13th year | June 2017

MAGAZINE #22

Sustainability

Robert Bosch Stiftung

LITTLE CLIMATE SAVERS

On the farm, schoolchildren convert straw to biochar. Scientists in the lab show how this protects the climate.

REPORT

A station for staying put

A youth center strengthens democracy in a rural area – and stimulates a whole town.

PORTRAIT

Rooting out hunger

Junior Professor Michaela Dippold researches ancient types of grain. Her aim: to wipe out hunger in Africa.

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> *Taking samples from the field and measuring the cleanliness of soil is more interesting than normal lessons.*

Appearances deceive: what's burning here is escaping gas, not straw. The latter carbonizes instead – into biochar.

MAKING UP GROUND FOR THE CLIMATE

One day in the mud, one day in the lab: as part of the "Our Common Future" project, the Gengenbach Gymnasium secondary school sends its students to an organic farm and the University of Applied Sciences Offenburg. There they learn how to make charcoal out of straw – and why it helps the environment.

by Markus Wanzeck

The morning sky is grey, the clouds dripping with rain, the temperature worthy of a refrigerator. Yet the farmer Mr. Witt knows how to warm up his guests, who have come down from the Black Forest to his organic farm on the outskirts of Offenburg. "There aren't many hares any more," he says. "They're threatened with extinction. But the few that are left are all right here – eating my organic lettuce." The students laugh. Laughing helps against the cold. Physical labor too. And fire.

And this March day holds plenty of all that in store – the students will be learning how to make biochar. The 14 students of year 8 and 9 from the Marta-Schanzenbach Gymnasium in Gengenbach will also learn a good deal about why that is good for both the sky and the soil. Today at Biohof Witt, they will be in raincoats. And tomorrow, in lab coats, at the University of Applied Sciences Offenburg. This unusual collaboration between the school and the university is a project funded by the Robert Bosch Stiftung as part of the "Our Common Future" program. The production of biochar is a sort of two-fold answer to both a pedagogic and an ecological question.

Nicole Diebold, research assistant at the University of Applied Sciences Offenburg, formulates the educational question as follows: "In their pre-school years, boys and girls are still very enthusiastic. Later, at school, that tapers off. How can we change ▸

that?" The environmental question is how we can make our farming practices more sustainable in view of climate change and increasingly intensive land use.

Daniel Kray, Professor of Process Engineering at the University of Applied Sciences Offenburg, and his research assistants divide the students into three groups. The first one prepares the steel boiler in which the miracle charcoal will be created. A second one gathers the requisite substrate: straw, hay, vegetable waste. The third group gets a bucket, a huge hammer, a soil probe – and a task that seemingly has little to do with charcoal: Dennis, Justin, Yannik and Shane are charged with collecting the soil samples.

Hands-on chicken: a great way to get kids interested in the natural sciences.

MORE INTERESTING THAN LESSONS

Together with Kray's assistant Esmeralda Lüdecke, the boys tramp off to the field behind a greenhouse for growing parsley; the sloppy ground sloshes and slurps as if it would swallow them up the next instant. "We have to fill up this bucket!", calls Lüdecke through the drizzle. "The important thing is that you don't take samples parallel to the tractor tracks, but diagonally to them." The youths don't have to be asked twice: Shane promptly drills the soil probe into the ground. Dennis gives it a forceful whack with the hammer. Yannik scrapes the soil sample and half a worm from the probe. Justin logs the results in a list.

Later, and tomorrow in the lab, the students will determine the type of soil: fine clay, rough sand – or maybe silt? What is the carbon and water content of the soil? And what is its pH value? "Taking samples from the field and measuring how clean the soil is – that's much more interesting than normal lessons," says Shane, the student team's probe-turner. The natural sciences can be captivating, and are also extremely relevant for everyday life and our environment. Conveying this experience is one of the goals of the "Our Common Future" program. And that simply cannot be done with a PowerPoint presentation in a heated classroom. It has to be out here, with rain in your face and up to your heels in mud.

The students take soil samples.

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> ***"The production of biochar is a sort of two-fold answer to both a pedagogic and an ecological question."***

LESSONS AT THE FIRE AND IN THE LAB

"Good soil should not be too sour or too dense," explains Lüdecke. "It should also be able to hold nutrients and water." Like a sponge, biochar is capable of holding water and nutrients and dispensing them gradually over time," explains Kray. It also loosens up the soil. It can even bind heavy metals like cadmium, chromium and copper and thus keep them out of the food chain. "Moreover," adds Lüdecke, "biochar offers space for the growth of microorganisms." Just how it achieves all of these positive things is then a matter for the lessons at the fire and in the lab to demonstrate to students.

While group three continues to make holes in the field, the other two groups have set up the coal boiler, filled it with substrate and ignited it. The straw and other materials are burning bright. Or so it seems, at any rate. But that's not the case. "Practically none of it burns," says Professor Kray. "Almost all of it carbonizes." As the students continuously pile on more straw and hay and plant waste, the biomass lacks the oxygen to burn. All that's really burning is the escaping gas: at up to 871 degrees Celsius, as the students measure using a pyrometer – a sort of laser pistol. What's left over is solid carbon. It's just before twelve when the soil sample group returns from the field bearing eleven kilograms of soil. It's a good amount to work with – after lunch. First the coal boiler becomes a barbecue: steaks, cutlets and vegetarian sausages land on the grill.

Our Common Future

FURTHER PROJECTS:

Space pioneers
Students of Vegesack Gymnasium are working together with the Institute of Space Exploration Systems of DLR Bremen to study how plant yields can be increased in the most resource-conserving manner possible. The research should benefit not only farmers on earth, but also space exploration: basic research to support a mission to Mars!

Good influence
In a social science project between the Karl-von-Closen Gymnasium in Eggenfelden and the University of Innsbruck, students are studying whether environmental protection projects with youths also help change attitudes in their families. The results will be published.

Hydrogen in public transportation
Students of the Carl-Friedrich-Gauss Gymnasium in Frankfurt (Oder) work with scientists from IHP – Innovations for High Performance Microelectronics to research whether hydrogen-powered vehicle use is technically suitable and economical for public transport.

More than **600 students** from **22 schools** have taken part in **19 projects** since 2015 and have worked together with **80 researchers** from **20 scientific institutions**.

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> *The cooperation between school and university fosters a sense of approachability.*

In the university lab, students examine their self-produced biochar.

Plenty of space for microorganisms: the surface of one gram of biochar covers 300 square meters.

"Operating a biochar oven is extremely simple," says Esmeralda Lüdecke. "But we're process engineers. We would like to improve a few things. Using the waste heat, for example." The energy question is one of the discipline's favorite issues.

"For us, it's more about the way there than the final product," explains Bernd Spangenberg, Professor of Chemistry and Dean of the Process Technology department, to his young guests during their tour of the lab on the second day. "We ask ourselves, how we can generate something using less energy and creating less toxic material?"

The goal of this two-day excursion is to transmit an impression to students of how process engineering can make a genuine contribution to mitigating environmental problems. The focus is to promote sustainability in two different ways. "First, the cooperation between the school and the university fosters a sense of approachability," explains Dr. Stephan Elge, who teaches chemistry, biology, and the natural sciences and technology at Gengenbach Gymnasium He is co-initiator of the biochar student project. The collaboration aims to create a lasting impact by encouraging more students to pursue a career in the natural sciences following their secondary school years – and thus, in a second step, contribute to making our economy and way of life more sustainable.

It's no accident that Elge is the one to act as the bridge-builder between the school and the university. Elge used to be a molecular biologist, conducting basic genome research at the Max Planck Institute. But ultimately he decided to pursue a teaching career – a good decision, looking back: "This is a great opportunity to impart the scientific knowledge." At Gengenbach Gymnasium, he has successfully led the "Jugend forscht" youth science research group for several years.

DOUBLY SUSTAINABLE

For over 2,500 years people have been using plant-based charcoal to improve soil, for instance in the Amazon basin and Indonesia. It increases the nutritional content of the soil while promoting plant health. At the same time, the carbon binds large amounts of CO_2 in the ground for more than 1,000 years. According to model calculations, up to twelve percent of annual greenhouse gas emissions could be offset in this manner.

Photos: Martin Wagenhan

BIOCHAR CAN MITIGATE THE EFFECTS OF CLIMATE WARMING

Shortly after the last sausage is taken off the grill, the barbecue fun comes to an end. Now begins the extinguishing of the fire, the quenching: water is pumped into the oven from the bottom. Steam at up to 700 degrees pours out and slowly extinguishes the embers. "The steam essentially washes the biochar out," explains Kray. "What remains is a carbon framework – pure active carbon."

This is where the students learn the first secret of biochar: its surface is truly miraculous. In the university lab, the young researchers will have the chance to see the lignin, the carbonized wood skeleton, under the two hundredfold magnification of a microscope – an intricate system of mini-caves. A single gram of biochar has an almost unimaginable 300 square metres surface area. That's a lot of space for water and nutrients, microorganisms and heavy metals.

Their second secret – that they're good for the environment – is demonstrated by Professor Kray with an illustration that he brought along to the farm. It shows the earth's carbon cycle: the carbon exchange between the ground, air and animal and plant worlds would be relatively balanced – if people were not simultaneously ensuring that seven billion tons of carbon were being pumped into the air annually as CO_2. The imbalance is growing larger all the time. One of the consequences is climate warming.

The biochar can at least minimize this effect somewhat. The carbon contained in hay, for example, would quickly be released into the air as CO_2 through decomposition or digestion if it were used for feed or composted. When carbonized, however, the carbon is captured long term. "This is ultimately the only way to keep it out of the atmosphere permanently," explains Kray. "The biochar keeps the carbon on the field soil for 50 or even 100 years. And, on top of this, it does the farmer some good as well."

Markus Wanzeck remembers his chemistry lessons as bone dry. So he enjoyed the biochar production at the farm all the more. He wouldn't have minded some things being a bit drier, though.