A CLOSE LOOK

TEXT **TOM RADEMACHER**

Evonik's precision livestock farming is bringing big data and biotech to poultry farming. The aim is ambitious: To produce meat from fewer resources while also improving animal welfare

"We can spot the outbreak of a disease five days in advance, without having to slaughter a single bird"

DR. EMEKA IGWE, BIOTECHNOLOGIST

Gerd Aepker knows whether his chickens are doing well. "You see it in the way they move," says the 70-year-old farmer. Nearly 20 years ago, he converted his small family farm into a large-scale intensive farming facility. Gerd's son André now runs the farm. It consists of two grow out houses, each of which is over 80 meters long. They are located in the midst of wheat fields in a rural area between Bielefeld and Bremen. Some 74,000 chicks of the Ross 308 breed scurry around inside the buildings. The fuzzy chicks are three days old and about the size of tennis balls. On this morning, men and women wearing overalls and rubber boots collect chicken dung in bags as they carefully walk through the throngs of chicks. They are conducting this unsavory task for the sake of science and the animals' welfare—as well as for the future of agriculture.

DATA HEIGHTENS PRECISION

The people collecting dung in Aepker's chicken coop are biotechnologists from Evonik. For many years now, the Essen-based company has been supplying feed manufacturers with additives that enable animals to process the feed more effectively. As a result, Evonik has laid the groundstone for making meat production more efficient and sustainable. On this basis, the company is now developing solutions for improving productivity, quality, and the animals' welfare in the grow out houses.

Meat production has a huge impact on the environment and the climate. Animal husbandry generates large nitrogen inputs that contaminate the soil, air, and groundwater. A large part of agricultural land is used to grow animal feed. Moreover, natural ecosystems are being replaced by fields and pastures, a development that reduces biodiversity. Areas that once were covered by rainforests are now used to grow soybeans, which are an important raw material for animal feed. All of these effects combined contribute to meat production's environmental footprint.

Radical change is needed if the demand for meat by the world's burgeoning population is to be met without putting too great a strain on the Earth's resources. The objective must be to produce meat with fewer resources while not losing sight of the animals' needs. One of the solutions to these urgent food issues is precision livestock farming, or PLF for short. It's a mix between big data, new networked technologies, and a holistic understanding of ways to keep animals healthy.

Less than an hour's drive to the south of Aepker's farm is an Evonik lab, where Dr. Emeka Igwe bends over his laptop. Here in Halle-Künsebeck, Igwe performs a feat that astounds even experienced farmers: →

At the Aepker farm in eastern Westphalia, 74,000 chicks are constantly monitored over the 40 days they take to reach slaughter weight

The graphs on Igwe's laptop tell biotechnologists not only how well Aepker's chickens are currently doing but also how healthy they'll be next week. This feat is made possible by a new testing method called ScreenFloX®. This technique analyzes telltale genetic fingerprints to identify pathogens in chicken dung. The process is similar to the way forensic experts detect traces of DNA at crime scenes. But Igwe knows not only whether pathogens are in the dung also but how many of them there are. That's the crucial point.

GENTLE METHODS

"The bacterium *Clostridium perfringens*, for example, can be found almost everywhere," explains Igwe. "However, it can trigger subclinical necrotic enteritis as soon as it accounts for a certain proportion of the intestinal flora." This illness costs the world's chicken farmers billions of euros every year. The disease perforates the chickens' gut, causing the birds to suffer and grow poorly. Once the disease has broken out, only antibiotics will help.

To determine if the illness had taken hold, a random sampling of animals used to have to be killed and their intestines examined. Without slaughtering a single chicken, Igwe and his team can now detect an outbreak five days before it occurs. More than 90 percent of these forecasts are accurate. This warning time enables farmers to take gentle countermeasures such as the addition of butyrate (the salt of an organic acid) to the birds' drinking water. This acid is also produced by the microbial inhabitants of the chickens' guts. The butyrate causes the pathogens to die off by changing the intestinal pH value.

Evonik has developed such tests for four of the most common problematic microbes in chicken farming. Igwe is currently busy demonstrating these tests all over the world. Most recently, he did it at an American company that operates around 350 feedlots permanently holding a population of 56 million animals. "Although such conglomerates have their own labs and veterinarians, they still can't do what we can," says Igwe. A chicken feedlot in China recently needed Igwe's help to track down a contaminated source of drinking water.

Aepker's farm isn't really typical of what Evonik generally deals with. The farm is much too small. However, Benjamin, the older of the two Aepker brothers, works for Evonik in Halle-Künsebeck. As a result, some new developments from Evonik are first tested in Aepker's grow out houses. "This is where we find out what the farmers' concerns are," says Igwe.

LOTS OF FEED, LITTLE DUNG

Time doesn't stand still in Aepker's farm either. When André took over his father's farm, he doubled the size of the grow out houses while at the same time reducing the relative number of animals. "This change was made to fulfill the criteria of the German government's animal welfare label," explains Aepker. The number of animals is reduced further before they reach the target slaughter weight. Smaller chickens are sold as broilers. This gives the other birds more room until they reach their target slaughter weight of 2.7 kilograms. Pecking stones reduce the chickens' stress levels and help their digestion. Because chickens don't have teeth, they swallow stones that grind the food in their gizzards.

The efficient processing of feed is absolutely essential in animal husbandry, because feeding the livestock accounts for around one third of the total costs. Shortly before Aepker's chickens are slaughtered, they consume eleven tons of feed—per day. A chicken needs to consume about 1.7 kilograms of feed in order to gain one kilogram of weight. Only 1.5 kilograms is needed if the feed is optimized. By contrast, pigs need to consume almost three kilograms of feed to gain one kilogram of weight, while cattle generally have to eat more than six kilograms. Aepker also has to pay for the disposal of the dung. As a result, as little of the feed as possible should be turned into dung.

Farmer André Aepker hears the results of the analysis of the samples taken in the grow out house from Evonik employee Dr. Frank Thiemann (left)

The chicks at Aepker's farm reach their target weight in 40 days. The feed mixture is adapted to the animals' needs as they go through five growth stages. A large proportion of the feed consumed at Aepker's farm consists of locally grown wheat. The grain is ground so that the chickens can digest it better. A mixture of protein, vitamins, minerals, and essential amino acids (including methionine) is added to the feed. This admixture is necessary because sources of vegetable protein generally contain relatively little methionine. Without this amino acid, chickens are unable to efficiently process the other ingredients (see box on page 21).

Evonik is one of the leading manufacturers of methionine, which it produces in Germany, Belgium, the USA, and Singapore. Moreover the company offers additional amino acid products to offset deficits in the feed. Special variants of methionine have been tailored for dairy cows, fish, and shrimps.

ENVIRONMENTAL BENEFITS IN FIGURES

Amino acids offer measurable benefits, particularly for the intensive farming of chickens and pigs. Farms that use Evonik's feed additives and feeding concepts significantly reduce the strain on the environment. "If the entire sector operated in this way, it would be possible to cut greenhouse gas emissions by around 60 million tons in 2030, while the amount of farmland could be reduced by 17 million hectares and nitrogen emissions by six million tons," says Dr. Ralf Kelle, who is responsible for sustainability at Evonik's Nutrition & Care Segment.

The composition of a feed mixture's raw materials has to be known so that it can be determined how much of an amino acid has to be added. Since 1997, Evonik has maintained what is now the biggest database of the amino acid content of fodder crops worldwide. Customers can now benefit from this knowledge, thanks to a smartphone app. Feed manufacturers can even have Evonik analyze their raw materials within minutes by means of near infrared (NIR) spectroscopy. →

In order to obtain viable results, a specific method is used to collect the dung samples everywhere in the chicken coop

Precision livestock farming will now provide deeper insights into animals and the conditions under which they are kept. In 2018 alone, Evonik invested in three startups that are pointing the way. The Dutch startup InOvo has developed a technology that can identify the gender of chicks before they hatch. As a result, male chicks may no longer get shredded. Optifarm, a startup from England, uses sensors and cameras to monitor chicken coops worldwide. Evonik has completely acquired another startup, Porphyrio, which was spun off by KU Leuven, a Belgian university. This startup develops big data systems and adaptive algorithms for making forecasts in all areas of poultry farming.

GOOD GERMS INSTEAD OF ANTIBIOTICS

“Precision livestock farming aims to achieve a holistic understanding of animal welfare and to make forecasts that are as precise as possible,” says Professor Stefan Pelzer, Head of Research for Gut Health Solutions at Animal Nutrition. Pelzer and the Belgian company ProDigest have developed an important tool for this purpose: the Dynamic Avian Intestine In-vitro System (DAISY). This system is the result of a publicly funded research project and consists of a laboratory model of the chicken intestine. DAISY uses a cascade of glass containers to precisely simulate microbiological processes in chicken guts. “Medicine has recently learned a lot about how the intestine and its microbiome influence human health,” says Pelzer. DAISY is helping Pelzer and his team in Halle-Künsebeck to gather data and findings that will enable them to reduce the use of antibiotics in animal husbandry to a therapeutically necessary level.

Evonik employee Michelle Dargatz prepares a sample in a multistage process in Halle-Künsebeck

Antibiotics have been used as growth promoters in animal husbandry since the 1950s. Although this practice was banned in the European Union in 2006, it is still common in other parts of the world. Experts fear that this practice breeds pathogens that are resistant to ever more antibiotics and thus endanger human beings.

“Our aim is to gain a holistic understanding of animal welfare”

PROF. STEFAN PELZER, HEAD OF RESEARCH FOR GUT HEALTH SOLUTIONS AT ANIMAL NUTRITION

However, another problem arises if antibiotics aren’t used: Chicks have a weak intestinal flora if they don’t have any contact with their mothers after they hatch and are thus unable to acquire any good bacteria from them. Such chicks are less robust and more likely to be affected by harmful germs.

To solve this problem, Evonik is using probiotics. In 2016 the Group acquired the probiotics business of the Spanish company NOREL. One year later, Evonik launched its first probiotics product to be developed in-house. It contains a strain of *Bacillus subtilis* that outperformed more than 500 other strains of bacteria in tests. The product counteracts the conditions that foster necrotic enteritis. In addition, it can withstand high temperatures during processing in the feed mill.

Farmers rely on their experience. “When the ground in the chicken coop gets moist, it means that something is wrong with the birds’ digestion,” says André Aepker. “When that happens, the first thing we do is to put more wheat into the feed. In most cases, that puts their intestines right again.” However, many farmers are also willing to try out new methods. Aepker Sr., for example, experimented with probiotics several years ago. He says this was very tiresome, “because I had to stir them myself and then let them ferment.” Moreover, they didn’t do a whole lot of good. But Aepker would try probiotics if they were already mixed in with the feed and were proven to be effective.

Probiotics are only one of the many different elements of precision livestock farming. “Advanced feeding concepts, the targeted inclusion of nutritional and functional feed additives, the strengthening of the animal’s intestinal systems, and the optimization of farming conditions—all of this helps to make animal husbandry fit for the future,” says Pelzer. He hopes that this holistic approach will make it possible to produce meat more sustainably in the future and with less of an environmental impact. Everyone will benefit from this in the end.

“I like chickens,” says André Aepker as we depart. He couldn’t do the job otherwise. “Mentally, you’re always with the animals,” he says. The chickens’ welfare is of existential importance for Aepker. When he closes the door to the chicken coop, we see a yellowed sticker that says: “Niemand soll es je vergessen, Bauern sorgen für das Essen” (Nobody should ever forget that farmers provide their food). —

A barrel full of amino acids

Amino acids are often called the “building blocks of life.” This should be understood literally. Every living organism on Earth connects amino acids into long chains of proteins that serve as the elements of everything from the DNA of the bark beetle to the cartilage in a knee joint. In order to produce certain proteins, humans and animals have to obtain essential amino acids through their food intake. The problem is that if even a single building block is missing, the others will be excreted without being used. In the 19th century, the German chemist Justus Liebig compared this law of the minimum to a barrel in which each stave represents a different building block. In this image, the shortest stave is the “first limiting” amino acid. In the case of chickens, this is methionine. If you specifically increase the amount of methionine in feed, the other nutrients will also become more usable.