

# Passion for agriculture

Our solutions



 **BASF**  
We create chemistry

# Contents

- 02 BASF and agriculture
- 06 Research and development
- 14 Environmental research and ecotoxicology
- 19 Consumer protection
- 21 Sustainability and product stewardship
- 24 Agricultural Center Limburgerhof



## Food is life

Providing food for a growing world population is agriculture's greatest challenge. To rise to this challenge, farmers need new technologies and new solutions.

Every man, woman and child must have access to healthy, nutritious food, both now and in the future. This is essential for everyone's quality of life. While the world has to feed a growing population, demand for renewable resources and bioenergy is also set to rise. To ensure that agriculture can satisfy both today's and tomorrow's needs for food and raw materials and fulfill the requirements of future generations, we need to tap the full potential of the world's constantly growing knowledge.

Working together to overcome challenges and find new solutions is one of BASF's greatest strengths, and it's something we've been doing in agriculture for over 100 years. Our employees are in constant contact with farmers and agricultural experts in every region across the globe. They work hard to understand what approaches are required to optimize agricultural production, increase farm profitability and so improve the quality of life for a growing world population. Their knowledge is reflected in the products and services we offer to our customers.

BASF has a long heritage of being a reliable partner to farmers. We believe that farming is the biggest job on earth. Our goal is to help farmers prosper with innovative and sustainable solutions, not only today but into the future.



## Innovation for successful agriculture

Good, high-quality harvests are crucial for farmers to enjoy a prosperous season. Our products help them achieve this.

BASF is one of the world's leading crop protection research companies. Every year, we invest around 9 percent of the turnover of our Crop Protection division into research and development for new products and solutions that help farmers be successful.

Modern fungicides, herbicides, insecticides, seed treatments and pest control products form the division's core. In addition, we also provide biological crop protection products and solutions for improving plant health, as well as innovations to improve nutrient management in the soil. We help farmers protect their crops against plant diseases, weeds, insects and rodents, and to reduce nitrogen loss when applying fertilizer.

For over 100 years, BASF has been committed to supporting farmers with new technologies, so that they can achieve high yields sustainably even on limited acreage, and satisfy the demands of the consumer.

### Leader in patents

BASF is top of the list when it comes to patent-protected agricultural chemicals. Our customers benefit from the wide variety of innovative products and solutions we offer.



## A reliable partner in the field

Modern farmers face huge challenges and bear considerable responsibility. We're here to support them.

Farmers run their businesses in a very complex environment and produce some of the most valuable goods that exist: healthy foodstuffs. In addition, they also produce animal feed, cotton to make clothing and even renewable raw materials as a source of energy.

It's a long way from our laboratories around the world to the soy farms in Brazil and the grainfields in Canada. New products must not only be an improvement on their predecessors, but they must always comply fully with a multitude of strict regulatory requirements – for the safety of the consumer, the user and for the environment.

“When all is said and done, agriculture still remains a very local business.”

Our aim is to try to understand our customers' perspectives and problems as best we can. It's the only way to develop even more effective products and solutions that will help farmers overcome some of their greater challenges more successfully – season after season. As a result, we are constantly tailoring our modern portfolio to the specific needs of the farmers locally. Because we know: When all is said and done, agriculture still remains a very local business.



## Ron and Philip from the USA

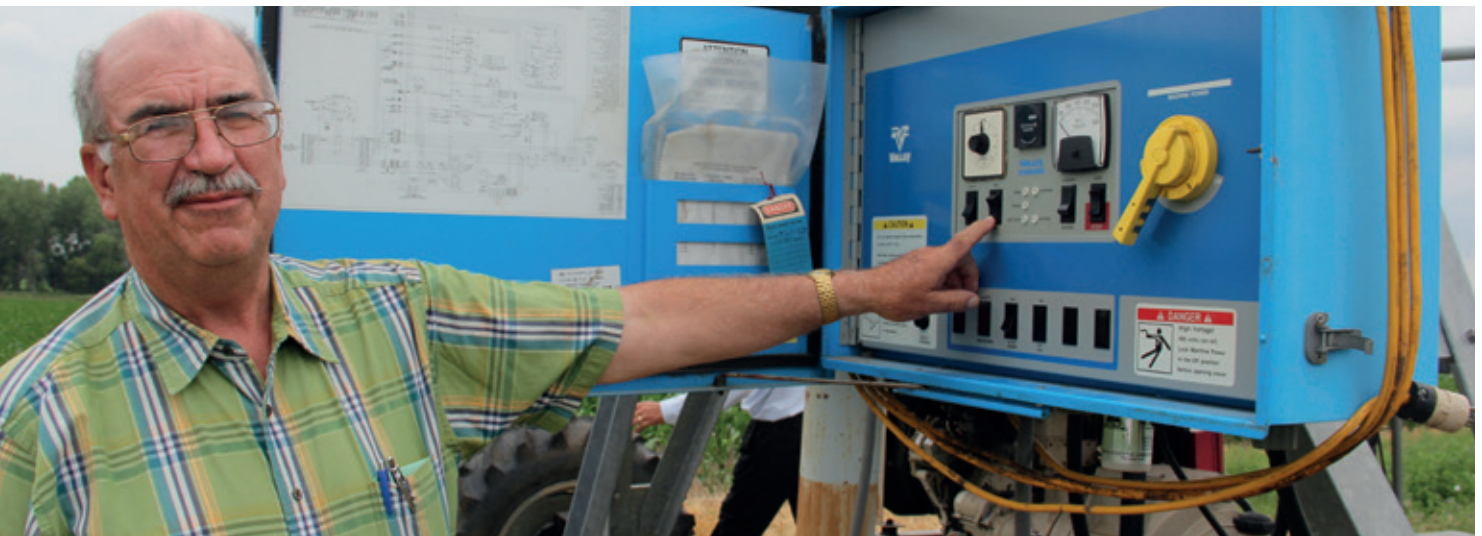
Name: Ron Bowman, Philip Meyer  
Location: Hooper, Nebraska (USA)  
Crop: Corn, soybeans and pumpkins



With growing worldwide pressure to use natural resources more sustainably, Ron and Philip's words won't come as a surprise. The two farmers grow corn, soybeans and pumpkins in Hooper in the US state of Nebraska. Over the last few years, they have experienced almost everything: drought, wind, flooding, cold and heat, as well as economic booms and busts.

BASF is in close contact with farmers such as Ron and Philip. We provide them with innovative and smart solutions to protect their crops and investments, and help them get the most out of every acre. 'Grow Smart™ with BASF' provides both agronomic advice and business consulting. Together with BASF specialists, farmers create personalized plans to help increase yields, reduce risk and improve crop quality to maximize their return on investment.

“I need to get more out of every seed, every inch of my land and every single drop of water.”



## Research for a future worth living

Successful farming benefits everyone – it's about providing safe, affordable food for all.

Our crops are waging a continuous battle with diseases and pests, and are constantly competing with weeds for access to water, light and nutrients. They need effective protection to ensure the quality of the harvested product and to avoid losses or even complete crop failures.

Crop protection products keep plants healthy and productive, but crop protection research is a constant race against the clock. Harmful organisms change their characteristics and new pathogens appear. Resistance often develops more quickly than new active substances can be found. In addition, product safety requirements are constantly on the rise.

Today's modern crop protection products must fulfill numerous requirements. Firstly, they need to be highly effective, work rapidly and not damage the plant. In addition, they must not be harmful to health or to the environment. Crop protection products must degrade before harvest leaving not more than minimal residues classed as harmless by the authorities. They must not contaminate ground water or have a negative effect on beneficial organisms.



### The popularity of the banana

On average, each European eats around 11 kg of bananas per year, For an American, it's 13 kg<sup>1</sup>. But we shouldn't take bananas for granted. Without modern crop protection, this sweet fruit would quickly become a luxury as diseases such as the Black Sigatoka fungus can cause considerable losses. Quality and yields would drop, and bananas would become rare and expensive.

## A wide-ranging portfolio – in our customers' best interests

From fungicides to new digital technology: Our customers' demands are many and varied.

How can we support farmers to make them more successful? We ask ourselves this question every day. Modern agriculture is a dynamic business, and we're constantly adapting our portfolio to the ever-changing needs of our customers.

The research team at BASF has been at the forefront of fungicide development for decades. Not only are these products hugely effective against a wide range of fungal diseases, but thanks to the innovative way in which they work, our fungicides have proved themselves indispensable for resistance management. To name a couple of examples: Xemium®, an active ingredient from the new chemical class of carboxamides, or Initium®, an agent which works against downy mildew and late blight.

One of BASF's latest herbicides, Kixor®, joins the list of groundbreaking advances. Kixor® can control over 100 types of weeds, even eliminating some that have developed resistance to other herbicides.

Our focus when dealing with insect pests is to develop insecticides that are harmless to beneficial insects, especially bees and other pollinators.

### Benefits above and beyond crop protection

AgCelence® is a premium umbrella-brand for products that provide our customers with benefits above and beyond conventional crop protection. They improve plant stress tolerance and increase vitality thanks to improved uptake of water or nutrients.





## Breaking new ground

The Functional Crop Care unit harnesses innovations in both chemistry and biology to deliver new solutions to help farmers unlock agricultural potential from soil to seed to crop.

We recently launched Limus® onto the market. Limus® improves the level of nitrogen that plants can use from urea-based fertilizers. Farmers can simplify their use of fertilizers, increase yields and see an improved environment footprint all at the same time.

Our highly-effective seed solutions help plants develop their full genetic potential. Our portfolio encompasses treatments with chemical and biological active substances, inoculants, functional coatings and pigments.

Serifel® is a biological fungicide based on a Bacillus bacterium. Whether used alone or in combination with chemical active ingredients, it offers efficient prevention of fungal diseases.

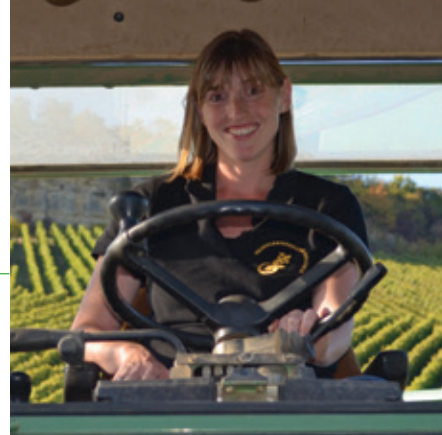
Agriculture has become a very sophisticated sector, with a whole range of different data and information needing to be collected, documented and interpreted for each field. Our new Maglis™ digital platform helps farmers do just that; helping them to make informed decisions about the cultivation of their land and to run their businesses more profitably.

We don't just offer solutions for ensuring crop yields – our rodenticides also protect crops in storage. The Food and Agriculture Organization of the United Nations (FAO) estimates that storage losses for grain in developing countries are around 15 percent. Our rodenticides protect crops stored in warehouses through to food processing factories. Our range also includes products that protect buildings against termites and mosquito nets that combat the spread of vector-borne infectious diseases. In addition, we also help our customers keep their buildings free of pest infestations.

## Our fight against malaria

In 2016, as many as 429,000 people were still falling victim to malaria<sup>2</sup>. Our Interceptor® mosquito net is treated with an active substance that controls mosquitoes effectively as they come into contact with it. The Interceptor® net is washable and provides long-lasting mosquito control for up to three years.





## Tanja from Germany

Name: Tanja Müller-Heinrich  
Location: Gemmrigheim, Germany  
Crop: Grapes

“When using agricultural chemicals, always keep one thing in mind: as little as possible, as much as necessary.”

Farmers across the globe are being asked the impossible. On the one hand they are expected to produce more and higher-quality results, while on the other hand they are being told to use fewer chemicals and fewer resources to do so.

For Tanja Müller-Heinrich, who lives in the small town of Gemmrigheim in southern Germany and produces wine for a living, the answer is all about achieving the right balance. We support wine producers like Tanja with innovative products and services that protect their grapes and help use natural resources sustainably. Our Crop Protection Information App (abbreviated to PIA in German) provides a simple, quick way to search for products and provides detailed information on all the agricultural chemicals permitted for use in Germany. Together with a BASF expert, Tanja Müller-Heinrich discusses an individual crop protection strategy for her vineyard over the complete growing season.



## Worldwide crop protection research

BASF maintains a global network of research stations where our experts and scientists conduct studies on different crops across all continents and climate zones for more sustainable agriculture.

The BASF Agricultural Center in Limburgerhof, Germany, is where we coordinate our crop protection activities around the world. We also run a research center in Research Triangle Park in North Carolina, USA, where most of our insecticide research takes place. Our research station in Asia Pacific is based on BASF's Innovation Campus in Mumbai, India.

Our network of agricultural stations spans continents and climate zones, which means our products can be developed under natural growing conditions in all the world's leading crop production areas. Our range covers everything from cereals, corn, soy and oilseeds to fruit farming and viticulture, forestry and turf management, as well as vegetables and ornamental plants.

### BASF Crop Protection – Major sites worldwide



## Active substances under the microscope

How do fungicides work? Are they safe for humans, animals and the environment? Our scientists carry out wide-reaching studies in laboratories, greenhouses and in the field to answer questions just like these.

Our chemical synthesis laboratories and nature itself provide us with numerous chemical compounds that may have the potential to become a successful crop protection product.

To evaluate a substance's efficacy, it is first subjected to a completely automated testing process, as used, for example, in fungicide research. Scientists are able to test up to 100,000 substances on fungal cultures each year in this BASF "pre-screening lab". With the help of the very latest computing technology and fully-automated lab equipment, thousands of compounds can be tested within the shortest possible time. Only around 10 percent of all the candidates pass these initial lab experiments. Further tests on plants then follow in the fungicide greenhouse.

“Before any crop protection product can be approved for sale, it needs to undergo an independent risk evaluation under the very strictest of conditions.”

### Strict selection procedures

Only one in every 140,000 tested substances will comply with the strict requirements regarding consumer and operator safety, environmental protection and efficacy. It takes around ten years to bring a new product to the market. By that time, BASF will have spent on average \$286 million<sup>3</sup> on research and development for that product.



## On the way to becoming a top product

Once the effectiveness of a substance has been demonstrated in both lab and greenhouse pre-screening, it then undergoes extensive individual testing in the herbicide, fungicide or insecticide research greenhouses. There, the substances are put through various testing stages, during which performance requirements are set increasingly higher. These greenhouse experiments also provide scientists with important data that they can use to chemically optimize the molecular structure of a prospective active ingredient. Only a fraction of the compounds tested will overcome this hurdle.

The most promising substances then reach the next phase of development: Every year, around 100 substances are selected for field trials where they need to prove themselves under nature's real-life growing conditions. The field trials take place in the world's leading growing regions and with the most important crops.

However, the biological effect is only one characteristic on which the substances are tested. In parallel to the greenhouse and field trials, the impact on humans, animals and the environment are tested.

Registration is the final step in releasing a new product onto the market. Before any crop protection product can be approved for sale, it must undergo independent risk assessment under the very strictest of conditions.

## Extensive approval testing

Agricultural chemicals and pharmaceuticals are two of the most strictly tested substances. To be approved for use, crop production products have to fulfill around 800 different requirements which involves submitting over 200 scientific studies.





## Silvio from Brazil

Name: Silvio Sarpa  
Location: Arthur Nogueira, Brazil  
Crop: Sugar cane

“Why would we be against innovation? Farmers have been open to new methods since agriculture began.”

Most farmers would agree with Silvio: They’ve always been open to innovation and improvements in agricultural practice in order to grow the highest quality crops, to feed a growing population and to fulfill the increasing demand for energy.

BASF maintains a constant dialogue with farmers such as Silvio and also representatives from the scientific and technological sectors. In Brazil, AgMusa™ is our solution for making sugarcane cultivation easier. BASF supplies farmers with pre-grown, disease-free seedlings that are ready to plant. We also provide the necessary agricultural machinery, expert advice and IT tools for precise cultivation of the fields.



## Minimizing risk

Crop protection products should only work where they are needed: around and inside the plant. To achieve this aim, BASF researchers examine a substance's effect on the environment during the development phase.

How quickly does the active ingredient degrade in the soil? How does it behave in water? Does it evaporate in the air? What effects does the substance have on beneficial insects or aquatic organisms? These are the questions environmental researchers and ecotoxicologists here at BASF investigate for any test substance, conducting experiments both in the lab and out in the field. Complex computer simulations and calculations supplement the comprehensive testing.

We put our crop protection products through years of the strictest testing in order to compile a risk assessment. Only substances which have proved themselves to be harmless have a chance of being developed into a final product. Thanks to this process, we can be sure that our products will not have any unacceptable impact on the environment.

“We put our crop protection products through years of the strictest tests in order to compile a risk assessment.”



Crop protection products are designed to control pests, weeds and fungal diseases in agriculture. No other animals and plants should suffer long-term harm. This also applies to the many different types of ecosystem which exist alongside agricultural land.

In order to prove that our products do not harm other ecosystems, our researchers use different ecotoxicology methods from biology, toxicology, environmental chemistry and ecology. Testing begins in the lab using standard experimental techniques on the common water flea and green algae, for example, and continues until field trials.

Trials lasting approximately one year in a 'mesocosm' facility, provide information on whether the substance affects aquatic life. Large ponds house crayfish, aquatic insects, algae and water plants that grow and develop just as they would in natural waters. The results are used to identify potential risks for aquatic environments and to ensure safe use of crop protection products.

## Studies mimic natural conditions

The BASF mesocosm testing facilities at the Agricultural Center in Limburgerhof consist of 16 ponds, each with a capacity of 6,500 liters. They contain water and sediment taken from a natural body of water, as well as a native population of organisms.





### Maintaining biodiversity

Wherever humans farm, they will always influence the habitats of plants and animals. Yet biological diversity and agriculture are not necessarily incompatible. In fact, we believe the opposite is true: Sustainable cultivation of food and animal feed can actually help maintain biodiversity and therefore the variety of organisms and species.

“An essential part of our commitment to sustainable agriculture is to protect biodiversity and the honey bee.”

BASF is actively involved in initiatives for the protection and conservation of ecosystems. For example, we have been working with an arable farm in Rawcliffe Bridge in England for many years, in order to better understand the complicated balance between agriculture and biodiversity. The aim is to achieve high yields while still ensuring the highest levels of biological diversity. The project has been remarkably successful: Today the Rawcliffe Bridge site has 103 different bird species (over half on the list for conservation concern), 22 species of butterfly and 120 species of moths, and even 6 different species of bumblebee.

It is possible to achieve harmony between modern agricultural techniques and biological diversity. To demonstrate and develop this further, BASF has established a new European farm network. Our own experts work hand in hand with independent farmers and other partners from science, industry and nature conservation organizations. Together, we are developing measures to protect bird and beneficial insect populations, to improve water protection and to conserve habitats.



### Protecting our water from the outset

When developing new products, we must prove that they are not harmful to one of our most important resources: ground and surface water. Our scientists employ field trials to monitor to what extent a substance leaches into the soil when used correctly. From these values, our scientists are able to make reliable calculations about the concentration of our substances in surface and groundwater. For regulatory testing, the experts usually use porous, sandy soil with low levels of humus to show what could happen in a worst-case scenario.

For further testing, our experts also use lysimeters. Lysimeters are large planted containers holding soil core samples with a structure similar to nature. Plants are grown in them and treated with the test substance just as they would be in the field. Over a period of two to three years, the researchers then monitor the leaching water for any residues or degradation products. Only substances that do not exceed the average precautionary drinking water limit of 0.1 micrograms per liter (or 0.1 millionth of a gram per liter) over one year can be developed further.

“Only substances which do not exceed the drinking water limit are developed further.”

### Increasingly precise analysis

The drinking water limit for agricultural chemicals is a precautionary value. A concentration of 0.1 microgram per liter corresponds to one person in a group of ten billion. Current analytical techniques are able to detect nanograms and even picograms of substances. Thanks to modern measuring techniques, it would be possible to detect a single sugar cube in Lake Constance.<sup>4</sup>





## Wei from China

Name: Wei Xiuyin  
Location: Nanning, Guangxi/China  
Crop: Sweetcorn

The demand for high-quality foods is growing across the globe, regardless of whether it is for local markets or intended for export. For farmers like Wei Xiuyin, this is completely normal.

Wei works hard every day: For her, the most important thing is to produce healthy, high-quality food. At the same time, this approach also keeps her business thriving. The right crop protection products and the right amount of fertilizer play a central role in achieving these goals. Thanks to our new Limus® technology, we can help Wei simplify her fertilizer use and secure her potential yields. At the same time, using Limus® considerably reduces nitrogen losses through volatilization and so helps the environment.

“For me, healthier,  
better-quality corn means  
better business.”



## Healthy plants, safe food

A wide range of healthy food all year round – that's what today's consumer demands.

Plants thrive with sunlight, water and nutrients. Unfortunately, the same can also be said for pests, diseases and weeds. Anyone who has ever cultivated their own garden knows this. However, today's consumers are accustomed to choose from a wide selection of fresh, high-quality foods – day in, day out. This is possible thanks to modern, highly professional agriculture.

Farmers are faced with two huge tasks when growing food: They have to ensure sufficient crop yields and fulfill the high standards set by both the market and the consumer. Crop protection products help them do both. Healthy plants are essential to produce high-quality foods, such as fruit and vegetables that both look good and contain high levels of nutrients.

Crop protection products keep the plants healthy, giving them more vitality and enabling them to produce better fruit. This is an advantage for both the consumer and the farmer: The consumer gets better product quality and a greater range of foods at affordable prices, and the farmer benefits from more reliable harvest yields.

### Protection against mycotoxins

Fungal diseases not only cause considerable crop losses, but can also contaminate foods with mycotoxins – highly toxic substances produced by fungi. If we do not control fungal diseases with effective crop protection products, these toxins could get into the human or animal food chain and pose a serious threat to both human and animal health.



## With food there can be no compromise

It's essential that any crops treated with our newly-developed crop protection products are harmless to health and therefore safe for the consumer.

Field trials show the maximum levels of residues in crops which can be expected when the chemicals are used correctly. Each year, up to 30,000 deep-frozen plant and soil samples from all over the globe are checked for possible residues in our agricultural research centers and allow us to evaluate the safety of our products.

### Food testing in Europe



In 2014, a total of **82,649** food samples were analyzed in Europe for crop protection chemical residues by official inspection authorities.

**97** percent of the samples returned values below the legal maximum, and **54** percent contained no measurable residues whatsoever.

**1.5** percent of the samples exceeded the maximum legal limits. These products are no longer approved for sale.

Source: EFSA<sup>5</sup>

We apply the minimization principle to residues in food: They should be as low as possible. What does this mean in practice? We will only use what is absolutely necessary to protect plants and keep them healthy.

At the same time, we work closely with farmers, distributors, regulatory authorities and advisors to ensure that our products are used responsibly and correctly.

### Program for South American grape producers

BASF has launched a program called “Sin Fronteras” (“Without borders”) to control pests and diseases across South America. Its aim is to help Chilean and Peruvian table grape producers to increase the quality of their product and ensure they comply with the strict export requirements for maximum residue levels.



## Only sustainable agriculture is successful

We work together with farmers to preserve their land for future generations.

The world must feed an ever-growing population. However, its natural resources such as soil, water or biodiversity have never been as limited as they are now. Ensuring a responsible balance between increasing productivity and the efficient use of scarce resources is the greatest challenge today's farmers face.

To meet the challenge, we need game-changing thinking, relentless innovation and ambitious investment in new technologies. And a correspondingly responsible treatment of our environment. This is what we believe in.

We will help farmers use our products and services responsibly, allowing them to operate in safe conditions, by giving them access to knowledge and information.

### Measuring sustainability in agriculture

We can only ensure sustainable agriculture if we take economic, environmental and social aspects into account and their complex interdependency. This is why we developed AgBalance™.

AgBalance™ provides a scientific evaluation of the broadest range of scenarios and makes recommendations on how to improve sustainability in agriculture. In collaboration with different partners, BASF has already conducted numerous studies around the world with this assessment system, to identify more sustainable processes and techniques in agricultural production.

### Comprehensive analysis

More than 200 data points are used to calculate the 69 sustainability indicators which make up AgBalance™. To name just a few: biodiversity, resource consumption, emissions, costs, residues in food or professional training.



## Product stewardship is at the heart of our corporate strategy

For us, safety comes first. This is why we monitor the use of our products throughout their entire life cycle – it’s the only way to make sure that they’re being used responsibly. The process begins with research and production, carries on through storage, delivery, sales and correct use of the product by the farmer, and finishes with the disposal of empty containers.

Our specially-trained global team accompanies every step in this process. Our aim is to improve our products continually, as well as their application to minimize any possible risks.

One example of our constant product improvement is “Stick and Stay” technology. Thanks to a new formulation, fungicides can now stick directly onto the surface of the leaf – which means that the plants can absorb the substance even more effectively. The advantage: less product wastage, and lower levels of product in the soil.

With our new “Supply Chain Track and Trace” technology, we can track the journey of crop protection products from filling line all the way to the farm. Not only does this make the supply chain more transparent, it also helps prevent the sale of counterfeit products.



### We support smallholders

Smallholders are the main pillar of rural communities. In Zambia, around 70 percent of the population works in agriculture. In 2014, we launched “Lima Chuma” (“Cultivating prosperity”), an integrated program to empower these rural communities. Partners from different areas of agriculture pool their knowledge in order to help smallholders run their businesses more efficiently. Better harvests lead to better income, which leads to a higher standard of living and ultimately better levels of education.

In developing countries, farmers tend to lack access to personal protective equipment for applying crop protection products. We have developed a safety kit specifically for them, which is easy and convenient to use. It contains gloves, a face mask and eye protection, as well as safety instructions, and is sold at cost.

Our product stewardship does not end with the successful research, development, manufacture or safe transportation of crop protection products. The circle only closes once you include disposal and recycling. To minimize the risks for humans and the environment, we promote simple yet effective processes for the disposal of unused products. We also cooperate with government bodies and other partners as part of our world-wide container collection and disposal program.

“Our stewardship starts with the development of products and ends with the disposal of empty containers.”





## Worldwide innovation and competence center

A reliable partner in agriculture for over 100 years.

Much has changed in the last 100 years at Limburgerhof: The Agricultural Research Station has become the Agricultural Center, BASF's world-wide center of expertise in crop protection. But one thing has remained the same: the dedication of our employees. Employees, who over the decades, have contributed to the development of many innovations, both large and small, to make farming successful.

The establishment of the Agricultural Center was preceded by a revolutionary development: In 1908, Fritz Haber developed an artificial nitrogen fixation process to produce synthetic ammonia.

Carl Bosch scaled the system up, and 1913 saw BASF open the world's first ever ammonia synthesis plant: the gateway to mineral fertilizer production.

Today, around 1,700 employees from a wide range of different professions work closely together to develop new active substances, seed treatments, biological crop protection solutions, formulation technologies and other applications and services for farming. They have thousands of square feet of green-houses and labs at their disposal, as well as large open areas for field trials.



## Rehhütte farm estate – the bridge between research and practice

Close to the Agricultural Center lies the Rehhütte farm estate. BASF manages the 480 hectare estate according to the principles of “integrated farming”, combining responsibility for the environment with the commercial requirements of a modern agricultural operation.

Locally adapted crops and resistant plant varieties are grown according to balanced crop rotations on this modern agricultural farm. The farm manager is supported by the very latest technology: The self-propelled crop protection sprayer runs using GPS satellite navigation to ensure products are applied so precisely on the fields, that flowering strips, for example, are left unsprayed.

With its enormous expertise, the Rehhütte farm estate is a valuable partner to the research department at the Agricultural Center. In addition, it is also an ideal venue for discussion and exchange with our customers and visitors from around the world who come to visit us each year.



## The latest technology in action

The very latest technology is used on the farm estate. The amount of fertilizer required can be measured using a nitrogen sensor on the spreader – the sensor measures the levels of light reflected by the plants and calculates the exact amount of nitrogen required. The result? The perfect amount of fertilizer: not too little, but not too much.



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# Legal notice

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