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PRESSEMITTEILUNG

Droughts & Digitalization: University of Hohenheim Wants to Use Big Data to Protect Against Droughts

In light of climate change, a 25-person research team dares a completely new approach / Excellence Strategy could give visions the necessary thrust

Climate change is here, and in Europe droughts and crop failures are already increasing. To arm agriculture, business, and society against this, a research team at the University of Hohenheim is not only relying on plant breeding and adapted cultivation methods. They are looking to find the breakthrough in the increasing digitalization and the Internet of Things. For this vision, hand-picked experts from all Faculties of the University of Hohenheim in Stuttgart unite their expertise and research ambitions. They can find additional expertise with outstanding colleagues from the University of Stuttgart, University of Tübingen, and the Max Planck Institute for Developmental Biology in Tübingen. Germany's no. 1 university in agricultural research thereby builds on established teams and high-profile preliminary work. The millions in funding for the extremely time-consuming basic research could be provided by the Excellence Strategy of the federal and Länder governments in the form of an Excellence Cluster. The project's working title: Agricultural Droughts in the Digital Era – AGER

The kinds of thoughts that occupy Prof. Dr. Thilo Streck as the head of the expert team are those such as: Because the energy needed to plow depends on factors including the moisture of the soil, computers could use the movement data from all tractors and their diesel usage to calculate soil moisture in Germany with unprecedented precision.

With this wealth of data, new computer programs could also be used to predict seasonal weather and make harvest predictions. Their predictions aim to let farmers know in March whether a drought may come in June or July and what loss of profits they can expect. The farmers could then sow crops in the spring that are quickly harvested, adapt the amount of fertilizer used, or switch to new drought-resistant breeds.

Contractors could plan the machines needed for their harvest seasons, and insurance companies could provide tailored programs for crop failures. Food producers could also orient their production processes on supply, amounts, and time periods.

Visions with a great need for research - but the important basics are already there

Of course, it's not quite as easy as it sounds. Besides the soil's moisture, the amount of clay it contains also affects plow resistance. These effects can probably be filtered out of the data, however.

A great deal of basic research is certainly still needed. And maybe this exact thought experiment will never be realized.
But: Newer tractors already have board computers that record this and much more data and transmit them to so-called data clouds. Additional data is collected e.g. by agricultural drones such as those already used by the University of Hohenheim or by special sensors that can recognize plants' fertilizer status and pest infestation.

The University of Hohenheim has particular experience in the development of cutting edge software for climate prognosis that can make predictions that are more precise and on a smaller scale than has ever been done before. What is helpful in such endeavors is that the University has physicists, plant scientists, and agricultural economists who work hand in hand.

"How the local climate develops is the result of highly complex interactions among plants that emit water, the atmosphere where clouds are built, and people who for example as farmers decide which plants they will sow when, where, and how," explains Prof. Dr. Streck. "At the University of Hohenheim, we have been able to successfully program computer models for all sub-processes, and we are currently putting them together to make up an overarching software program for the super computer in the high-performance computing center in Stuttgart."

Key requirements: A better understanding of plants and ecosystems The AGER-researchers want to build on this and other previous research work as they now look into how agriculture, business, and society can arm themselves against the increasing drought periods.

One building block is the new breeding concepts for types of plants that can survive worse conditions without serious crop failure. But in order to able to better breed these, the researchers first need to understand the genetics and processes that occur within plant cells during droughts.

"Previous findings come from greenhouses and often don't correspond to reality," explains Prof. Dr. Streck when discussing the special need for research. The goal is to analyze thousands and thousands of substances in innumerable plants - a task that can only be done with state-of-the-art analytics and bioinformatics.

Another team looks at the ecology of the entire ecosystem on the field: "This looks at questions such as how various types of drought shift the equilibrium among crops, weeds, soil life, beneficial insects, and pests. Or at the question of whether we can make it through droughts better if on one single field we mix various crops that each pull water from different layers of the soil."

Indispensable: better seasonal predications and Big Data analyses Great importance is also placed on better seasonal weather and thus harvest prognoses. Prof. Dr. Volker Wulfmeyer from the Institute

of Physics: “Our goal is to improve seasonal predictions for the upcoming vegetation periods and thus provide better prognoses of the yields that can be achieved. Up to now we can only predict the weather precisely for a few days, so we need to find ways to collect and analyze a great deal of very detailed measurement data.”

One of the University of Hohenheim’s specialties is including human adaptation behavior in the computer simulations. With the so-called “Agent Technology,” researchers created a virtual parallel world in which virtual farmers decide based on market prices, weather predictions, agricultural policies, and environmental regulations how they manage their farms, what they plant in the upcoming season, how much fertilizer they use, and how they protect their plants.

“We now want to include Big Data in this virtual world, which means that we want to use all the data that comes from production, processing, and sales of agricultural products,” says agricultural economics Prof. Dr. Thomas Berger. “What is particularly promising is that we can also simulate cooperation among farmers with our computer models. For example, we can find out whether the exchange of farm manure, jointly used harvesting machines, or plant protection campaigns coordinated among neighbors are worthwhile.”

The data analysis and simulations could later even help real farmers, businesses, and politicians with their decisions. Individual parts of production, logistics, and processing could be better coordinated, mineral fertilizer and natural resources could be conserved, and the complete bioeconomic system would be more resistant to extreme situations such as droughts.

Special benefit: Combination of top researchers and top technology For its vision, the University of Hohenheim relies on numerous competences, the combination of which is unique in Germany. It extends from basic research in molecular biology to breeding informatics, smart farming or precision farming, climate research, remote sensing to Big Data analysis and innovation economics.

That is why biologists, plant farmers, ecologists, soil scientists, physicists, economists, and specialists for business financing are working together on the project. They are handpicked experts who are among the very best in their respective disciplines. The core is made up of the research group Regional Climate Change funded by the German Research Foundation - a well-established team that has been working together in Hohenheim for over 10 years.

An advantage they have had is that the University of Hohenheim has used every opportunity for groundbreaking investments in recent years. The results have been a Core Facility with high-tech analytics especially oriented on the needs of research in Hohenheim.

A special data lab (X3-Lab) is also being established for Big Data analysis and the simulation of complex systems. The new Land-Atmosphere Feedback Observatory with a measurement technique unique in the world and the Phytotechnical Center, Germany’s most modern research greenhouse, are also part of Hohenheim’s investment in the future.

President's Office offered initial funding with equipment and new professorships “Our researchers are on fire for the idea. In the President's Office, we therefore support the plans as much as we can,” states Prof. Dr. Stephan Dabbert, President of the University of Hohenheim.

Support includes not only technical equipment and personnel. “Especially for these research projects we have established a separate professorship, ‘Quantitative Genetics and Genomics of Crops’ and two junior professorships for ‘Physiology of Yield Stability’ and ‘Data Assimilation in the Earth System.’”

Funding as an Excellence Cluster could help realize the vision
A big breakthrough will only be achieved with a massive amount of funding such as that available as an Excellence Cluster in the context of the federal and Länder governments’ Excellence Strategy. The University of Hohenheim therefore submitted an application to the German Research Foundation today.

“It focuses on research associates and more high-tech equipment to simulate, measure, and analyze droughts and their effects outdoors. It also includes the necessary expansion of our high-performance computer network for the immense amount of data that accumulates and needs to be processed.”

“What is key for more research are two additional professorships ‘Quantification of Insecurity’ and ‘Digital Bioeconomy’ as well as junior professorships in specialized areas of agricultural ecology and molecular biology information processing, which we could set up with the right funding,” reports President Prof. Dr. Dabbert.

One-of-a-kind working conditions for early career researchers The University of Hohenheim is counting especially on talented early career researchers. The majority of the funding requested in the excellence application would therefore go toward setting up groups of young scientist research groups and an additional doctorate program.

“We’ve had great experiences with the ‘wild young ones’ in recent years. That’s why the University of Hohenheim has concentrated on developing its early career research - to offer particularly talented young scientists a stimulating working environment,” explains the President.

The successes in recent years include an award-winning graduate program, specialized personnel development for academics in the context of the Hohenheim-Konstanz-Ulm Research Alliance, making all junior professorships tenure track, and offering individual coaching programs. With funding as an Excellence Cluster, it would be possible for the University of Hohenheim to make these offers permanent and continue to strengthen them.

Gender equality and gender concepts can build on success The University of Hohenheim also places particular

importance on gender equality and gender aspects in the new project.

“In recent years, the proportion of women in our professorships has increased significantly. That has been good for the University,” reports President Prof. Dr. Dabbert.

For the newly appointed professors, gender equality has already been achieved in the past two years: The University of Hohenheim has appointed as many female professors as male professors. “What helped us was that our gender equality plan has defined gender justice as a cross-cutting topic for the entire university,” states the Representative for Gender Equality, Prof. Dr. Ute Mackenstedt.

The University of Hohenheim has long since fulfilled the state’s requirement of 20% of professorships with females - currently 25% of Hohenheim’s professors are women. This also puts it well above the state average, which had only just reached the required 20% of women professors in 2015.

Currently, the University is working on an ambitious new version of the gender equality plan. “The goal we have set ourselves is a gender ratio of 1:1 at all qualification stages,” says Prof. Dr. Dabbert.

Long years of excellent research leads to a groundbreaking vision We’re certain that we’ll be able to achieve extremely ambitious basic research that will be able to be transferred to other regions of the world and make a contribution to a social problem that is extremely urgent,” summarizes director Prof. Dr. Streck.

President Prof. Dr. Dabbert also emphasizes that only the Excellence Strategy offers the unique opportunity to realize these challenging plans.

For this project, the top researchers in their respective areas have come together. “This team brings together one-of-a-kind expertise as it can only be found at the University of Hohenheim. It was then complemented with outstanding colleagues from the Universities of Stuttgart, Tübingen, and the Max Planck Society. Together, they have developed long years of excellent research into an absolutely unique vision,” appraises the President.

BACKGROUND:

Bioeconomy at the University of Hohenheim New food and fodder, energy from harvest waste, chemicals and plastics from plants: Bioeconomy opens new paths to new products, new production processes, and to a modern, sustainable economy. Its raw materials are bio-based, meaning that they come from plants, animals, or microorganisms.

The University has made this key social topic to the focus of the entire institution. Due to its unique combination of disciplines, it can illuminate the topic of Bioeconomy from the production of resources to the required re-structuring of the economy.

The topics of climate change, droughts, and digitalization are important aspects within a bio-based economy. They are therefore pursued emphatically at the University of Hohenheim in the context of Bioeconomy research.

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