

Advancing sustainable

Fruit & Vegetables in Europe

Think sustainable – use VELUM® Prime!

Your solution for safe and effective nematode control

- Low application rates
- Unique safety profile for sustainable agriculture
- Gentle to soil and to beneficial organisms
- Flexible application techniques
- **Reduced operational costs**

Use plant protection products safe Nways read the label and product information before us

BAYER E R

VELUM PRIME

Content

04 Editorial

To The Farm

- **08** FLiPPER[®] bio-insecticide: Controlling foliar pest naturally and sustainably
- **10** Switch on a plant's self-defense
- **12** Vegetable Seeds
- **18** Two-way protection for high-quality fruit and vegetables

On The Farm

- 22 The new dimension of growing Indoor Farming
- 26 Luna Flower Power: Fungicide boosts table grape growers' incomes in China
- **28** Innovative virus management novel breeding combined with selective pest management tools
- **30** Shaping Agriculture to benefit farmers, consumers and our planet
- **32** One Step Ahead with Sustainable Agriculture
- **35** Root 2 Success
- **36** The Hidden Curse
- **38** Shaping the future of citrus production in China

Beyond The Farm

- **42** Fruits and vegetables: At the heart of good nutrition and overall health
- 44 Healthy food from field to fork

Bayer AG

Crop Science Division Alfred-Nobel-Str. 50 40789 Monheim am Rhein Germany

Always read and follow label directions. Visit us at: www.bayer.com

The brochure is printed on 100% recycled paper, FSC[®] certified and awarded the Blue Angel and EU Ecolabel.



There are fundamental changes affecting the horticultural markets that will change the way we operate as an entire industry. The nature of the relationships of the different players will also have to evolve to address those transformational changes. Just to name a couple as examples, the more fundamental ones are the breath of choices that the consumers expect with respect to convenience, quality and nutritional value for its fruits and vegetables, and digitalization and automation that are going to enable greater efficiency on the farm, regardless of whether it is for the use of input or available resources such as water, nutrients and labor.

More than ever, the need for portfolio innovation and innovative field-to-fork models will be needed to ensure that we meet the needs of a diverse population in the different parts of the world, looking for a better consumer experience with their fruit and vegetables whatever that means for them. This can mean different things to different consumers: from the need to increase productivity and quality in Asia and Africa to feed a middle class growing in size and income, the need to increase convenience and purpose in North America and Europe and address societal concerns, and the need to increase nutritional value almost everywhere.

WHAT DOES IT MEAN FOR THE INDUSTRY?

the farm:

the farm:



higher nutritional value for fruit and vegetables, and breeding for specific genetics that will satisfy specific consumer segments in the future,

With the digital transformation affecting many industries as we know them today - fruit & vegetables are no exception - the way farms are operating, the way consumers make their choices, and the way the entire food chain eco-system is competing will be and is already undergoing important changes that also aim at reducing a large part of the inefficiencies we currently see today in the fruit & vegetables supply chain.

WHAT MAKES BAYER SO UNIQUE IN THE INDUSTRY THAT IT HAS A BETTER CHANCE OF SUCCESS WITH THIS STRATEGY?

We have been a leader in the fruit & vegetables business for many decades with our robust crop protection and seeds business, but also with our new products pipeline. We remain committed to this innovation and will continue to launch new products on the market in the next years - in conventional crop protection, biologicals and seeds. At present, we are launching Tiviant, a product that stimulates natural plant defenses. We also have signed an agreement with Alpha Bio Control to market a new biological product called Flipper, which is a natural extract of olive oil to control mainly aphids and whitefly. We are continuing to focus on promoting the benefits of our biological products such as Serenade for the growers and value chain and provide increased yield and quality thanks to enhanced soil health and roots development.

On the genetic side, we have a variety of breeding programs to develop tomatoes with improved flavor and color. Our Torelino tomato combines a unique disease resistance package with high yield potential and excellent taste. Our Whitex cauliflower combines bright white uniform curds with excellent shelf life.

On the digital front, the Internet of Things and satellite imagery are rapidly changing the way solution providers interact with their customers and the quantity of information that is available on the spot to make certain decisions on the farm or beyond the farm. With our leading digital capabilities available in The Climate Corporation, our IT and Computational Life Sciences organizations, we are uniquely positioned to design specific algorithms and solutions to enable smarter decision-making on the farm and better consumer choices.

BAYER HAS RECENTLY DEVELOPED A "TO THE FARM, ON THE FARM, BEYOND THE FARM" STRATEGY FOR FRUIT & VEGETABLES – WHAT ARE ITS MAIN ELEMENTS AND

The "to the farm, on the farm, beyond the farm" strategy is meant to provide an innovation framework for Bayer's Crop Science Division to drive its R&D, Marketing and Sales and digital capabilities toward addressing the transformational changes that I talked about earlier.

> Our ability to constantly produce better innovation in genetics, crop protection & biologicals, on the farm to equip fruit & vegetables growers to provide the right yields and consumer specifications in quality will be key to remaining the market leader.

> Excellence in farm management practices with digitally enabled, tailored solutions will help farmer makes the best use of that innovation while increasing productivity on the farm, preserving natural resources and reducing the environmental footprint.



ne farm

Our ambition is to constantly provide improved innovation in genetics, crop protection & biologicals to farms to enable fruit & vegetables growers to produce the right yields and consumer specifications in quality.

We have been a leader in fruit & vegetables with our robust crop protection and seeds business, but also with our new products pipeline. Our commitment is that we will continue to launch new products on the market in the next years in conventional crop protection, biologicals and seeds. For mulas and smart application profiles, a new generation of high-efficacy biocontrol agents and genetic innovation for higher crop-growing efficiency and enhanced biotic and abiotic stress tolerance on the input side as well as improved nutritional value, convenience, and processing addressing future consumer needs.

With our leading digital capabilities available in The Climate Corporation, our IT and Computational Life Sciences organizations, we are uniquely positioned to design to digital farming platforms and specific algorithms as well as enable smarter decision making on the farm and better consumer choice.

FLiPPER[®] bio-insecticide: Controlling foliar pests naturally and sustainably

Can a by-product of extra virgin olive oil control pests like whiteflies, aphids, thrips, mites, psylla, and leaf hoppers in many fruits and vegetable crops? It may sound rather unlikely, but that is exactly what FLiPPER[®] does. This innovative bio-insecticide has already proved its worth, as the two case studies below show, and is now being launched in many countries in the EU.

FLiPPER[®], a bio-insecticide-acaricide formulation based on a natural active substance obtained from an extra virgin olive oil by-product, delivers broad-spectrum control of foliar pests in fruit and vegetable crops. When pests come into of the larvae. The tests showed that, about 70% of the contact with FLiPPER[®], their cell functionality is disrupted and feeding activity interfered with. FLiPPER[®] controls all stages of insects and mites: juveniles and adults, as well as eggs. FLiPPER[®] is soft on beneficials and pollinators; its active substance leaves no chemical residues, and it has been classified as Food Grade material and is therefore exempt from MRL testing requirements. On top of that, it is approved for organic farming. As an excellent resistance management tool, FLiPPER[®] is the ideal partner for integrated agronomic solutions consisting of seeds, biological products, and conventional crop protection chemistry.

Future-proof weapon

Rien Poortvliet, who manages the fruit-growing company Agri Base in Arnemuiden in the Dutch province of Zeeland, has seen his pear trees plagued by psylla in recent years. "Traditionally, pear psylla has always been a big problem, which often makes it very difficult to avoid using strong but less selective crop protection agents, especially toward the end of the season," Rien explained. When Bayer asked Rien whether his farm could be a test location for FLiPPER®, he readily agreed because his aim is always to get on as green a track as possible and maximally combat pear psylla's natural enemies. "It was very interesting to see the difference between the pest burden at the test location and the

burden across the rest of the plot throughout the season," Rien reported. He was struck by how effective FLiPPER® was. "It proved especially effective on the first two stages larvae had been killed after four days. This is higher than other non-chemical alternatives." Although FLiPPER® is not a "miracle cure" to control pear psylla, Rien is positive about the product's prospects. "In coming years, we will increasingly have to abandon the use of chemical agents in favor of green alternatives," he stated. "FLiPPER® provides us with a sustainable and future-proof weapon against pear psylla."

Excellent in cucumbers and strawberries

Cultivating cucumbers and strawberries in one and the same company is far from commonplace in greenhouse fruit & vegetables. But that is exactly what VieVerde does in Castenray in the Dutch province of Limburg. As Rob Weiis, VieVerde's crop protection specialist points out, "We're dealing with the same bugs and the same fungi in strawberries and cucumbers." In the 27 years he has been working for VieVerde, Rob has experienced the major shift from traditional spraying to integrated pest control measures, and where possible, VieVerde always uses biological agents. It was in this context that VieVerde agreed to test FLiPPER®. "We used it twice against aphids and that went really well," Rob said. "it was very effective on aphids within three to four days. We have only had good experiences with this product, so we will use it again when necessary," Rob concluded.



Global rights for FLiPPER®

In June 2019, Bayer and AlphaBio Control, the developing company of FLiPPER®, signed a distribution agreement granting Bayer worldwide exclusive rights (except for France) to commercialize FLiPPER® for agricultural and non-agricultural uses. As lain Fleming, AlphaBio's CEO, said, "We could not hope for a better partner to help promote and deliver FLiPPER® to growers. We have seen the complete determination within Bayer to deliver comprehensive integrated solutions for all crop needs."

- Soft on beneficials and pollinators Leaves no residues and is exempt from MRL requirements
- Approved for organic farming (FiBL)
- Excellent resistance management tool

As one of the world's largest developers and providers of pest management solutions, Bayer is glad to provide growers across the world with a new tool to safeguard crops sustainably."

Hartmut van Lengerich Global Head of Crop Protection Asset Management, Bayer

• Innovative bio-insecticide with active ingredient from natural and sustainable sources

• Broad-spectrum control of foliar pests in fruit and vegetable crops through contact activity

Switch on a plant's self-defense



PORTFOLIO









... against a broad range of bacterial diseases.

Bacterial diseases in fruit & vegetables cause an estimated €10 billion in commercial damage for farmers worldwide every year. But farmers don't have suitable solutions at hand – usually they apply copper or antibiotics with insufficient efficacy, environmental issues, and decreasing public acceptance.

Wouldn't it be great if plants could simply protect themselves? Humans stimulate their immune system and protect themselves against many diseases preventatively with vaccinations. Farmers will soon be able to do the same for their crops, since there is now a vaccination for plants: TIVIANT.

TIVIANT - our new innovative plant defense modulator switches on the plant's natural self-defense mechanisms. Its mode of action is based on the active ingredient Isotianil, which works like a general immunization, providing reliable, long-lasting protection against a broad spectrum of bacterial diseases. TIVIANT can be applied flexibly throughout the growing season and is complementary with biologics and beneficials based on its favorable environmental profile.

The first registration of TIVIANT was granted in Korea in 2018. Soon, TIVIANT will be available for use in fruit and vegetables in plenty of selected geographies around the globe.

TIVIANT has three key features: SELF-DEFENSE, **PREVENTION, and TRAINING.**

Activating plant self-defense without pathogen attack Every crop can defend itself against pathogens. When being attacked, the plant produces a signal that moves through the whole plant and triggers the production of defense molecules. This natural self-defense mechanism is called "Systemic Acguired Resistance" (SAR). TIVIANT also switches on SAR.

TIVIANT even activates the plant's natural self-defense without a bacterial attack. Comparable to a vaccination, TIVIANT protects the plant and prevents damage.

Improving speed and efficacy of disease protection

When a plant is attacked by pathogens for the first time, it takes a few days to establish SAR. This triggers a structural rearrangement in the plant, which makes the defense genes more readily accessible for the next pathogen attack. The defense response therefore becomes faster and stronger with every attack.

Just as humans exercise to get fit, TIVIANT in fact provides fitness training for crops. Repeated TIVIANT application puts SAR on the plant's fast track and provides a much faster self-defense response and more efficient protection against bacterial diseases.



MELON

The breeding program emphasizes melon hybrids for the Harper, honeydew and specialty markets with innovative combinations of flavor, flesh firmness and maturity indicators. Seminis melon varieties are developed to be grower-friendly while also providing exceptional quality for consumers.

PROCESSING TOMATO

The breeding program is focused on processing tomatoes that best serve the needs of today's top processors. With new genetics that help drive industry leadership, our processing tomato line brings exceptional quality to processors without ever missing a beat.

WATERMELON

Providing products for the Americas, Europe, the Middle East and Australia, the trials feature seedless varieties for North America, as well as seeded fruit for South America, Europe and the Middle East. A few plots include varieties grafted onto our squash rootstock. Not common in the U.S., grafting is used as a control for Fusarium wilt race 2.

SWEET PEPPER

The breeding program is a team effort at Seminis[®], and we work together to maximize yield potential through better disease resistance and achieve higher packout with better plant and fruit setting characteristics. The team aims to lead the market by offering varieties that provide value creation for specific regions.

Vegetable Seeds

Innovating to enable access to safe, nutritious and delicious produce

For more than 150 years, Bayer has used science and imagination to better people's lives by advancing health and nutrition. Our Vegetable Seeds business is at the heart of this purpose. We work to innovate, collaborate and help ensure that people around the world have access to safe, nutritious and delicious fruits and vegetables.

To do this, our teams collaborate with customers across greenhouse, large and small open-field farms and processing environments to provide innovative vegetable seed varieties and integrated solutions that create value on and beyond the farm. Working with partners across the value chain, we turn our pioneering research into real-world tools and analytics, passionately providing growers with smarter, safer ways to produce nutritious food that is enjoyed by consumers worldwide.

Dr. Jacqueline (Jackie) Applegate

Dr. Jacqueline (Jackie) Applegate is a purpose-driven, innovative leader with 25+ years of global leadership experience at Bayer. Currently, Jackie serves as President of Global Vegetable Seeds and Environmental Science for the Crop Science division.

Jackie, when people think of Bayer Crop Science, many likely think about its large presence in row crops such as corn and soybeans. How does Bayer's Vegetable Seeds and Fruit & Vegetables business fit within Crop Science and the larger company?

- Our Vegetable Seeds business is central to Bayer's purseeing when it comes to today's needs and trends? pose of Science for a Better Life by enabling better health • Changes in consumer lifestyle and preferences for speand good nutrition. We develop innovative new vegetable cialty foods, convenient packaging and home delivery options will challenge our industry's ability to meet its seed varieties that farmers around the world can grow into quality, nutritious produce, as well as create unique inteneeds in a cost-effective way. grated solutions with our fruit & vegetables business col-• The public's continuing concern about how food has leagues that solve the complex problems of our customers. grown and what impact it has on the environment and • First, fruits and vegetables are an indispensable part of a our health also requires us to be more transparent healthy human diet, yet millions around the world lack access about our products and practices. Bayer has a strong
- to these essential foods.
- Second, from a business perspective, this developing market offers attractive growth rates and profitability opportunities, which enable us to make future

Our Vegetable Seeds teams are always exploring and discovering new and better ways to advance health and nutrition for people all over the world."

investments in innovative products and services. Bayer has made an intentional commitment to fruit & vegetables given its strong alignment with our company purpose.

• Finally, fruit and vegetable crops are important economic engines of growth around the world, particularly for smallholder farmers, which can lead to greater prosperity, stability and security not only for their families, but also for consumers maintain a healthier lifestyle. entire communities. Bayer is committed to empowering • In short, people want greater convenience and digital con-100 million smallholder farmers with sustainable solutions nectivity to their food. They desire the power to decide by 2030 and our Vegetable Seeds business is a key conhow they shop, how it's delivered and how their food is tributor to this promise. grown. They want products with purpose that are good for their health.

The Vegetable Seeds business being central to Bayer's purpose must be exciting to a veteran Bayer leader With this in mind, how is the landscape changing with such as yourself? respect to your customers and competitors?

- First and foremost, we need to challenge ourselves to see fruit & vegetables, our Vegetable Seeds organization is sinthings through the eyes of our customers who are working gularly positioned not only to contribute to, but to accelerate just as hard to meet changing consumer expectations. Bayer's commitment to advancing health and nutrition and Our customers are being pressured to adapt to new retail deliver on our purpose of Science for a Better Life. and consumer demands, and this requires a partner who can work alongside them and deeply understand their grower and ends with the consumer. Our goal is to work at needs and provide tailored solutions.
- It's hugely exciting. Working closely with our colleagues in • A sustainable fruit & vegetables business begins with the

- both ends of this spectrum to provide growers with the tools they need and consumers with the foods they desire.
- In Vegetable Seeds, we're developing products that help growers and retailers connect people to nutritious food around the world. Our company and our society need us now more than ever. This is what really drives all of us!

A Changing Landscape

Let's talk about some of those shifting preferences. Since it all starts with the consumer, what are you

> commitment to transparency in everything we do, and we are constantly rethinking how we approach our business to ensure that every commitment to innovation is

also a commitment to sustainability.

• A big part of this shift in awareness around health and nutrition involves a greater demand for nutritious fruits and vegetables. By working with partners to better understand these nutritional preferences, we at Bayer and particularly in our Vegetable Seeds business have the keys to help

to the farm

• When it comes to competitors, the landscape is truly transforming. In addition to strong competitors and major players such as ourselves, trends such as urban, vertical farming and farm-to-fork delivery have enabled smaller, more nimble businesses to pop up seemingly overnight. Meanwhile, disruptive technologies will continue to pose challenges to customary business models. Finally, our industry is shifting toward new supply chain methods that can meet the needs of a growing and more demanding population. While all of these changes have resulted in a crowded competitive landscape, it gives us new opportunities for collaboration to foster disruptive innovation.

What are some of the ways in which Bayer's Vegetable Seeds business is responding to these major developments?

- Embracing change is key. We have challenged ourselves to look more deeply and broadly to better understand the grower environment, so that we can tailor solutions specifically designed to meet its unique needs.
- We are changing our culture to be more agile and nimble, more receptive to market signals and trends that can, in turn, spark new innovations to benefit our customers on the farm and beyond. We are focusing not just on maintaining our market leadership but on demonstrating our thought leadership in the produce industry.
- From a consumer standpoint, our R&D teams are developing innovative seeds to enhance grower productivity and increase worldwide consumption of fresh produce. Using grower analytics and consumer research, they are breeding seeds that not only help growers produce nutritious and flavorful food, but also reduce challenges in shipping, processing and retail to ensure this great quality can reach consumers' plates. We are truly looking at each link in the value chain to deliver new solutions.

You mentioned tailored customer solutions. How are you transforming to be closer and more responsive to your customers' needs?

- · We have transformed our organization so that we can work better together with our customers across four strategic segments associated with the growing environments: protected professionals, open-field fresh professionals, smallholder farmers and processing professionals.
- · Focusing on these strategic segments enables us to deliver specific solutions that meet the unique growing environments and needs of the customers in each segment. We are working with our colleagues across fruit & vegetables and the entire Crop Science business to leverage our industry-leading portfolio, R&D engine and digital capabilities to provide a holistic approach beyond the seed.

The Opportunities Ahead

You've shared what the business is doing internally to stay ahead of the changes in the industry and marketplace. What about beyond the walls of Bayer?

- I'm so glad you asked this, because Bayer is not in this alone. That's because no amount of innovation will be successful without the full engagement of the entire fruit and vegetable food chain. Our food chain partnerships work at every level to accomplish our vision and ensure the success of each of our partners.
- We are also looking beyond and up! - to discover new possibilities in the area of vertical farming. With the development of megacities around the world, our entire industry must rethink how we grow crops to meet the needs of growing urban populations. Through highly-controlled indoor growing environments, we have an opportunity to produce fresh, local and high-quality produce without leaving the city! Our leading



Innovating for today's consumers

Our goal is to work across the value chain to provide growers with the tools they need and consumers with the foods they desire. One way we do this is through a deep understanding of consumer preference and the genetic differences that affect the human sensory experience. By collecting and analyzing data from around the world, our teams of researchers can provide seeds that strike the right balance between meeting consumer preferences and addressing grower needs.

Here are just a few examples of the latest varieties in our portfolio:

Delisher® tomatoes from our De Ruiter brand are a delicious cherry plum tomato that outshines other varieties because of its sweet taste, texture, and looks, in addition to its convenience.

- **Taste:** The unique combination of sweetness and acidity create a nice first bite with a lasting taste experience.
- Appearance: A mini plum truss variety combines the best of both worlds "snacking on the vine".
- **Convenience:** The strong fitting on the truss makes it easy for the shopper to take it home without losing tomatoes off the vine during transport. An added plus of this strong truss is no plastic packaging on the shelf, making it even more sustainable.

The Whitex variety within the Curdivex[™] cauliflower series from Seminis has an appealing white color and excellent shelf life. As it stays whiter for longer, this variety is more appealing for consumers and sells better for retailers. This same feature makes it easier to see when it is mature in the field, enabling a more efficient harvest for growers.

Delivering a Solution Delivering a Solution

For customers and value chain partners seeking an up-close look at how our Vegetable Seeds teams are working to provide new, innovative solutions, we welcome visitors to our De Ruiter Experience Center.

The De Ruiter Experience Center opened in Lansingland, Netherlands in March 2018 and has since welcomed thousands of visitors from around the world. The Center allows visitors to learn about our heritage, and our work in technology and breeding. It includes a state-of-the-art demo glasshouse where visitors can get a glimpse of our precision fruit & vegetables growing practices, and a market space to sample and see our varieties on the shelves.

To learn more about the De Ruiter Experience Center or to schedule a visit, we encourage you to check out our webpage: https://www.deruiterseeds.com/en-no/de-ruiter-experience-center.html.

BIOLOGICALS BY BAYER

The power of nature. Empowered by science.



The easy way to market.



FLiPPER, the highly effective **biological insecticide**, opens up new markets with residue-free* crops, is safe for the environment, and helps you meet consumers' demands for sustainably produced food.

*FLiPPER is exempt from Maximum Residue Levels (MRL)

Two-way protection for high-quality fruit and vegetables

Consumers around the world want healthy, high-quality fruit and vegetables. Lettuce heads invaded by aphids, oranges speckled with scale insects, or grape bunches with damaged or dirty fruit are not the consumers' choice. Achieving a harvest free of these invaders and defects is a big challenge for every fruit and vegetable grower.

MOVENTO[®] is our proven insect-control solution as it gives fruit & vegetables farmers all over the world an extra amount of protection against major sucking pests such as aphids, whiteflies, mealybugs, scale insects, and psyllids.

What makes MOVENTO[®] so unique is its broad spectrum of activity along with the two-way protection it provides. That is because it works throughout the plant in both an upward and downward direction. After the leaf absorbs MOVENTO[®], it moves directly to those parts of the plant where damaging insects feed, including those hidden in any part of the plant as well as dense crop canopies, new shoots, and root systems. This fortifies the entire plant.

MOVENTO[®] provides the most effective and long-lasting control with fewer applications at a relatively low cost per day – and even works against hidden and resistant pests. The good thing is that it is also non-hazardous to most beneficials, which additionally helps to keep the crop clean.

MOVENTO® in Spanish citrus crops

For years, California Red Scale has been the main pest in Spain's citrus production, causing serious pest control difficulties. The products predominantly used in the past were organophosphate insecticides. "Organophosphate insecticides caused natural enemies to die, and this affected the control of other pests, such as mites or mealybugs," explains Antonio Ribes, a technician at the Estate Masía San Vicente in Borriol, the center of clementine production in Spain. He grows 60 ha of citrus crops. "I needed several applications a year to keep pests under control," he says.

Since the launch of MOVENTO[®], Antonio has used this Bayer product and changed his pest management to an IPM* strategy. Currently, California Red Scale is easily being controlled. "With MOVENTO[®] I'm confident it doesn't fail, so in the last few years MOVENTO[®] has given me security and peace of mind. By using MOVENTO[®], I additionally increased the natural populations of beneficial insects, which means better pest control and fewer applications," Antonio adds.

integrated pest management

2 WAY PROTECTION: Fortified Crops & Growers







Our excellence in farm management practices with digitally-enabled, tailored solution will help farmers make the best use of innovation while increasing productivity on the farm.

Sustainability is an integral part of our fruit & vegetables strategy and is embedded in all our business practices as a fundamental condition for achieving this. Therefore, we will provide solutions aiming at preserving natural resources and reducing the environmental footprint while maintaining on-farm productivity.

In this context, we will continuously leverage smart farming and breeding technologies to sustain soil health and reduce limited inputs, such as water, nutrients, and labor. We will set industry standards in consumer & operator safety as well as effective stewardship measures and services

The new dimension of growing **Indoor Farming**



Indoor farms are rapidly gaining ground in and around big city centers in Asia, North America, Europe, and the Middle East. However, their economic viability, compared to open field or greenhouse operations, is still unknown.

What is "indoor farming"? Why is it an intriguing opportunity for investors? Why should consumers, food businesses, governments, and health providers pay attention? My favorite way to look at this is through a culinary lens and the universally celebrated act of cooking.

I love cooking, and the challenge of combining all kinds of vegetables, herbs, spices, and other ingredients into what I hope will result in a most delicious dish is one of my favorite ways to spend time. Unfortunately, I fail to create the same

experience time after time. Sometimes my guests really enjoy what I serve at the table, other times they are just being polite. There is a secret ingredient that can improve the odds that my dinner guests will get what they expect - let's explore this together.

I like to compare cooking to growing vegetables. Whether we are busy in the kitchen or in the field, multiple variables define the outcome of our creation. These changing factors can result in a meal or crop that is delicious, consistent, and high-quality or in some cases can lead to disaster.

Growing vegetables and other crops in an opaque closed environment with artificial lighting and full environmental control, known as an indoor farming ecosystem, allows us to minimize inconsistencies and reproduce the same outcome anywhere, anytime. In such an environment, we can apply different inputs to a crop and obtain specific flavors, nutrition densities, colors, shapes, and sizes. Some refer to this as vertical farming. However, this may include growing in more familiar

FFWe are excited about the immense potential for breeding seeds for 'Indoor Farming.' We focus on seed innovation that unlocks flavor, increases nutritional density and explores plant and leaf size. The opportunities are endless, and we are transforming the consumer experience in produce through heightened flavor, better quality and superior freshness."

Irving Fain / CEO and founder of Bowery

structures like greenhouses, where crops are exposed to creased the interest in expanding indoor farming. To make sunlight, possibly complemented with artificial light. the crops that are grown in this new, high-precision growing environment more affordable and to attract more consumer In Japan, indoor farming has been practiced for over three segments, production costs per unit will need to be redecades and is sometimes referred to as "plant factories with duced further.

artificial lighting," a term coined by Dr. Kozai, grandfather of indoor farming.

We often hear the term "Urban Farming" as a mega trend, which is the result of large cities expanding and producing food where people live. Urban farming borrows several facets from gardening and enables food to grow in unconventional places, from the rooftops of houses and skyscrapers down to old underground subway tracks with artificial lightning. The real future of urban farming is indoor farming.

Breeding to improve crop performance in an open field environment has been going on for a very long time and has been guite successful, yet is often affected by environmental variability and disease pressure. Yield performance in greenhouses has more than doubled over the past 30 years, partially through adoption of technology, but mostly through Today, there are about as many different designs of indoor access to better-performing varieties, which are excelling in farms as there are indoor farmers, each of them exploring these more controlled environments. We should expect

how to maximize efficiency and minimize costs. The investment needed for indoor farms is much higher than for greenhouses and thus depreciation costs, besides high labor and energy expenses, are the major hurdles to scaling up rapidly. Over the past

FF The development of a vast range of high-yielding varieties with increased light use efficiency and adapted to short crop cycles will greatly expand the crop portfolio of vertical farms."

Mark Korzilius / CEO and founder of Farmers Cut GmbH

couple of years, automation has been adopted to reduce ing, to disclose the full potential of a variety and share the some of the labor expenses and increased lighting efficiency best recipes with our partners. has helped to lower energy costs. The increasing willing-Why do we think it is so important to enable indoor farming ness of consumers, foodservice operators, and food companies to pay a premium for sustainably grown, hyper-fresh to expand during the next 10 years and why do we as Bayer ingredients with exceptional eating quality has further in-Crop Science have an interest in this exciting dimension?

And this brings me back to the "secret ingredient" analogy. The secret ingredient of indoor farming - and growing the best crop — is the seed.

> completely new and very different specific varieties to be grown in indoor farms during the next 10 years. The high number of controllable environmental factors to impact each specific variety will result in very high complexity but will allow us, through machine learn

Overall, the current organization of the world's food production and distribution is under pressure. New economies and increasing urbanization demand more, better, safer and more secure production capacity, while growing land and water shortages, climate change and changing plant protection needs result in increasing challenges in open field food production. Today's farming practices, with crops being grown where the climatic conditions and land values are favorable, especially for fruits and vegetables, will not remain sustainable. They result in long and complicated supply chains, poor food quality and enormous food losses.

Indoor farming can help meet many of the challenges and needs expressed by global citizens, as they are increasingly concerned about the future of our planet and more interested in improving personal health. When we think about our contributions to a healthy planet and how we can each make a positive impact, we must acknowledge the topic of food waste. Fresh produce items are perishable and 40% of what is produced is never consumed. The reason we spoil so much of this valuable food is mainly because we grow, order, and buy more than we need, and because we don't grow it where we need it. Because indoor farms enable us to produce on demand (very short grow cycles) and produce locally, they can considerably contribute to reducing food loss and waste, as well as the carbon footprint. At the same time, indoor farming allows us to produce more with fewer precious resources, such as water and land. Secondly, whereas fresh produce items are acknowledged as excellent natural sources of nutrition, contributing to better health and life, Nutritional governmental policies around the world recommend that we all increase our fruit and vegetable consumption. Grape tomatoes or mini peppers can be great snacks, but sometimes these do not offer a consistently great eating experience. Belgian chocolates overwhelmingly taste good every time we indulge. However, lettuce or cucumbers that have been on the road and on the shelf for several days or weeks do not always leave you wanting more.

Indoor farming has the potential to change our food system, enabling us to consume hyper-fresh, great tasting nutrition, produced sustainably on demand, where and when it is needed. The secret ingredient for successful indoor farming is the seed – in other words, the right genetics bred specifically to flourish in indoor farming. It is about the varieties that are most suited to fully controllable indoor growing conditions, yielding tasty, nutrient-dense and essential quality traits. It is about producing high-yielding varieties with increased light used efficiently and adapted to short crop cycles, as well as high germination quality and seed treatments for optimal seedling vigor. We are committed to the future of indoor farming, and we welcome the opportunity for partnerships that will contribute to the growth of this practice.

For the first time since I started my career in produce, talking to my millennial kids about this next generation of farming, and showing the magenta-rich pictures with beautiful crops, they let me know that this is "really COOL."

Our passion at Bayer Crop Science for innovation will support indoor farmers so they can scale faster in a more profitable way.

Bon Appetit! Bruno Libbrecht Global Produce Business Insights Lead



SANANBIO



seminis-us.com/summerslice

on the farm

Luna **FLOWER POWER:**

Fungicide boosts table grape growers' incomes in China

No country cultivates more table grapes than China, Chinese table grape growers have always preferred to apply and consumer demand is increasing year by year. **Chinese consumers naturally want tasty and nicely** disease pressure is high. The fruit stage, it has been said, is shaped grapes, while retailers are looking for a longer a kind of battlefield in Chinese fruit & vegetables. If not conshelf life. These are the requirements that are being passed on to China's grape growers. Ultimately, the main latent in the developing fruit before growing and damagchallenge they face is how to deal with problematic ing the grapes close to or after harvest. Applying Luna at the fungal diseases such as botrytis, monilia, sclerotinia, alternaria, anthracnose, scab, or stem end rot. And table grape quality. The challenge facing the Luna FLOWER this is where Luna FLOWER POWER comes in.

high-end crop protection products at the fruit stage, when trolled early enough, the above-mentioned diseases can reflowering stage demonstrably improves produce shelf life and POWER team in China was to convince farmers that it was more effective to apply this fungicide at the flowering stage.

Conviction starts with communication

As the initial step towards conviction is communication, the first hurdle to be overcome was finding an appropriate phrase to express FLOWER POWER in Chinese. The solution chosen - "hua hao guo xian" - means fresh fruit with a healthy flower. That was a good start, but nothing more. After the Luna team had defined this phrase as the fungicide's technical positioning and not just a campaign slogan, they started systematically explaining the meaning of Luna FLOWER POWER to various target audiences.



Proof of concept be found. Our customers generally prefer to apply fungi-Peng Wang, Bayer China's Crop Manager Grapes, explains cides at the fruiting stage as it can impact their income very how Chinese grape growers were familiarized with and ultimuch. But we were able to prove to them that when Luna is mately convinced by the new application concept: "We foapplied at flowering, grapes have a much better fruit setting cused on three key actions: collecting evidence, showing rate and build a strong foundation for high-quality grapes to develop a better shape and fruit skin." value with demo trials, and conducting internal and external education measures. We first collected all the available information and created a huge database full of technical Seeing is believing knowledge about Luna's product features, local demo trial The time spent demonstrating the benefits of applying Luna data, and arguments supporting latent disease pathogeneto blooming grape vines was well invested. Around 1,000 sis. Then we conducted over 240 demo trials across China demonstrations were accompanied by an online pull marand organized farmer meetings to showcase the value of keting campaign with some 500 posts showing the value of Luna FLOWER POWER in practice. And last but not least, Luna FLOWER POWER. Since its large-scale launch in we set up a special team to train the Bayer sales team and 2019, it is no exaggeration to say that Luna FLOWER POWER external channel partners to enable them to train farmers." has proved a game changer in growing table grapes in Chi-All in all, some 60,000 farmers were directly educated about na. Grape growers who have been using the FLOWER the advantages of flowering stage application. POWER solution are already reporting a rise in annual incomes of 2-5%. And that is certainly a powerful argument Overcoming obstacles for application at the flowering stage.

The path to success was far from smooth, as Peng Wang points out: "A key challenge was to convince farmers to apply Luna at the flowering stage when no symptoms can









Innovative virus management –

novel breeding combined with selective pest management tools

Insect-vectored viruses: a re-emerging threat

Aphids, white fly and thrips are well known troublemakers for crops and growers. They not only feed on plants reducing the growth and yield, but they also contaminate the plants with viruses. These viruses live in the body of the insects, and the viruses are transferred into the plant tissues when the insects feed on the plant. The viruses multiply and spread quickly throughout the plant. Within a couple of weeks, the plant shows the symptoms of its suffering: leaves start to curl, turn yellow or get brown. Flowers might be malformed or aborted reducing the fruit setting. In addition, the harvested fruits may be affected, showing irregular maturation and loss of fruit color. Some well- known examples of these insect-virus combinations are the peach tion of young plants in clean nurseries

leaf curl virus, the western flower thrips (Franklienella occidentalis) and tomato spot virus, and white fly (Bemisia tabaci). The latter is able to transmit multiple viruses, of which tomato yellow leaf curl virus (TYLCV) is probably the most devastating.

aphid (Myzus persicae) and the potato

Insect-vectored virus damage

The losses caused by virus diseased may range from 10-20% of the yield at low pressure up to a complete loss of the harvest in case of high pressure of tomato yellow leaf curl virus. Growers and value chain partners pay substantial attention to this by implementing preventative control strategies to prevent contamination of the crop with the insects. These programs start with the use of healthy seeds and the produc-

protected with insect netting. Pest control products are applied to keep the levels of insects at a very low level.

Unfortunately, the control tools applied are continuously being challenged by the forces of nature. In addition, tomato yellow leaf curl virus has mutated over time. These new virus isolates are able to overcome the crop tolerance of recent new varieties. At the same time, white fly has become resistant to multiple insecticides. In consequence, growers lost effective insecticides to control the increase of white fly populations. In many regions around the world, Bemisia tabaci reemerged as an upcoming pest problem in vegetable production. Growers are concerned about the increasing losses and are desperately look for new solutions.

Breakthrough innovation

Bayer's research infrastructure and facilities are dedicated to discovering and developing novel solutions to control and manage insect-vectored virus diseases. Using a holistic approach, multifunctional research teams around the globe have teamed-up and complement each other to develop new tools for effective control of insect transmitted virus diseases successfully. In the USA, the colleagues at Vegetables Seeds use classical breeding technologies to produce new virus tolerant vegetable varieties. One of the recent releases of this breeding program is the tomato variety XYZ. In parallel, the research platform for biological solutions in West Sacramento/ California, USA, has developed a stable formulation of a plant extract to control white fly, thrips and aphids. This biological product called Requiem has been registered in many major vegetable producing countries in the meantime. To complement the breeding programs and the biological research, the fundamental research platform for pest control in Monheim, Germany, develops new tools based on synthetic chemistry. Over the last 10 years, two new insecticides with

novel modes of action have been invented. One of them is MOVENTO[®]. This novel insecticide has a perfect activity spectrum that only controls the damaging bugs while conserving the beneficial insects at the same time such as predatory wasps and pollinators. The most recent innovation is SIV-ANTO®. This synthetic insecticide belongs to a new chemical class, the butenoloids. Similar to MOVENTO®, SIVANTO[®] has an activity spectrum focused on damaging bugs while safeguarding beneficials and pollinators.

Virus control with customized agronomic solutions

Bayer is striving to make the new innovations available to all growers around the world. The agronomic solution is customized to cover the local needs of growers and to the respective vegetable crop grown under either protected or outdoor conditions. These customized agronomic solutions support integrated pest management practices and they safeguard the use of pollinators and beneficials. In addition, the customized agronomic solutions are designed to strengthen effective resistance management by alternation of the different modes of action.

Growers in important vegetable producing countries such as the USA. Mexico, The Netherlands, Spain and India are among the first to have access to these recent innovations. The first feedback from growers and value chain partners is verv rewarding.



Symptoms of tomato yellow leaf curl virus (TYLCV) vellow colors and curling leaves

Excellent results have been achieved with the integrated approach using new varieties with high tolerance to virus diseases and a whitefly management program with MOVENTO®, SIVANTO[®] and Requiem. reduction of virus damage and improved quality and yield of the erops.

Shaping Agriculture

to be in agriculture, focusing on innovation, and spending time listening to diverse perspectives on complex challenges.

to benefit farmers, consumers and our planet

Why Sustainability?

We believe every investment in innovation should also be an investment in sustainability. By doing so, we can shape a more sustainable future for one of the world's most important industries. And as an agriculture leader, we have the opportunity - and responsibility - to address the challenges of climate change, biodiversity loss and food security to create a better tomorrow for our planet.

Let's start where we all agree: We need production of more sometimes incremental improvement isn't good enough. safe and affordable food under conditions which enable We need disruptive change to make the kind of impact farmers to thrive, invest in new sustainable practices, and necessary to solve challenges such as climate change, handover to the next generation. But we also need to im- biodiversity loss, and improve food security. prove on preservation of biodiversity and the world's other limited resources like soil and water. And we also must com- How can we do it? By completely rethinking what it means bat climate change.

Taking advantage of what we already know to make agricul- Bayer has set ambitious commitment targets for 2030, ture more sustainable is relatively easy to implement. But including:

// Reduction in field greenhouse gas emissions

in the most emitting cropping systems by 30 %

We will do this by providing climate smart solutions - with digital and data at the forefront that meet farmers' specific needs, field by field and greenhouse by greenhouse.

// Reducing the environmental impact of crop protection per crop produced by 30%

We aim to achieve this by developing new technologies that enable farmers to employ more precise applications of crop protection. In doing so, we are helping farmers sustainably grow more while using fewer resources and inputs such as pesticides and fertilizers.

// Empowering < 100 million smallholder farmers

As the leader in agriculture, we are committed to supporting 100 million smallholder farmers in low-and-middle income countries by 2030. In this way, we want to help to increase local food supply and reduce poverty in rural communities. With innovative products and new business models, we want to give them better choices, improve their wellbeing and provide them with solutions to growth crops more sustainably as well as increase their yields and their incomes.

Our long-term success as a company is dependent on contributing to a more sustainable future. These commitments reflect our strong commitment to sustainability and to providing farmers with the best technologies and solutions for a better future.

GOur approach to sustainability at Bayer is clear. We will focus on areas where we can create an impact; the areas reflected in our transformational commitments. Our aim is to create value to farmers via the adoption of sustainable agricultural practices."

Business Stewardship, Bayer

Dr. Klaus Kunz

Dr. Klaus Kunz Head of Sustainability &

One Step Ahead with Sustainable Agriculture

Population growth, the increasing demand for more and better food, declining agricultural acreage, climate change: the world of farming faces numerous challenges. At Bayer we firmly believe that sustainable agriculture is the best way to overcome these challenges through innovative solutions shown at Bayer ForwardFarming, the knowledge platform for sustainable agricultural practices.



What Bayer ForwardFarming entails

Many skills are needed to sustainably grow an agricultural business. Normally, they exist separately with little mutual integration. Bayer ForwardFarming, the knowledge platform for sustainable agricultural practices, is an advanced farming concept that unites all these competencies into a single holistic system. Through Bayer ForwardFarming we are expanding and intensifying the possibilities for exchanging know-how and experience between farmers, Bayer's own specialists, and other stakeholders such as consumers, politicians and academics. The aim is to continuously improve our knowledge of sustainable agricultural practices – and, not least, to promote the benefits farmers bring to consumers and society through sustainable farming.

Bayer ForwardFarms make use of three basic mechanisms:

- Tailored Solutions with high-quality seeds and crop protection products – both chemical and biological – to protect crop yields and quality. These solutions are backed by customized services ranging from agronomic support, field demonstrations and diagnosis to prediction tools and documentation.
- **Proactive Stewardship** to ensure seed and crop protection product integrity, to protect human health, and to preserve the environment. Bayer offers training to raise handling and usage standards, as well as to minimize any risks to human health and the environment.
- **Multi-beneficial partnerships** to enhance the quality of life for farmers, communities, and society in general – partnerships that include all the players in the value chain and help to leverage the potential for collaboration in modern agriculture.

Château Lamothe - sustainable winemaking

Château Lamothe is a French vineyard in Haux near Bordeaux. Its roots go back to the 16th century but its approach to winemaking is entirely modern – as a Bayer ForwardFarm. Damien Chombart, the fourth generation of his family to manage Château Lamothe, cultivates 75 ha of vineyards on limestone-clay slopes. Of the 500,000 bottles of Bordeaux wine produced a year 90% are exported to North America and Asia. "Our customers appreciate knowing where our wine is from, and how it has been crafted," Damien says. "Bayer ForwardFarming helps us to build and maintain this trust." He is committed to the collaboration with Bayer because "this initiative allows me to show that viable viticulture and winemaking can advance side by side with respect for the environment and humans." For Damien sustainable agriculture is about continuous improvements in farm practices that lay the foundations for the next generation of his family to continue producing world-class Bordeaux wines.





REGION, COUNTRY Haux, near Bordeaux, France



HISTORY Château Lamothe's foundations date back to the 16th century.



CROPS Wine Grapes



SOIL Limestone-clay on slopes in the heart of the Bordeaux wine region.



CUSTOMERS Export 90 % to North America and Asia

// 33



SERENADE

Marketability +

Biologicals: Enhancing Crop Protection

With multiple modes of action. Serenade is an excellent fungicide choice for anyone concerned about marketability. That's because Serenade biological fungicide easily meets local and regional MRL standards, enabling growers to reach more markets. When used in combination with our other world-class crop protection products, Serenade is a vital component of an integrated crop solution that reliably boosts yield and the potential for profit at harvest time.

For more information about Serenade and other Bayer biologicals, visit www.cropscience.bayer.com

© 2021 Baver Bayer, the Bayer Cross, and Serenade are registered trademarks of Bayer.

Consult country registration status, local registrations may differ. Use plant protection products safely. Always read the label and product information before use



Root2Success tailored solution for fruit & vegetable growers

Every farm is different and it has its own challenges and Explaining the concept of Root2Success, Jose Luis Robles opportunities. With the help of our innovation solutions (EMEA Business Venture Lead Fruit & Vegetables and using data and insight, we at Bayer are trying to develop Food Chain) said, "Root2Success is our holistic approach tailored solutions to make every grower successful. To to support farmers to manage different problems such as maximize the productivity of a farm sustainable, the grower soil-borne diseases, soil pests or nematodes. It comhas to manage various factors such as changing pest, bines different approaches like cultural practices, genetdisease pressure, variation in temperature and other ics (vegetable seeds including rootstocks), small moleweather factors etc. Root2Success is one of such efforts cules and biologics as well as digital tools, for example where we are trying to help maximize growers' productiv- Nematool. We are currently working on solutions for difity with a tailored solution for the growers in many counferent vegetable crops such as tomatoes, pepper and tries in Europe and Mexico. cucurbits in Europe."

Potato quality & yield in Mexico

Agrojaba is a company with more than 35 years of experi- and there was no need to apence in potato production for the chips market.

We grow potatoes in the states of Coahuila and Sinaloa. This region is characterized by the water scarcity, so the controlled the Mexican water for irrigation is extracted from deep wells. Other potato Psyllid, we had a challenges in this area are pests and diseases. In 2003 better performance in Paratrioza hit our land the hardest and it is still present. In terms of potatoes spotted addition, there are parts that may have root problems such by purple top. Potatoes as Fusarium, Black scarf and Nematodes, among others, with these symptoms take that have a significant negative impact on harvests.

Bayer introduced the Root2Succes concept to us to help manage the issue with crops using innovative crop protection solutions applied through drip technology.

The test we have carried out showed good results as well as good control of soil pathogens. We had no problems I'm happy that we were able to achieve significant increases in the yield and quality of potatoes working together with protecting crops using drip irrigation systems. For example, Emesto provided effective control of Black Scarf, the Mexican team of Bayer in the Root2Success program.

ply any additional products. With the systemic properties of SIVANTO[®] that on a dark color at the time of frying, which is undesirable color for chips. The



Francisco Javier Chapa

Nematodes controlled by Verango was also quite effective. Untreated Nematodes can also be an issue as it would also be a quality problem on fried potatoes.

The Hidden Curse

Detective Goodnose

n idyllic island with ideal growing conditions for tomatoes – isn't Crete a paradise for growers? Not quite. Little voracious soil pests, nematodes so small many farmers hardly notice them, are causing existential damage to tomato plants and their yields. Detective Goodnose was intrigued. He'd never even heard of nematodes so he set out to investigate this underground menace.

Where better to go than to Monheim, Germany, the headquarters of the Crop Science division at Bayer? Goodnose was shocked to learn that nematodes cause crop losses of around \$100 billion a year. Yet many farmers underestimate their impact because they are microscopically

small. Marc Rist, one of Bayer's nematode experts, explained to Goodnose how nematodes do massive damage to tomato roots and can never be fully eradicated from the soil. Obviously, a new approach was needed to tackle the problem. Further investigation unearthed their answer – a combination of Velum[®] and and a biological crop protection product BioAct[®]. Curious to discover more about this phenomenon, Goodnose headed for the Bayer labs in the North German city of Wismar where he learnt that Velum[®] controls the nematode larvae while a BioAct[®] based on a harmless fungal spore deals with the nematode eggs. The challenge Bayer scientists successfully overcame was to stabilize the fungus so growers can easily use it.

But would Bayer's BioAct[®] and Velum[®] pass the practical test, Goodnose wondered. To find out he returned to Greece where the first large-scale trials were conducted in 2017. And what did he discover? Whoever he talked to – growers, wholesalers, exporters – he got to hear the same story: The combination of Velum[®] and BioAct[®] works wonders as a highly effective nematicidal solution that keeps a nematode population below the damage threshold and ensures healthy, tasty, safe-to-eat tomatoes. The Hidden Curse had lost its destructive power!



Va lera Crop Mark

What first comes to your mind when you think of Bayer?

// Safety for the crop, confidence in the results, and innovative solutions.

What is your experience of Bayer's nematode solutions?

// Following Bayer's suggestions I used both Velum[®] Prime & BioAct[®] Prime. The program brought excellent results with respect to the nematodes' problem, providing better plant growth and yield as well as safety for the crop.

What do you value most about Velum®? // We had quick and long-lasting efficacy as well as flexibility in use. Flexibility in use and availability for more applications, a better root system, and increased yield.





Vasilakakis Michalis

lerapetra/Crete

Crop: Tomatoes, 1 ha **Marketing of produce:** Anatoli farmer cooperative

Will you continue to use our solutions? // Yes, because they constitute a branded and safe solution. Additionally, this program consumes less water than fumigants, which is very important for our region.

What would you like to see in the field of nematode control?

// Short post harvest interval (PHI) products that are both environment- and consumer-friendly.



See Detective Goodnose's full adventure on YouTube

Bayer solution + UAS application Shaping the future of citrus production in China



XAG developed various Plotting Spray modes.

Yi Ye Bayer CropScience Greater China, Customer Marketing, Value Chain Manager

Akihisa Oshima Bayer CropScience North East Asia, Head of Field Solutions NEA

Agrochemical application by UAS (Unmanned Aerial System) was initiated about 30 years ago by radio-controlled helicopters in Japan, but the treated area was limited (approx. 1 million ha). The introduction of Multi-Rotor UAS in China, however, has drastically changed the situation. The agrochemical treated area by UAS reached more than 30 million ha within 4 years (2016 - 2019), and the technology is very much welcomed by farmers who suffer from heavy workloads and high labor costs growing crops such as rice (muddy paddy fields), corn/cotton (high crops), citrus (cultivated in hilly areas), etc.

Fresh citrus fruits are one of the most important sources of vitamins and

minerals for Chinese people, especially with the amazing growing number of the middle class families. It is no doubt that citrus has exceeded apple and became the biggest fruit & vegetable crop in China, which has a planted area of 2.5 million hectares, the most of any country in the world.

However, the citrus industry in China is still facing many challenges. First, more than 90% of the citrus growers are the small holders, who own less than one hectare in their families. The income of the growers, who have an average age more than 59.1 years, are not good enough due to low productivity. Secondly, most of their orchards are developed and managed on hilly or mountainous areas. This means that large ground-based machines are too inflexible to reach these regions. Last but not least, there is the threat of citrus greening disease in southeast and southwest of China, i.e., Asian Citrus Psyllid, which has resulted in eradication of more than 200 million

citrus trees in the recent 10 years and has reduced citrus production in a lot of counties like a plague.

Bayer has collaborated with the leading UAS Company XAG in China to develop a combined solution to tackle the problems of citrus growers.

Weiguo He, a 57-year-old typical grower in Jiande county Zhejiang province, has planted citrus for more than 25 years. Due to global warming, the population of the psyllid is growing rapidly, and the threat of the citrus greening induced him to apply chemicals more than 12 times a year, increasing the cost of labor and agrochemicals significantly. His orchard covers a small area of 1.5 hectares but is located in rugged hills, where the mandarin trees are planted in uneven density and have grown to different heights. It used to take three days for three workers aged over 60 to spray the entire orchard manually one time. Bayer and XAG provided an integrated

precise and smart farming solution to Weiguo He this season. The innovations are the SIVANTO[®] insecticide, which provides the fast feeding cessation to the adult of psyllid, and the MOVENTO® insecticide, which provides the long-lasting efficacy for the nymph in the new shoots. The field result showed that one XAG P Series Plant Protection UAS could effectively spray half of the orchard area in only 10 minutes. While Bayer's experts had provided plant disease and pest diagnosis as well as a prescription for combatting them, XAG utilized its newly released 3D flight modes - band, hover and spiral - to conduct precision spraying of SIVANTO® and MOVENTO® on different types of terrains. Each of the citrus trees only received its required dosage, without excessive waste of water and agrochemicals. Weiguo He was pleasantly surprised at the results of the new technology, since it reduced application times by 50%, agrochemical costs by 30%, and even labor costs by 80%. In addi-

tion, Bayer also has a close relationship with the e-commerce leader Alibaba in China. UAS has collected the huge data of orchard management, which have already been transferred to Ali Cloud and used block-chain technology to connect Bayer, growers, traders and consumers to increase the sales value of the Weiguo's citrus fruit.

There are many similar stories in Guangdong, Guangxi, Jiangxi and Fujian provinces, which are facing the threat of citrus greening disease. Although the UAS application cannot replace traditional manual application in all the spraying windows, it is resulting in sustainable citrus growing thanks to its benefits of cost-savings and high efficacy using Bayer agrochemicals such as MOVENTO®, SIVANTO® and LUNA EXPERIENCE® in citrus pest and disease control. All of these advantages are giving more and more citrus grower's peace of mind and confidence to fight citrus greening disease to produce high quality citrus

XAG developed various spray modes to adapt to various field conditions, e.g., 3D Spot, 3D Band and 3D Free

fruit to meet the demand of the growing middle class market in China.

Bayer has numbers of active ingredient and advanced formulation technology suitable for UAS Application. The combination of Bayer's solution and UAS application technology provides labor/cost saving and significant benefit to growers. Furthermore, the digital technology like automatic field mapping, pest diagnosis, plant growth monitoring, etc. will enable more precise application, which can maximize the performance of crop protection solutions and minimize the risk in human and environmental safety.

This new technology also attracts the younger generation to become the citrus growers or managers in rural area to increase the competitive power of the future farming in citrus industry.

Bayer is intentionally supporting UAS Application for our valued growers in the world.



We promote market access for growers (incl. smallholder farmers) around the world by connecting them with value chain partners and help them meet changing consumer requirements. This not only creates win-win situations for all value chain stakeholders, but also increases transparency and trust in food systems by connecting the consumers with growers.

We work together with growers, processors, traders, retailers, and consumers to support the responsible and efficient production of consistently high-quality crops as well as balance the demand and supply from fork to farm to reduce

Consumers want sustainably produced and healthy food at reasonable prices – all year round if possible. They are also increasingly concerned about environmental, social, and economic topics. By bringing together the entire food value chain, consumers can be sure the food they buy has been produced sustainably, and all food chain partners have done their best to safeguard the well-being of future generations.

Fruits and vegetables: At the heart of good nutrition and overall health

Bayer is working to meet some of the world's most basic A diet rich in fruits and vegetables, along with maintaining needs: access to quality, sustainable nutrition and support a healthy weight and physical activity has been shown to to individual's overall health. There has never been a more lower risk for certain cancers, heart disease, and type-2 important time for innovation and collaboration in pursuit of diabetes. With this top of mind, many consumers are lookthese endeavors as our world faces enormous challenges ing to mega-trends like "proactive wellbeing". More confrom a changing climate, a growing population, limited nat-sumers are actively investing in their health, with nutrition ural resources, and food scarcity across polarized markets. as a core for physical and mental well-being; increasing

one of Bayer's key commitments underlined by the long- with high-quality, nutrient rich, fruits and vegetables. Often term investments into innovation supporting the sustainable thought to be "superfoods", some fruits and vegetables production of fruit and vegetable crops. Our focus is dual, help the growers improve their sustainable productivity and help them provide consumers with high quality, nutri- duce department can provide plant-based active ingredients-rich fruits and vegetables.

Governmental institutions and private industry (World Economic Forum) have taken strong initiatives to initiate behav- As a compliment to support overall health and diet. Bayer ioral changes at the consumer levels to stimulate the adoption of a healthy diet, the foundation of good health. In these tritional supplements rich in vitamins, minerals, and other policies, increased consumption of fruits and vegetables natural phyto-ingredients from natural sources. plays a pivotal role.

demand for "natural", "good for my health" and "sustain-Improving nutrition through healthy fruit and vegetables is able for the planet". Many of these requests can be met are often making headlines. While no one individual food is the answer to health, getting a variety of color in the proents called "phytonutrients" to your day along with fiber, vitamins, and minerals.

has additional commitment and strengths in delivering nu-

So what are phytonutrients and what do they do? Individual categories of phytonutrient rich foods such as Phytonutrients support the growth and vitality of the plant berries, dark leafy greens, legumes, citrus fruits, melons and have numerous health promoting properties in huand spices emerged as important contributors of immune mans. These unique molecules are not essential nutrients health, eve health, bone health, heart health and brain for life like carbohydrates, proteins, fats, vitamins and minhealth. erals, but provide powerful anti-oxidant, anti-inflammatory, and immune supporting properties which, emerging sci-As a general trend for healthier diets, rich in fruits and vegence, has shown to help reduce the risk of certain diseases. etables, continues to rise in the general population, so will

Foods rich in phytonutrients largely include fruits, vegetables, also whole grains, legumes, tea and numerous spices. There are many thousands of naturally occurring phytonutrients in our foods with unfamiliar names like polyphenols (in berries), flavonoids (in citrus fruits), glycosylates (in cabbage), phytoestrogens (in soy), carotenoids (in tomatoes) to name just a few.



Citrus: rich in Vitamin C. folate. Vitamin B6, and flavonoids, which add to the significant antioxidant properties of these fruits.

Berries: rich in Vitamin K, copper, manganese, and which help reduce inflammation.

the demand and appreciation from our consumers for accessible, sustainable, and high-quality crops, rich in phytonutrients supporting overall health.



Cabbage: rich in Vitamin C, Vitamin K, folate, thiamin and glucosinolates, phytonutrients known for their antioxidant and anti-inflammatory properties.



Food Chain Partnerships – creating benefits for stakeholders across the F&V value chain

Healthy food from field to fork

Consumers are becoming increasingly aware of the need for healthy and sustainably produced food. Food Chain Partnerships help supply consumers with high-quality fresh produce as the basis of a healthy diet. But such partnerships can only succeed if they involve the relevant players in the food chain – from the farmer, exporter, importer, and trader to the processor and retailer.

A key element in all our initiatives is helping farmers run a profitable farm, especially in view of changing climatic conditions. Furthermore, new resistant pests and diseases have emerged in recent years. All these alarming developments have led to just one conclusion: farmers need to adapt their farming practices to these new circumstances. To achieve this goal, farmers are striving to further enhance their knowledge and skills in order to increase their yields and the quality of their produce – particularly if they want to export their produce to foreign markets or supply local food service and retail chains.

Moreover, as many processors or traders have a global footprint, they already have a broad network of globally and locally linked supply chains. But in view of the ever-growing world population, they need to constantly scale up or build new networks and thus have to reach out to farmers in various geographies. That is where Food Chain Partnership steps in. With our agronomic expertise, certification support program, and capacity-building approach, we help processors, traders, and retailers create sustainable, high-quality, and safe supply chains, which ultimately benefit all stakeholders along the food value chain, including consumers worldwide.



Bayer has the global and local experience and the cutting-edge expertise to create successful Food Chain Partner-ship initiatives at every level of the food chain and from field to fork, as the following examples prove. ►

Bio-fungicide boosts potato yields, skin quality and freshness

In the Netherlands, one of the world's top ten producers of potatoes, key players in the potato value chain are very much aware of the increasing consumer demands for more sustainably produced food and environment-friendly

> agronomic methods. This was the background to a Food Chain Partnership initiative based on the ASO biofungicide Serenade® and involving seven food chain partners.

It is difficult to measure the efficacy of a soil-applied biological solution by visual means alone. So to obtain robust data to validate the performance of Serenade[®], digital farming methods were applied in collecting and analyzing the result of trials conducted at 37 sites across the country. Drones flew over the potato fields, applying thermal imaging technology to capture the crop temperature, while sensors collected and transmitted real-time soil moisture data and multispectral imaging detected crop growth and photosynthesis. Moreover, quantitative polymerase chain reaction (gPCR) technology was used to track and trace the ability of the Serenade® bacteria to colonize the roots.

The results of the trials were impressive. The use of Serenade[®] led to a 10% increase in yields and significantly improved the skin quality with a reduction in Helminthosporium, Rhizoctonia, and Streptomyces as well as in the number of green potatoes. Serenade[®] also enhanced the tubers' macro- and micro-nutrient content, especially in calcium, iron, zinc, and manganese levels. The higher calcium content is particularly benefiting retailers and consumers, as the potatoes stay fresher longer.

Moving sustainable carrot production forward

The market for fresh produce in Europe is increasingly being driven by stricter societal demands. More and more consumers want to know where and how their food is produced. Besides taste and quality, sustainable production is now a key requirement. Group Verduyn, a Belgium-based family-owned company operating in several European countries, serves the fresh market, food service sector and frozen food industry with fresh vegetables such as cabbage, leeks, peas, and in particular, its specialty, striving to produce carrots. In high-quality carrots by sustainable means, Group Verduyn and Bayer set up a Food Chain Partnership in 2018 in Belgium

It is not just the emotional debate about food and its influence on political decisions that is giving farmers

in Europe a hard time; weather conditions and the declining crop protection toolbox are additional challenges. Advances in residue detection technology are pushing admissible levels down even further and the question of what chemistry might next be banned is always in the back of growers' minds. In response to this challenging market environment. Group Verduvn. its farmers' association Green Farm, and Bayer have committed themselves to a holistic approach involving new carrot varieties, the use of fewer chemical and more biological crop protection products (e.g., Serenade®), and optimized application technologies to minimize the impact on the environment - an important consideration given the limited farmland available in a small country like Belgium. Besides growing carrots sustainably, this Food Chain Partnership is also focusing on engaging stakeholders through visits to key food chain value partners to stimulate an open dialog, share the sustainability vision, and create trust, credibility and acceptance for this holistic approach to carrot production.





How can we help cocoa farmers in Africa or vegetable farmers in Guatemala grow safe and healthy food and bring their produce to market? With its Food Chain Partnership initiative Bayer Through its BayG.A.P. program, Bayer takes a variety of approaches to support farmers worldwide in running sustainable, profitable farms.

Growing potatoes is a challenge in national market," says Darupan Sansubtropical Thailand, particularly in the siripan. Senior Agricultural Extension main cultivation area in the mountain- Manager at Berli Jucker Public Comous north. The weather here frequently changes from muggy to cool, and fungal diseases are prevalent. To tackle Asian countries that strongly focus on this challenge, the Thai government began introducing good agricultural practices (G.A.P.) in 2003. However, it has remained difficult for the predominantly smallholder farmers to deliver potatoes of the required quality, while Chain Partnerships are helping Thai guaranteeing operator safety and envi- potato farmers supply domestic and ronmentally sound production. That is international consumers with tasty, why the government introduced its healthy, and sustainably grown pota-Thailand 4.0 policy to enable an inno- toes. vation-based and sustainable economy based on partnership with the agroindustry. The BayG.A.P. Service Program is playing an important role here. "To achieve the 4.0 goal for potato growing and overcome common challenges, farm management needs to be standardized," says Nongnuch Yokyongsakul, Bayer's Regulatory Affairs making use of the BayG.A.P. program." Manager in Thailand. "The potato industry is growing fast here in Thailand, but we need to build and maintain they are also proving successful for the strong relationships in order to make value chain in that new capacities are this development sustainable."

Bayer, the certification organization GLOBALG.A.P. and Thailand's Kasetsart University initiated the BayG.A.P. program in Thailand at the beginning of 2017. Since then, it has proved to be the perfect platform for training smallholder farmers in sustainable farming practices and safeguarding their livelihoods by helping them obtain the certificates they need to successfully market their potato crops in domestic and international markets. "BayG.A.P.

supports farmers in exporting their produce," says Dr. Kliment Petrov of GLOBALG.A.P. Around 4,500 farms are now participating in the BayerG.A.P. program and 800 farmers were trained in good agricultural practices in 2018 alone.

wants to promote sustainable agriculture and support farmers in growing healthy and safe potatoes. "These farmers are not just producing for the pany Limited, Thailand's second-largest potato producer. "Exports to other traceability, such as the Philippines, are important pillars. BavG.A.P. helps Thai farmers comply with international standards, enabling them to access these markets." Here again, Food

"We also have success stories in other regions," says Dr. Stephan Brunner, Global Key Relation Manager at Bayer. "For instance, in the lvory Coast and Mali, where we help cocoa and mango farmers greatly increase their efficiency by implementing tailored solutions and All these achievements are great successes for farming businesses, but being developed.

scнос

2277







WE DON'T PROMISE YOU THE MOON.



WE ARE DOWN TO EARTH.

The power of nature. Empowered by science. BIOLOGICALS BYBAYER

VISIT: GO.CNB/BLX-HUB