid C., Stam R. (2023). Laminarin-triggered defence responses are geographically dependent for natural populations of *Solanum chilense*. J. Exp. Bot.: 74: 3240-3254, https://doi.org/10.1093/jxb/erad087.

3. Dervishi, V., Fleckenstein, C., Rahman, M. A., Pauleit, S., Ludwig, F., Pretzsch, H., & Rötzer, T. (2023). Trees in planters – Growth, structure and ecosystem services of *Platanus x hispanica* and *Tilia cordata* and their reaction to soil drought. Urban Forestry & Urban Greening, 86, 128024.

4. Rahman, M. A., Fleckenstein, C., Dervishi, V., Ludwig, F., Pretzsch, H., Rötzer, T., & Pauleit, S. (2023). How good are containerized trees for urban cooling? Urban Forestry & Urban Greening, 79, 127822.

5. Bauer, M., Krause, M., Heizinger, V. & Kollmann, J. (2023). Increased brick ratio in urban substrates has a marginal effect on tree saplings. Trees, 37, 875–889.

6. Heinen, R., Sánchez-Mahecha, O., Bezemer, T.M., Dominon, D.M., Knappe, C., Kollmann, J., Kopatsch, A., Pfeiffer, Z.A., Schloter, M., Sturm, S., Schnitzler, J.P., Vlot, A.C. & Weisser, W.W. (2023). Part-night exposure to artificial light at night has more detrimental effects on aphid colonies than fully lit nights. Philosophical Transactions B, 378, 20220357.

7. Rojas-Botero, S., Teixeira, L.H. & Kollmann, J. (2023). Low precipitation due to climate change reduces multifunctionality of urban grasslands. PLOSone, 18, e0275044.

8. Rojas-Botero, S., Teixeira, L.H., Prucker, P., Kloska, V., Kollmann, J. & Le Stradic, S. (2023). Root traits of grasslands rapidly respond to climate change, while community biomass mainly depends on functional composition. Functional Ecology, 37, 1771–2085.

9. Heinen, R., Sanchez-Mahecha, O., Martijn Bezemer, T., Dominoni, D. M., Knappe, C., Kollmann, J., ... & Weisser, W. W. (2023). Part-night exposure to artificial light at night has more detrimental effects on aphid colonies than fully lit nights. Philosophical Transactions of the Royal Society B, 378(1892), 20220357.

10. Neuhaus-Harr, A., Ojeda-Prieto, L., Eilers, E., Müller, C., Weisser, W. W., & Heinen, R. (2023). Chemodiversity affects preference for *Tanacetum vulgare* chemotypes in two aphid species. Oikos, e10437.

11. Sanchez-Mahecha, O., Klink, S., Rothballer, M., Sturm, S., Weisser, W. W., Zytynska, S., & Heinen, R. (2023). Microbe-induced plant resistance against insect pests depends on timing of inoculation but is consistent across climatic conditions. Functional Ecology.

12. Witzgall, K., Hesse, B. D., Seguel, O., Oses, R., Grams, T. E. E., & Mueller, C. W. (2023). Tracing low-CO_2 fluxes in soil incubation and ^{13}C labeling experiments: a simplified gas sampling system for respiration and photosynthesis

measurements. Journal of Geophysical Research: Biogeosciences, 128(9), e2023JG007410.

13. Brajkovic S., Rugen N., Agius C., Berner N., Eckert S., Sakhteman A., Schwechheimer C., Kuster B. (2023). Getting ready for large-scale proteomics in crop plants. Nutrients. 2023 Feb 3;15(3):783, doi: 10.3390/nu15030783, PMID: 36771489.

14. Wei, K., Silva-Arias, G. A., Tellier, A. (2023). Selective sweeps linked to the colonization of novel habitats and climatic changes in a wild tomato species. New Phytologist 237:1908–1921, doi: 10.1111/nph.18634.

Contributions to conferences

This was not recorded for the GPU.

FCU

1. Camenzind M.P. & Yu K. (2023). UAS-based multispectral imaging and feature selection for yield prediction. In Precision agriculture ’23 (pp. 831–837). Wageningen Academic. https://doi.org/10.3920/978-90-8686-947-3_104.

2. Lemke J.A.I., Soitinaho R. and Oksanen T. (2023). Highly accurate obstacle localization using fused inertial, RTK-GNSS, and Lidar positioning for agricultural field operations. IFAC World Congress 2023, Yokohama, Japan.

3. Mokhtari A., Sadeghi M., Afrasiabian Y. & Yu K. (2023). An optical trapezoid model for actual evapotranspiration and winter wheat yield estimation. In Precision agriculture ’23 (pp. 293–297). Wageningen Academic. https://doi.org/10.3920/978-90-8686-947-3_35.

4. Soitinaho R. and Oksanen T. (2023). Local navigation and obstacle avoidance for an agricultural tractor with nonlinear model predictive control. IEEE Transactions on Control Systems Technology, Vol 31(5), pp. 2043–2054.

5. Song X., Luca S.V., Deng Q., Camenzind M., Qin W., Yang H., Minceva M. & Yu K. (2023). Tracking wheat senescence based on UAV multispectral imaging. In Precision agriculture ’23 (pp. 213–219). Wageningen Academic. https://doi.org/10.3920/978-90-8686-947-3_25.

6. Urbatzka P., Heuwinkel H., von Tucher S. (2023). Einfluss von P-Recyclingsdüngern auf Ertrag und P-Gehalt von Silomais im ökologischen Landbau. Statusseminar der BMBF-Fördermaßnahme „Regionales Phosphor-Recycling“ (RePhoR), 03./04.05.2023, Frankfurt a.M..

7. Urbatzka P., Kimmelmann, S. (2023). Wirkung des Gerätes CombCut auf die Ackerkratzdistel bei verschiedenen Getreidearten. Beiträge zur 16. Wissenschaftstagung Ökologischer Landbau, 188-191.

8. Urbatzka P., Salzeder G., Eckl T., Mikolajewski S, Castell A. (2023). Ertrag und Qualität von Winterweizen in Abhängigkeit der Fruchtfolge und der Sorte in einem Dauerfeldversuch. Beiträge zur 16. Wissenschaftstagung Ökologischer Landbau, 262-265.

9. Urbatzka P., Eckl T., Salzeder G., Castell A. (2023). Leistungen von Kleegras in Abhängigkeit des Saatzeitpunktes und der Nutzung in einem Dauerfeldversuch. Beiträge zur 16. Wissenschaftstagung Ökologischer Landbau, 74-77.

10. Amann M., Hülsbergen K.-J., Flaig V., Kühling I., Kage H., Chmelikova L. (2023). Intensitäts- und Standortdifferenziertes Klimaschutzpotential von Leguminosen in Anbausystemen mit N-effizienter Düngung (ISLAND). Mitt. Ges. Pflanzenbauwiss. 33, 199-200.

Dissertations

This was not recorded for the GPU.

FCU

1. Hammerl Sonja (2023). Die genetischen Grundlagen der Kohlenstoffisotopendiskriminierung

und Trockenstresstoleranz in Mais, Dissertation, Technische Universität München.

2. Mittermayer, Martin (2023). Analysis of site-specific N balances using digital methods in heterogeneous croplands in southern Germany, Dissertation, Technische Universität München.

Master theses

FCU

1. Amann, Michael (2023). Wirkung von Pflanzenkohle in Kombination mit Biogasgärresten und Mineraldünger in einem Feldversuch mit Silomais (*Zea mays L.*).
2. Lipp, Michael (2023). Validierung der Sickerwassermodelle Monica und BOWAM an Lysimeterdaten der Standorte Dürnast (Bayern), Buttelstedt (Thüringen) und Brandis (Sachsen).
3. Mutz, Elisa (2023). Charakterisierung von Biomasseertrag und Stickstoffentzug der Grünlandvegetation mit hyperspektralen Daten und Vegetationsindices in einem Grünland-Düngungsversuch im Voralpenraum.
4. Qiqi Deng, Horticultural Science (2023). Tracing leaf optical senescence of winter wheat grown under different nitrogen supply conditions.
5. Rachna Singh, Sustainable Resource Management (2023). Remote monitoring of chlorophyll and nitrogen dynamics in winter wheat: is chlorophyll content a good proxy for nitrogen estimation throughout the growing season?
6. Salwin Maliakal Shaju, Horticultural Science (2023). Utilizing LAI, plant height, and SPAD as indicators for determining grain yield and nitrogen use efficiency in winter wheat: a UAV-based approach.
7. Scharfe, Lukas, Agrarsystemwissenschaften (2023). Einfluss von unterschiedlichen Grünlandsaaten und Düngungsstufen auf die Ertragsparameter des Sommerweizens sowie auf die organische Bodensubstanz.
8. Schuster J., Mittermayer M., Maidl F.-X., Nätscher L., Hülsbergen K.-J. (2023). Spatial variability of soil properties, nitrogen balance and nitrate leaching using digital methods on heterogeneous arable fields in southern Germany. Siehe auch Publikationen.
9. Subash Sedai, Horticultural Science (2023). Mapping wheat crop canopy structures and chlorophyll seasonal dynamics in a diversified experimental field using remote sensing.
10. Vladyslav Pitsyk, Agricultural Biosciences (2023). Comparative analysis between aboveground biomass and photosynthetic parameters as predictors of winter wheat yield.

GPU

This was not recorded for the GPU. Only the thesis supervised personally by Dr. Hausladen is listed.

1. Liebl, Judith (2023). Erforschung der Wirksamkeit verschiedener Biologicals gegen *Phytophthora infestans* an Kartoffel in einem Feldversuch/Testing of different biological control agents for control of *Phytophthora infestans* on potato under field conditions.

Bachelor theses

FCU

1. Bauersachs, Leonie (2023). Entwicklung einer Methodik zur Bewertung der Ernährungsleistung verschiedener Anbausysteme und beispielhafte Anwendung in einem Dauerfeldexperiment.
2. Fruth, Alina (2023). Analyse der N-Dynamik in Böden nach Einsatz von Pflanzenkohle mit organischen Düngern in Inkubationsversuchen.
3. Gandorfer, Julia (2023). Analyse von Ertrag, Ertragsstruktur und Stickstoffbilanz von Winterweizen in einem Feldexperiment mit Pflanzenkohle

in Kombination mit Gärrest- und Mineralstickstoff-Düngung.

4. Merkle, Johanna (2023). Einfluss von Pflanzenkohle auf den Ertrag und die Artenzusammensetzung von Luzerne-Kleegras.

5. Milde, Manuel (2023). Feldexperimentelle Analysen der Auswirkungen verschiedener mineralischer Düngesysteme auf Ertragsparameter sowie auf die N-Effizienz im Winterweizen.

6. Moser, Adriana (2023). Einfluss von unterschiedlichen Zwischenfrüchten auf Lachgasemissionen, Nmin-Dynamik und Bodenwassergehalt unter den Bedingungen des ökologischen Landbaus.

7. Schindler, Marie (2023). Analyse der Einflussfaktoren auf die Stickstofffixierung der Futterleguminosen Luzerne und Rotklee.

GPU

This was not recorded for the GPU. Only the theses supervised personally by Dr. Hausladen are listed.

1. Jakob Held (2023). Einfluss des Genotyps der Kartoffel auf die Wirksamkeit von *Trichoderma harzianum* 20761 als Bio-Control Agents (BCA) gegen *A. solani* / Influence of potato genotyp on the efficacy of *Trichoderma harzianum* 20761 as a bio-Control agent (BCA) against *A. solani*.

2. Carolin Dürr (2023). Einfluss verschiedener Temperaturstufen auf die Befallsentwicklung von *Alternaria solani* und die Genexpression an der Kartoffel / Influence of different temperature levels on *Alternaria solani* infection and gene expression in potatoes.

3. Claire Haumann (2023). Einfluss von VOCs emittiert von *Trichoderma spp.* auf das Wachstum von *Alternaria solani* und *Phytophthora infestans* / Inhibition of *Alternaria solani* and *Phytophthora infestans* through volatile organic compounds emitted by Trichoderma spp.

Furthermore, Benedikt Schiestl's bachelor thesis submitted in 2022 on the topic ‘Effectiveness of *Trichoderma spp.* culture filtrates against various *Alternaria solani* isolates in relation to the cultivation time’ was awarded by the *Promotion Association of the Potato Industry e. V.*.

Phytochambers of the TUM Model Ecosystem Analyser (TUMmesa). Foto: GPU.

7. Supplement

Table A1 – Detailed list of the FCU's experimental activities

Nr.	Chair/Institution	Experimental Farm	Title of the trial	Gross trial area [ha]
1	Agricultural mechatronics	Dürnast	Agricultural mechatronics test field (since 2020 for 5 years)	5.20
2	Crop Physiology	Dürnast	Calcium phosphate fertilization test, long-term test	0.15
3	Crop Physiology	Dürnast	Nitrogen phosphate enhancement test, long-term test	0.32
4	Crop Physiology	Dürnast	INPLAMINT, trial to investigate the N transfer from winter rapeseed to the subsequent winter wheat crop using wheat straw and under the influence of spring drought	0.2
5	Crop Physiology	Veitshof	Grassland deficiency trial, long-term trial	0.10
6	LfL	Viehhausen	Long-term trial on crop rotation in organic farming V049	1.50
7	LfL	Viehhausen	Seeding time trial in lupine	0.25
8	LfL	Viehhausen	Maize undersowing	0.30
9	LfL	Viehhausen	Influence of type and timing of clover-grass tillage on crop rotation in organic crop production	1.00
10	LfL	Viehhausen	Effectiveness of P-recycling fertilizers in organic farming	0.80
11	LfL	Viehhausen	State variety trial soybean	0.20
12	Organic Agriculture & Agronomy	Thalhausen	StMELF TerraBayt: long-term effects of biochar on soils, plants and the environment in conventional agriculture	0.97
13	Organic Agriculture & Agronomy	Wolfratshau-sen / Baierlach	StMELF TerraBayt: biochar and manure in organic grassland	0.30
14	Organic Agriculture & Agronomy	Burgkirchen	StMELF TerraBayt: biochar and nitrate in winter wheat	0.52
15	Organic Agriculture & Agronomy	Burgkirchen / Viehhausen	StMELF digisens: sensor-based fertilization and yield determination	1.00
16	Organic Agriculture & Agronomy	external sites	ProBio: strip tests with different composts	3.25
17	Organic Agriculture & Agronomy	Roggenstein	Energy crop trial, long-term trial	0.90

18	Organic Agriculture & Agronomy	Roggenstein	Energy trees, long-term test	0.20
19	Organic Agriculture & Agronomy	Roggenstein	StMELF digisens: reduced nitrogen fertilization through crop rotation	0.70
20	Organic Agriculture & Agronomy	Roggenstein	StMELF digisens: winter wheat - sensor-based nitrogen optimization	0.60
21	Organic Agriculture & Agronomy	Roggenstein	StMELF TerraBayt: long-term effects of biochar on soils, plants and the environment	0.63
22	Organic Agriculture & Agronomy	Roggenstein	StMELF digisens: winter barley - sensor-based nitrogen optimization	1.00
23	Organic Agriculture & Agronomy	Viehhausen	Energy crop rotation trial, long-term trial	5.30
24	Organic Agriculture & Agronomy	Viehhausen	System comparison of 4 organic and 2 conventional farming systems	2.00
25	Organic Agriculture & Agronomy	Viehhausen	ProBio: effect of different compost fertilizers in organic farming, exact test	0.90
26	Organic Agriculture & Agronomy	Dürnast	Effect of different nitrogen forms on the yield of wheat, barley and maize, long-term test	0.15
27	Organic Agriculture & Agronomy	Dürnast	ISLAND (intensity and site-specific climate protection potential of legumes in cultivation systems with N-efficient fertilization) 1 – crop rotation effects of soybeans	0.82
28	Plant Breeding	Dietersheim	BMBF MAZE - maize breeding trial, see also 31-35	1.26
29	Plant Breeding	Langepoint	Maize breeding garden	0.10
30	Plant Breeding	Rolling house	Maize, drought stress test	0.03
31	Plant Breeding	Roggenstein	BMBF MAZE – Accessing the genomic and functional diversity of maize to improve quantitative traits - various maize breeding experiments	0.60
32	Plant Breeding	Roggenstein		1.82
33	Plant Breeding	Roggenstein		0.77
34	Plant Breeding	Roggenstein		0.77
35	Plant Breeding	Roggenstein		0.15
36	Plant Breeding	Roggenstein		0.07
37	Plant Breeding	Roggenstein		0.27
38	Phytopathology	Dürnast	Experiment on primary infection of *Phytophthora infestans* on potatoes	0.16
39	Phytopathology	Dürnast	Increasing the effect of biologicals by adding excipients (potatoes)	0.21

40	Phytopathology	Dürnast	Investigation of the interaction of culture filtrates and varieties in an *Alternaria* infection (potatoes)	0.78
41	Phytopathology	Roggenstein	Investigations regarding the adaptation of the fungicide strategy for the control of *Phytophthora infestans* (potatoes)	0.37
42	Phytopathology	Roggenstein	Treatment strategies against *Alternaria* with different biologicals and potato varieties	0.22
43	Phytopathology	Roggenstein	EU Ecosol: Different treatment strategies for *Phytophthora* on potatoes with biologicals	0.47
44	Phytopathology	Roggenstein	EU Ecosol: Different treatment strategies for *Alternaria* on potatoes with biologicals	0.47
45	Phytopathology	Roggenstein	StMUV BayKlimaFit 2: seed propagation of spring barley Golden Promise	0.01
46	Precision Agriculture	Roggenstein	Different fertilization levels (nitrogen) for wheat and monitoring with drones and satellites	1.86
47	Precision Agriculture	Dürnast	Reducing NH_3 losses to increase N efficiency when using synthetic nitrogen fertilizers	3.28
48	Precision Agriculture	Dürnast	Improving wheat variety using high-throughput field phenotyping	0.50
49	Precision Agriculture	Dürnast	Legacy Net: Influence of different grassland crops and fertilization levels on the yield parameters of spring wheat and on soil organic matter	0.46
50	Precision Agriculture	Dürnast	AgroMissionHub Weihenstephan AmAlzed GPU Dürnast - exterior area	0.13
51	Precision Agriculture	Dürnast	AgroMissionHub Weihenstephan AmAlzed area D3	0.30
52	Precision Agriculture	Dürnast	Different fertilization levels (nitrogen) for wheat and monitoring with drones and satellites	2.12
53	Restoration Ecology	Dürnast	HEF and StMUV project ‚BlühDiv' – biodiversity in different green strip mixtures	0.80
54	Forest Management	Dürnast	Agroforestry systems as key components of multi-functional landscapes, for DFG grant application, showcase	1.46
55	Forest Management	Roggenstein	Agroforestry systems as key components of multi-functional landscapes, for DFG grant application	31.00
	Number	**55**	**Sum**	**79.72**

Table A2 – Detailed list of the experimental activities of the GPU Dürnast

Nr.	Chair/Institution	GPU Dürnast area	Project / crop
1	Agricultural Systems Technology	Cold storage room	Breeding and cultivating lettuce and herbs – vertical farming
2	Agricultural Systems Technology	Outdoor area	Optimization of sports turf under LED lighting
3	Biotechnology of Natural Products	Climate chamber	Ingredients of strawberries (*Fragaria spp.*) – detection of secondary metabolism
4	Biotechnology of Natural Products	Greenhouse with tables	Reduction of pollution by birch trees
5	Biotechnology of Natural Products	Greenhouse	iRotation project: apple, pear - diseases
6	Brewing and beverage technology	Greenhouse cabin	StMUV BayKlimaFit 2: winter barley (*Hordeum vulg.*)
7	Campus Office / Lecturer	Greenhouse with tables	Cultivation of *Tagetes, Helianthus, Brassica* under different fertilization levels
8	Crop Physiology	Greenhouse with tables	BayKlimaFit 2: rapeseed (*Brassica napus*) – boron deficiency
9	Crop Physiology	Greenhouse with tables	StMUV BayKlimaFit 2: Brassica QTL mapping (crossing experiments)
10	Crop Physiology	Greenhouse with tables	BMBF InnoSoilPhos: breeding and cultivating pak choi
11	Crop Physiology	Cylinder facility	BMBF InnoSoilPhos: maize (*Zea mays*)
12	Crop Physiology	Greenhouse with tables	Preparatory work for grant application - MaizeNutriUp: maize nutrient accumulation
13	Crop Physiology	Greenhouse with tables	
14	Crop Physiology	Greenhouse with tables	DFG SPP2089: ariel maize amplification
15	Crop Physiology	Cold storage room	StMUV BayKlimaFit 2: rapeseed (*Brassica napus*) - vernalization
16	Crop Physiology	Greenhouse with tables	StMUV BayKlimaFit 2: Brassica QTL mapping
17	Digital Agriculture	Climate chamber	With the support of the Werner Siemens Foundation for vertical farming projects: dwarf wheat - summer (NASA) – environmental and cultural conditions, different approaches
18	Digital Agriculture	Climate chamber	
19	Digital Agriculture & HEF	Climate chamber	
20	Digital Agriculture & HEF	Climate chamber	
21	Dust BioSolutions GmbH	Outdoor area	Erosion protection through biocement
22	Forest- and Agroforest systems	Greenhouse cabin	Breeding of young plants: beech, Douglas fir, fir

23	Green Techn. in Landscape Architecture	Outdoor area	Grafting deciduous trees for living architecture
24	Green Techn. in Landscape Architecture	Outdoor area	Planting and irrigation systems for urban greening (Urban Micro Climate Canopy)
25	LfL, IPZ 3a	Greenhouse with tables	StMUV BayKlimaFit 2: potatoes (*Solanum tuberosum*) - drought stress and variety
26	Food Chemistry and Molecular Sensory Science & Walding Foods GmbH	Vegetation hall	Cultivation of mushroom mycelium as a meat substitute
27	Leibniz Institute for Food Systems Biology at TUM	Greenhouse with tables	Indian curry leaf – cultivation for ingredient analysis
28	LfL, IPZ 1b	Climate chamber	Winter barley (*Hordeum vulgare*) - interaction with *Rynchosporium*
29	LMU/Biology/Genetics/	Greenhouse with tables	DFG SFB924: breeding and crossing of lotus for molecular biology work
30	LMU/Biology/Genetics/	Greenhouse with tables	
31	Ecoclimatology	Climate chamber	Different tree species/branches in bottles - bud and climate change
32	Organic Agriculture & Agronomy	Greenhouse with tables	Effect of compost composition on the cultivation of large-leaved cress (*Lepidium sativum*)
33	Plant Genetics	Greenhouse cabin	DFG SFB924: Cultivation of lotus as a model plant for climate change
34	Plant Breeding	Greenhouse with gutters	StMUV BayKlimaFit 2: research project maize (*Zea mays*)
35	Plant Breeding	Climate chamber	
36	Plant Breeding	Climate chamber	
37	Plant Breeding	Climate chamber	
38	Plant Breeding	Greenhouse with gutters	
39	Plant Breeding	Greenhouse with gutters	
40	Plant Breeding	Climate chamber	
41	Plant Breeding	Climate chamber	
42	Plant Breeding	Greenhouse with tables	Cultivation of barley for practicals
43	Plant Breeding	Greenhouse with gutters	BMBF MAZE: research project maize (*Zea mays*)
44	Plant Breeding	Greenhouse with gutters	
45	Plant Breeding	Greenhouse with gutters	
46	Plant Breeding	Greenhouse with gutters	
47	Plant Breeding	Greenhouse with gutters	DFG SFB924: maize (*Zea mays*)

48	Plant Breeding	Greenhouse with gutters	- breeding project
49	Plant Breeding	Greenhouse with gutters	
50	Plant Breeding	Greenhouse with gutters	
51	Plant Breeding	Greenhouse with gutters	
52	Phytopathology	Greenhouse cabin	Potatoes (*Solanum tuberosum*) - interaction with pathogens
53	Phytopathology	Climate chamber	Potatoes (*Solanum tuberosum*) - heat stress - susceptibility to disease
54	Phytopathology	Greenhouse with tables	EU Ecosol: breeding potatoes (*Solanum tuberosum*) – analysis of interaction with pathogens
55	Phytopathology	Greenhouse with tables	StMUV BayKlimaFit 2: Propagation of seeds, breeding cultivation and infection of summer barley (*Hordeum vulgare*)
56	Phytopathology	Greenhouse cabin	
57	Phytopathology	Greenhouse with tables	
58	Phytopathology	Greenhouse cabin	Wild cereal *Aegilops tauschii* – unsuccessful interaction with pathogens
59	Phytopathology	Greenhouse with tables	DFG SFB924: propagation, breeding and cultivation of summer barley and interaction with pathogens (cv. Golden-Promise)
60	Phytopathology	Greenhouse cabin	
61	Phytopathology	Greenhouse cabin	
62	Phytopathology	Greenhouse with tables	
63	Phytopathology	Climate chamber	QS Science Fund Project: potatoes (*Solanum tuber.*) - interaction drought stress and pathogen
64	Phytopathology	Greenhouse with tables	Potatoes (*Solanum tuberosum*) - breeding
65	Plant Insect Interactions und Crop Physiology	Climate chamber	StMUV BayKlimaFit 2, project FruKlimaBest: rapeseed (*Brassica napus*) - vernalization
66	Plant-Insect Interactions	Greenhouse with tables	StMUV BayKlimaFit 2, project FruKlimaBest: rapeseed (*Brassica napus*) - breeding
67	Plant-Insect Interactions	Greenhouse with tables	StMUV BayKlimaFit 2, project FruKlimaBest: pollination behavior of cornflower (*Cyanus segetum*) – breeding for TUMmesa
68	Plant-Insect Interactions	Greenhouse with tables	StMUV BayKlimaFit 2, project FruKlimaBest: pollination behavior of strawberries (*Fragaria spp.*) – breeding for TUM-mesa
69	Population Genetics	Greenhouse cabin	DFG project: tolerance to drought and heat stress and pathogens - cultivation of wild tomatoes (*Solanum chilense*)
70	Population Genetics	Greenhouse cabin	
71	Population Genetics	Greenhouse with tables	
72	Population Genetics	Greenhouse with tables	

73	Population Genetics	Greenhouse with tables	
74	Population Genetics	Greenhouse with tables	
75	Population Genetics	Greenhouse with tables	
76	Population Genetics	Greenhouse with tables	
77	Population Genetics	Greenhouse with tables	DFG project: tolerance to drought and heat stress and pathogens – comparison of cultivation of cultivated tomatoes (*Solanum lycopersicum*)
78	Population Genetics	Greenhouse with tables	Cultivation *Arabidopsis spp.*
79	Population Genetics	Greenhouse with tables	Practical course – breeding and cultivating sunflowers (*Helianthus spp.*)
80	Population Genetics	Greenhouse with gutters	Practical course – cultivating maize (*Zea mays*)
81	Precision Agriculture	Greenhouse with tables	Interaction of drought stress and fertilization status in wheat cultivation (*Triticum spp.*)
82	Restoration Ecology	Greenhouse with tables	DAAD project: Breeding and cultivation of African tree species for drought stress experiments
83	Restoration Ecology	Greenhouse cabin	
84	Restoration Ecology	Greenhouse with tables	DFG Research Training Group 2679: research project on ecological diversity development of native species mixtures
85	Plant Systems Biology	Greenhouse cabin	DFG SFB924: tomatoes (*Solanum lycopersicum*) - long culture for proteomics studies
86	Plant Systems Biology	Greenhouse with gutters	DFG SFB924: cultivation of maize (*Zea mays*) – for proteomics studies
87	Plant Systems Biology	Greenhouse with tables	DFG SFB924: cultivation of wheat (*Triticum spp.*) – for proteomics studies
88	Plant Systems Biology	Greenhouse with tables	DFG SFB924: cultivation of summer barley (cv. Golden-Promise) for proteomics studies
89	Terrestrial Ecology	Greenhouse with tables	DFG project: growth behavior of the tansy species *Tanacetum vulgare* for ecological assessment
90	Terrestrial Ecology	Vegetation hall	
91	Terrestrial Ecology	Outdoor area	DFG SPP 1374: herbivory in beech as a function of land use management
92	Urban Productive Ecosystems	Greenhouse with tables	DFG Research Training Group 2679 Urban Green Infrastructure: interactions of different members of Asteraceae, Fabaceae, Apiaceae and Poaceae for ecological assessment

Picture Cover back: Wheat growing in greenhouse compartments at the GPU. Foto: GPU.

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