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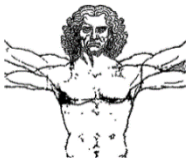

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CASE STUDY

Towards Future Land Use Technologies: Life-long Learning Experiences on Excursions

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Abstract – The integration of current agricultural research results including the use of the latest technologies into professional practice and university teaching requires direct exchange between employed people, students, and researchers. One possibility is the visit of research stations to observe, interpret and discuss the effects of different land-use treatments. This article explains the advantages, challenges and efforts of universities as organizers of excursions. Therefore, a pilot excursion to a well-known research station with a visit to an orchard in Central Germany with students and employees took place. Besides the numerous experiments, the challenges of agriculture in a dry climate (average yearly precipitation from 1896 to 2004 is 484mm) on the very nutrient-rich chernozem were an important topic. Our experiences from this excursion show high potential and the special value of this event to combine the practical challenges of land use with the new possibilities of research. Preparing the content of the excursion to support practical understanding and discussion with the scientists proved to be an advantage. Also useful is a follow-up session for sustainable use of the information gathered during the field trip. Of great importance is an administrative structure at the university that supports this type of teaching.

Keywords – agricultural research, education, land-use, life-long learning

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INTRODUCTION

The quality of studies at universities is challenged by fast technology development and growing demands in modern equipment. Research centers are well equipped and distinguished by carrying out several research projects. Connection of these opportunities with teaching demands may be hampered by formal, bureaucratic, or legal challenges, but could enhance education activities with low expenses. A strategic partnership was funded by the European Union in order to install innovative teaching events as a Trojan Horse to bypass bureaucratic limitations and facilitate sustainable social development in the SUMCULA (Sustainable Management of Cultural Landscapes) project.

One of the initiatives at the University of Applied Sciences Dresden for this project connects research activities in leading research facilities with education demands for different study courses. It aims to inform students about current trends in land use technology development using the latest modern devices and to simplify knowledge transfer by means of direct communication with scientists and individual impressions from field experiments.

Overall approach, participants and organization

A one-day excursion was organized to the Helmholtz-Centre for Environmental Research GmbH (UFZ). It included:
1) Visit of the famous and more than 100 years old long-term field experiments as an assessment base for sustainable management of soil fertility and productivity.
2) Explanation of the Global Change Experimental Facility (GCEF) - one of the world's largest and freshly installed experiments under field conditions about the impact of climate change on different approaches to land use.
3) Information about ongoing research in ECOTRON installations simulating ecosystem development in different environments under controlled laboratory conditions.
4) Several small, field and laboratory experiments such as federal Lysimeter net about leaching of nutrients depended on soil types and climate conditions, exact determination of nitrogen immissions to soil from the atmosphere, optimization of fertilization in agriculture, study consequences of natural succession on soil fertility, provide insight into

chernozems as most productive soil in Germany, and many others.

These activities were combined with a visit at a cherry plantation in order to compare the ongoing basic research activities at research centers with practical needs and achievements of farmers.

Students, docents, and employees of the university were invited to participate by covering the costs of the excursion by private means as a precondition for future self-sustaining teaching events as a part of study courses in the SUMCULA-project.

The organization started with a request of support to the UFZ followed by solving demands of transportation needs, advertisement, preparation meetings for participants, organization of food and others supported by a Master student financed by the SUMCULA project. After the establishment of collaboration with the main partners, they were requested to provide us with program content and schedule which was used for the overall excursion planning and advertisement to find participants.

Main outcomes and content of teaching

The participants were students of Bachelor and Master studies from different fields of knowledge such as agriculture, horticulture, and environmental engineering. Furthermore, several docents from different faculties and employees from governmental authorities and enterprises were accepted as participants due to their support of the SUMCULA idea about sustainable cultural landscape development.

According to the scheduled approach, the research center offered a detailed program to the participants, which was discussed and adjusted to **the** wishes of most participants.

At the beginning of the full-day excursion, the participants were informed about the structure, organization and tasks of the UFZ on the territory of the experimental station in Bad Lauchstädt. The following explanations based on comparing natural conditions (geology, climate, vegetation) with ongoing changes by agricultural use, forestry, climate and technology development which are partly presented below.

Nature conditions

The station is located at the border of the region "Querfurter Platte" and is part of Saxony-Anhalt with chernozems on silty loam in the foreland of the Harz mountains in relatively dry conditions. The visited chernozem profile was elected to be the "Soil of the year 2005".

The chernozems developed on primary carbonatic loess substrates in an open park-like landscape with isolated forest stands. The carbonates were later leached, and the silt transformed to silty loam by weathering under changing climate conditions (Altermann et al. 2005)**.**

The climate conditions are characterized by a mean annual temperature of 8.7°C and mean annual precipitation of 484 mm (mean of years 1896-2004) (Merbach and Schulz 2012). Figure 2 provides an overview of precipitation and temperature since the beginning of the long-term field experiments in 1895. As can be seen, the temperature shows an increasing trend whereas in case of precipitation a high variation year by year by low mean level is a specific feature of the site. In addition, we were informed about very low annual precipitation in 2018 with 250 mm and **a** deficit in precipitation in the current year.

Figure 1. Chernozem profile in Bad Lauchstädt. Photo: I. Merbach (UFZ & iDiv, 2019)

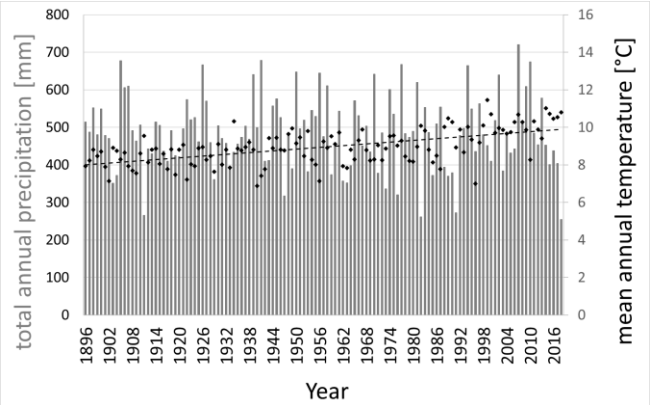

Figure 2. Total annual precipitation and mean annual temperature 1896 till 2018, including linear temperature trend (data received from Dr. Ines Merbach, UFZ).

Impressive experiments

The oldest field experiment was started in 1902 as a static fertilization experiment to study the long-term fertilization effects. In modern times it is in use for the quantification of

the nitrogen and carbon cycling, to detect the interaction between plant growth, soil fertility and water storage, assessment of sustainable soil use in different agro-ecosystems and many other details of modern production demands (Merbach and Schulz 2012). On 3.09 ha, the treatment includes the application of different mineral fertilizer and farmyard manure including parcels without any fertilization (Körschens et. al. 2012). The main crop rotation is based on potato, spring barley, sugar beet, winter wheat with substitution of potato and sugar beet by silage maize in 1978. The fertilization and crop rotation were adapted to modern challenges of land use as described in (UFZ & iDiv, 2019). The information about the experiment during excursion includes detailed information about changing carbon and nitrogen content, yield and climate.

Figure 3. Dr. Merbach explaining the static fertilization experiment. Photo: Ina Krahl (2019)

Figure 5 clearly reveals wilting leaves on corn as the consequence of low precipitation in 2018 and 2019.

Another long-term experiment at GCEF started in 2014 to investigate the effects of future climatic conditions on ecosystem processes under five different land-use scenarios. The facility simulates higher temperatures and altered precipitation patterns in Central Germany with reduced rainfall rates by 15% in summer and increased precipitation in winter and spring by 5% (Schädler et. al. 2019).

Figure 4. Global Change Experiment Facility. Photo: UFZ (2016)

The participants were informed about the technical structure of the experimental facility. The climate changes are controlled by a steel construction with mobile roof and side walls as well as an irrigation system. To simulate rainwater as closely as possible a special water treatment plant is used. A total of 5 repetitions per climate and land use will be realized. The following land use systems will be implemented: conventional farming, organic farming, intensively used meadow, extensively used meadow and extensively used pasture (sheep grazing) (Schädler et.al. 2019).

Figure 5. Integrated total nitrogen input system with corn growing in 2019, Photo: Ina Krahl

A relatively small but interesting experiment is the INTI system, which measures the total nitrogen input from the air. The system is based on the N-isotope dilution method. The plants grow on nitrogen-free quartz sand and nitrogen absorption is possible on the sand surface and trough the sand (UFZ & iDiv, 2019). The individual components of the special circulation system were explained and the used plants (maize and winter rye) were named which ensure the performance of year-round measurements (Merbach and Körschens 2002).

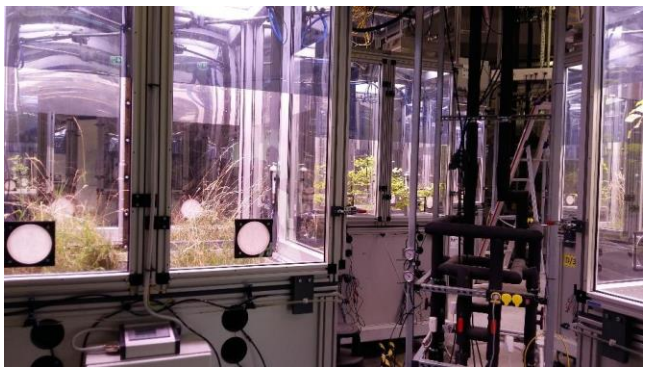

Figure 6. Ecotron hall with grassland and oak experiments. Photo: Ina Krahl (2019)

The large indoor experiment Ecotron with 24 individual manipulable plant chambers (EcoUnit) was of high interest for the excursion participants. The influence of interactions between above and below ground organisms on ecosystem functions under different climate conditions will be investigated. The individual EcoUnits offer the unique opportunity to regulate numerous environmental parameters such as temperature, sunshine hours, precipitation and nutrient supply. At the same time, data on ecological processes will be measured using non-invasive methods, e.g.

lysimeters (Eisenhauer and Türke 2018). During the excursion, the chambers were equipped with several terrestrial ecosystems such as forest and grassland habitats with different plants, insect species (Eisenhauer et. al. 2019), soil organisms and microorganisms.

In the second part of the excursion, the participants got a valuable insight into fruit growing, especially cherries, on very fertile soil, but with little annual precipitation. Therefore, during harvest time the trees are watered all day with a drip irrigation system. Based on soil investigations, missing nutrients are applied precisely via the irrigation system, in the growing season additionally via leaf fertilizer. The need to use large quantities of pesticides is kept to a minimum through the care of beneficial insects in the sense of growing flowering plants, mulched paths and structures for birds of prey as well as regular visual inspections. In the immediate vicinity of the trees, weeds are reduced with herbicides instead of mechanical weed control. The farmer reports that this results in a high ground breeding wild bee population. This is confirmed by Prof. Dr. Robert Paxton (MLU Halle-Wittenberg), who observed in 2019 that 25% of bees visiting flowers on the plantation were wild bees. The fruit grower also reported on the challenge to produce high-quality fruit, which can compete on the regional market against cheaper imported fruit.

DISCUSSION

The interest in such teaching events was reflected in the number of participation requests, which were not limited to students and employees of the university. An enhancement to vocational training does not seem to be out of the question. It could generate income for the university, would meet the growing demands for lifelong learning, support accelerated technology development, and answer complex requirements for sustainable land use as a surviving base for the society (Montgomery, 2012).

The simultaneous participation of students and professionals enriches the teaching and motivates the exchange of experiences and knowledge. We did not observe any negative consequences.

Against previous expectations, the university's collaboration with research institutions allows free of charge teaching caused by the interest and didactic skills of scientists to motivate students for research. The existing infrastructure of the University of Applied Sciences Dresden simplifies the organization of the excursion, e.g. by offering inexpensive bus rentals. On the other hand, the lack of regulations in the financial administration makes it more difficult to deal with possible revenues. In this case, the paid fee could be refunded to the participants.

Cooperation with scientific institutes enables easy access to unique experiments and thus a valuable enrichment of the study offers as well as the professional everyday life. An important criterion to achieve the best possible insights into agricultural research for the participants is the right time during the growing season. In order to identify differences in farming practices, guidance should be provided between seed emergence and fruit ripening. The staff members gave an overview of the overall goals of the UFZ and explained individual research projects in detail. The direct exchange between students and researchers in the field made it possible to question the applicability of the research results in agricultural practice. In addition, the participants were able to identify the motivation of the researchers in the experiments, which favored an increase in interest on the part of the students to deal more closely with the presented contents and solutions of future land use issues. This multisensory knowledge absorption and experience improve memory, knowledge acquisition and motivation to study. In many respects, the combination of science and practice has proven to be successful and exciting for the participants as well as the lecturers.

In a relatively short excursion, a lot of information had to be processed in comparison to a usual course. As a result, we observed a discrepancy between a high concentration and reserved questions about the application of the research results, many questions came afterward on the way back and during the next days. The experimental guide was provided for post-processing.

The impressive variety of experiments and the complexity of the research questions revealed partly unexpected, differentiated perceptions. For example, the perception of fertilizer-related differences in the static fertilization experiment was less prominent than the consequences of the precipitation deficit (Figure 3). At the GCEF the technological implementation to simulate climate change was more impressive than the consequences of climate change for productivity. Both the realization of the measurement of nitrogen input from the air in the INTI system is methodically very interesting as well as the missing lack of N at the plants. The large Ecotron hall was convincing due to the scope of the experiments and technical possibilities. In summary, the combination of traditional and organic farming practices was welcomed by most of the participants.

CONCLUSIONS

The participants emphasized the special value of this event and the connection of practical challenges in land use with new opportunities from research. In particular, access to the new technological solution and the attendance of field experiments increased the learning performance. According to the evaluation results, a preparation should in the future help to reduce the temporary strain on the students during the excursion and support discussions with scientists. A follow-up seminar is proposed for the sustainable use of the information and experiences provided. In our experience, the adaptability of decision-making structures established by the university management is responsible for higher risk of success than didactic design, development of financial solutions and teaching content.

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