ipòma

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DIGITAL ONLY

COVER STORY **Genetic Research** Will New Breeding Techniques (NBTs) Change Everything?
Digital Revolution The Apple Orchard of Tomorrow — **Arctic®** The First GM Apple
Honeycrisp An Unexpected Triumph — **Dazzle®** Asia's Favorite: A Success Story

Interpoma

Welcome

Dear Readers,

How do you envision the apple of the future? And what will the apple orchard of tomorrow look like – in a world that will be shaped on all continents by climate change and temperature fluctuations, new plant diseases, revolutionary technologies, and changing consumer preferences? These questions are the focus of this year's Interpoma, the only international trade show dedicated to all things apple. Answers are provided by the many exhibitors at the show in Bolzano as well as by the experts at the concurrent Interpoma Congress, and – last but not least – by this issue of the trade show magazine, **ipoma**.

In this issue we discuss the arrival of technology in the apple orchard: sensors that scan the plants with pinpoint accuracy, automated crop protection, and artificial intelligence that decides how much water the plant needs. Elsewhere, our in-depth dossier illustrates how rapidly apple breeding is evolving. Whereas up to now it took decades of breeding work to control the natural inheritance of characteristics such as taste, color, or disease resistance, this process could soon accelerate significantly with New Breeding Techniques. Genetic engineering offers solutions to many problems inherent in apple growing, although it still encounters skepticism not only among European consumers but in the political sphere as well. An exciting debate – join the conversation!

Interpoma 2024 takes place from November 21 to 23, 2024.
We hope you find this magazine an inspiring and enjoyable read!
The ipoma team

Read this issue online:
ipoma 03 in English

ipoma 03 in Italian

Do you have any suggestions, ideas, or feedback?
Get in touch at
interpoma@fieramesse.com

From Our Editors

__ 6 billion apples – that's one million tonnes – were harvested in South Tyrol, the Interpoma host region, in 2023.

__ That's how many new apple varieties the editorial team sampled in their work. Bottom line: Taste is highly personal!

AUDIO STORIES:
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Humans have been modifying the apple since time immemorial. A slice through the history of breeding. — 06

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New Varieties, New Ideas

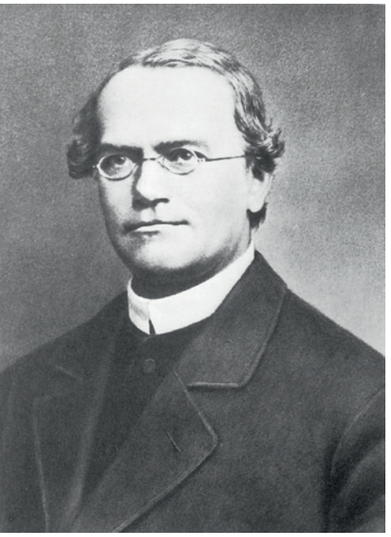
Innovative variety management: two best practices. — 52

From Mendel to Genetic Scissors

The precursors of the apple arrived in Europe from Kazakhstan in ancient times – with humans influencing its development right from the start. None of today's cultivars would exist without breeding. A slice through the *history of apple breeding.*

01

It isn't known exactly when apples first started being bred. Cultivation of carefully selected plants under controlled conditions began in Mesopotamia around 12,000 years ago – with barley, emmer, and einkorn, the ancestors of today's wheat. From 2500 BC, apples were already being described in Sumerian poems and on clay tablets.



The game changer: Botanist Gregor Mendel, born in Silesia in 1822, was the first person to lay the mathematical foundations of genetics. Although it was known that hybridization created new varieties, the laws behind it were unclear. These laws were of particular interest to landowners, and so the abbot of the monastery in Brno gave Mendel permission to conduct a program of experiments there. But Mendel, who died in 1884, made little effort to publicize his work during his lifetime.

02

Breeding by selection: Trees with tasty fruit were being deliberately propagated as early as the Middle Ages. Plants with special characteristics were grown together so that they reproduced naturally. Those with the desired properties were selected from the resulting mutations and grown on together until as many of these characteristics as possible were found in one plant.

03

04

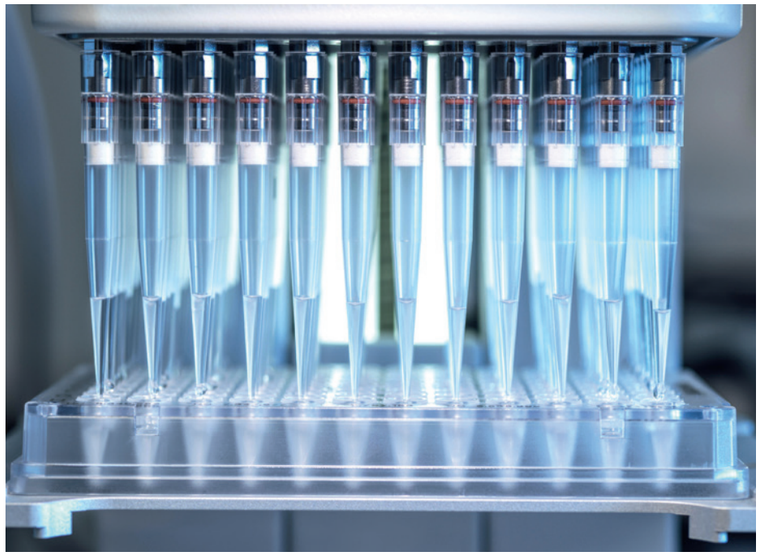
Convenient test subject: The pea allowed Mendel to experiment with 28,000 plants and 22 varieties, which differed in seven characteristics. He discovered that all first-generation offspring only have one expression of a trait, such as violet-colored flowers. When crossed again, a quarter of the next generation exhibited the previously missing trait, white flowers. Ultimately, he established his three laws of inheritance, which still hold true today.

05

Mendel and the apple: In the 19th century, the botanist, teacher, and Augustinian prelate also studied fruit characteristics in orchard trees and set up hybridization programs. In 1883 he was awarded a medal for his new varieties by the Imperial and Royal Austrian Pomologists' Association at the National Fruit Exhibition in Brno. The apple has some phenotypic features that follow Mendel's laws and are easy to detect for selection, such as columnar growth, red flesh color, seedlessness of the fruits, and resistance to scab and mildew.

06

Genomic selection: From 1900, Mendel's findings were revisited. Genetic researchers first succeeded in deciphering the genome of a plant in 2000. Now, through smart breeding, it is possible to select the appropriate partner in advance using the decoded genome to more quickly achieve the desired traits without altering the genome of the parent plants.



07

New Breeding Techniques: Genome sequencing makes it possible to intervene directly in the DNA of plants. Today, new methods enable targeted mutations to be created using gene scissors, mimicking those that could arise in nature – a more "natural" form of genetic engineering that does not produce transgenic plants. Nevertheless, many are critical of these methods; more on this in the dossier starting on p. 30.

In 2003, new club varieties made up close to zero percent of total apple production in Italy. Golden Delicious reigned supreme with a share of 49 percent. By 2023, two decades later, 11 percent of apples produced in Italy were club varieties, while Golden Delicious had declined to 33 percent.

Sources
Assomela, CSO Italy

Did You Know...

TREE NURSERIES

... South Tyrolean apple trees were exported to Nepal?

Well traveled: Up until the mid-1990s, South Tyrol's tree nurseries grew around three million trees a year, mainly for new local orchards. But rising quality standards, high technical expertise, and optimal climatic conditions boosted production, giving rise to the need for new markets. Initially exported to Europe, from 2010 onwards the trees were also sent to former Soviet Union countries as well as to North Africa, Argentina, and Nepal; sometimes, as shown here, on unconventional means of transport. A substantial proportion went to India, which took 6 million South Tyrolean trees in recent years.

QUALITY MARK

... there are 20 geographical indications for apples?

Clear origin: The EU's "protected designation of origin" (PDO) and "protected geographical indication" (PGI) identify food products whose qualities are closely linked to the place where they come from, with the aim of boosting consumer confidence and optimizing marketing. Twenty such designations in Europe are recognized for apples, among them Pommes de Savoie, Pommes des Alpes de Haute Durance and Pomme du Limousin in France, Poma de Girona in Spain, and five regions in Italy: South Tyrol, Val di Non, Trentino, Valtellina, and Cuneo. The label is also awarded for apple products, such as *wędzone jabłko sechlońskie*, wood-smoked apple slices from Poland. The latest contender? Äppledalen, the climatically mild "Apple Valley" in Sweden.

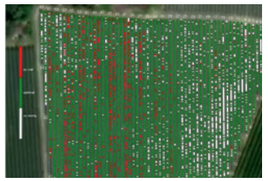
Innovations

START-UP 1 PLANTVOICE

Giving Plants a Voice

Plantvoice offers an innovative solution for plant stress management. Whether it's water stress, high salt levels, or fungal or bacterial infestations: using sensors that do not harm the plants and artificial intelligence in real time, the app recognizes different types of stress by the specific "fingerprint" they cause. The collected data can also be inserted directly into ESG reports. CEO Matteo Beccatelli and his team have packaged the patented system into a device no bigger than a matchbox. plantvoice.it

START-UP 2 NATURAMON

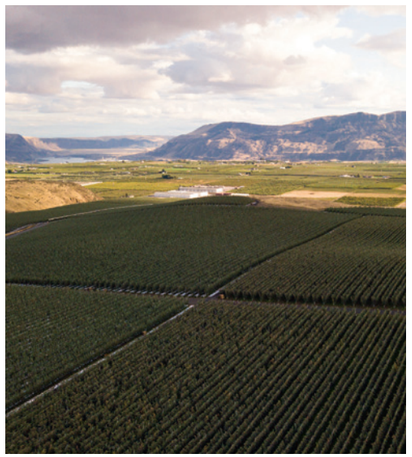


Fieldmap uses conventional smartphones or action cameras to record videos of orchards as you go about your day-to-day operations. The app from startup Naturamon then analyzes the videos using an AI algorithm and provides information on leaf mass and flower or fruit numbers – a particularly cost-effective tool for growers, who can use this data to optimize their fields and increase yields. Future plans for the app include recognizing harmful plant diseases and applying it to other crop types. fieldmap.naturamon.com

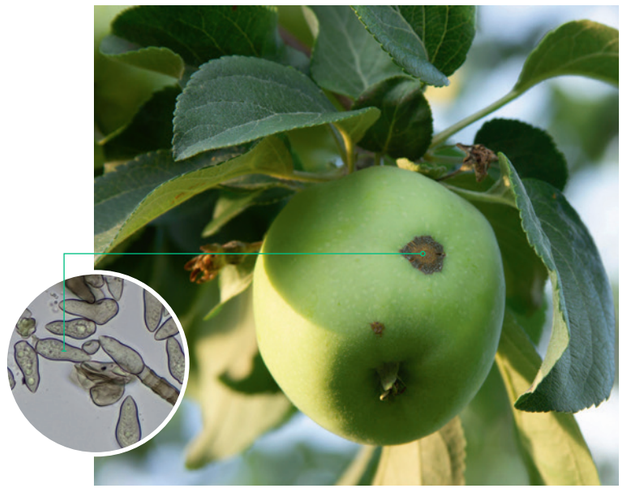
ECONOMY INVESTMENT FUNDS IN THE APPLE INDUSTRY

Hunger for Apple Orchards

A new driving force of innovation is currently emerging in the fruit industry: large investment funds. They are buying up smaller orchards or investing in large, vertically integrated operations. Despite their size, many of these operations are still family-run today, such as in Washington State (USA, pictured), Chile, or Australia. Large family businesses are selling because the valuations appear lucrative or because succession planning is proving difficult. With their vast financial resources, these funds are enabling technological advances to combat climate change and boost global competitiveness through market consolidation. The downside? Many small producers feel pressured to sell.



RESEARCH GENETIC ENGINEERING AGAINST SCAB



Close-up of the apple scab pathogen: Scientists hope that the genes of resistant varieties will help achieve permanent resistance to the fungus.

Farewell to Scab?

Genetic resistance to apple scab could be within reach. Researchers at Cornell University and the University of Minnesota are working on isolating and marking genes for scab resistance in commercial apple varieties. Genetic resistance to the fungal disease, which forces growers to increase their use of pesticides, is a sought-after characteristic. One such resistance gene is the Vf gene, which comes from a crab apple. It took years for breeders to work scab resistance into commercial breeding lines, with Honeycrisp and Antonovka among the varieties with the desirable characteristics. The genomes of both varieties will now be "fine mapped" to develop long-term resistance – because the pathogens also continue to evolve.

INTERPOMA TRADE SHOW NEWS

The Future Is Here

The digital apple orchard is the red thread running through the entire 2024 edition of Interpoma. The show highlights what the apple orchard of the future will look like and what impacts this will have.

1. Catching the eye this year is the **apple orchard in exhibition hall** H1: a row of real trees planted in the middle of the hall representing the orchard of the future. Here, several exhibitors, including two innovative startups (see opposite), present their solutions: apps that boost the sustainability of apple growing, monitor fruit growth, color, and ripening; sensors that detect current conditions in the orchard; or even devices that use AI to support the harvesting phase.

2. The **Interpoma Award 2024** will honor digital technologies that boost sustainable management of apple orchards by optimizing the use of plant protection products and fertilizers and reducing their carbon footprint.

3. Digitalization also plays a central role at the more academic **Interpoma Congress**. Keeping up to speed with the latest innovations helps envision the apple industry of the future. Although some of the technologies are still in the early experimental phase, they are sure to influence the way we grow apples in the future. Just how close this future is remains to be seen. interpoma.com

Let’s Rockit!

Small but oh so mighty! The world’s first snack apple from New Zealand whisks the humble apple away from the supermarket shelves into a whole new world – and proves that Asian consumers are definitely different from their European counterparts.

Po, the goofy star of the *Kung Fu Panda* films, loves apples. But not just any apple – he goes wild for the world’s first miniature apple, Rockit®. In 2024, the cartoon bear features in all his glory on the transparent tubes these snack apples are usually sold in. New Zealand apple producer Rockit Global’s vision is to make its product the most popular apple in the world. The secret behind it? Being different from the average apple. With fruits just five to six centimeters in diameter – not much bigger than a golf ball – packaged in a tube reminiscent of a tennis ball pack, and often positioned far from the fruit aisles. For instead of vying with other premium apples, this Gala x Splendor cross competes with chocolate and candies. And not just on supermarket shelves, but also in places where apples aren’t usually found: from online retailer Amazon to amusement parks like Disneyland.

In Asian markets, Rockit® is a massive sales hit among young people who would otherwise never bite into an apple. Today, the snack apple, developed at New Zealand’s Plant & Food Research institute without the use of genetic engineering, is sold in 30 countries. It is not only produced in New Zealand but currently in ten regions worldwide, each growing under license. In Europe, however, many negotiations have failed due to the packaging. Despite being advertised as recyclable, the plastic tube is seen here more as a no-go than as a trendy must-have. In Germany, where more than 300,000 Rockit® trees have been planted so far, the apple is available in a variety of cardboard packs, while in Italy, where the Melavì cooperative holds a growing license, the plastic tubes were replaced with cardboard versions after coming in for public criticism. **SP**

1

2

Rockit®: fruit or snack? Its *innovative packaging* makes this mini apple an eye-catching addition to snack shelves. The plastic tube is seen as cool in Asian markets, but for Europe, more sustainable alternatives have had to be developed.

LIDO is both a *trial orchard* and a production facility: this is where the highly disease-prone variety Rosy Glow Pink Lady® grows – on vertical fruit walls that give the engineers easier access.

AUDIO STORY

Digital Revolution

The apple orchard of tomorrow: the *LIDO field lab* at the Laimburg Research Centre is a testing ground for agricultural scientists, engineers, and IT specialists. It sets worldwide standards in AI and digitalization in apple growing.

By Barbara Bachmann
Photography by Michael Pezzei

When agricultural scientist Elias Holzknecht wants to apply a plant protection product, all he needs to do is press a button. In front of him is a monitor displaying 19 numbers, each representing one of the 19 adjacent rows of around 40 Rosy Glow Pink Lady® apple trees. On a Tuesday in early April, they are in full bloom.

On the monitor, Holzknecht can select which rows he wants to spray, with what product, and for how long. Seconds after he presses the button, the sprinklers – a permanent fixture above the tree canopies – distribute the spray mist from above. “Timely application allows for effective and environmentally sound pest control,” he says, explaining the main advantage of the fixed spraying system. Compared to the standard mobile application with tractors and sprayers, this method is unique in South Tyrol. In this apple-growing region, it is currently only being piloted here at LIDO, a field lab on a manageable 0.65-hectare site at the Laimburg Research Centre.

“In 2023, we started measuring soil moisture operationally,” says Walter Guerra, pointing to a sensor that provides information about water availability for the plants. Watering is done automatically when required. Guerra has led the Pomology working group at the research center since 2005 and as such is also responsible for the LIDO project. “This year, we want to expand our research to look at sensors for measuring and counting fruit.” The aim is to use them to determine how quickly the individual fruits are growing.

“With the new technologies, we will inspire young farmers for agriculture again.”

Walter Guerra, *head of the Pomology working group at the Laimburg Research Centre and LIDO project lead*

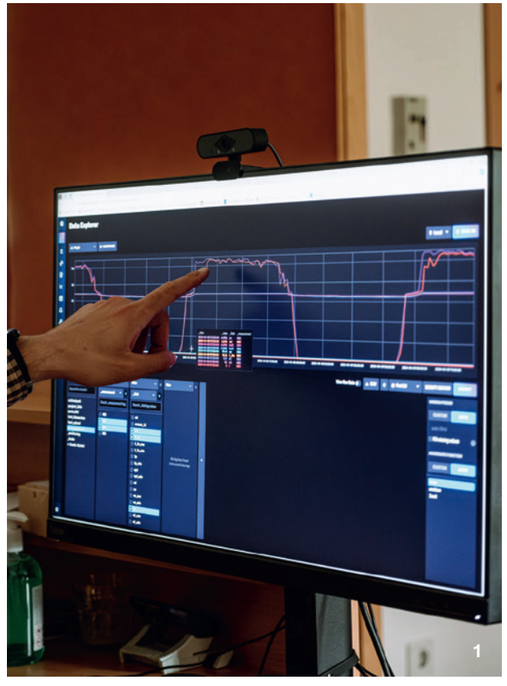
Digitalization and smart technologies have been central themes at the Laimburg Research Centre for many years. In the early 2000s, for example, the center developed the dynamic controlled atmosphere (DCA) for apple production: a sustainable storage system in which sensors monitor the condition of the apples in storage and which adjusts the air composition to the apples’ needs. Today, this system is used worldwide to store hundreds of thousands of tonnes of fruit.

AI has been used in sorting and storage for decades. “But in the storage room, you can’t improve on what comes in from outside,” Guerra points out. Therefore, most investments are increasingly being focused on field production, like at LIDO. The information here comes directly from the field. Testing, development, validation, and demonstrations are carried out on a small scale, underpinned by the search for added value for apple production worldwide.

Elias Holzknecht holds a clip with a sensor that he attaches to the underside of an apple leaf. The apple tree absorbs water from the soil through its roots, which is transported through the tree via the xylem (transport tissue). “The remaining liquid is transpired through the leaves,” explains Holzknecht. This creates moisture, which the sensor detects. “In dry conditions, the plant’s stomata close, so transpiration no longer correlates with the radiation from the sun. The system then sends the signal in time to turn on the drip irrigation.”

The LIDO is a showcase garden for the future of apple growing. It’s also a real commercial production facility. Since Rosy Glow Pink Lady® is particularly susceptible to diseases like scab or mildew, it is the perfect variety for testing technologies that detect pathologies early. Due to the late fall harvest, the trial period is particularly long. Unlike the standard three-dimensional cropping system, LIDO is planted up in a multi-axis system; only 100 of the 18,000 hectares of growing area in South Tyrol are currently structured this way. Guerra points to the vertically growing fruit walls. Easy to manage and two-dimensional, they simplify the work of engineers and IT specialists.

Guerra and his team are currently collaborating with over 20 different companies at LIDO. They are also helping to develop algorithms for, among other things, harvest forecasting. “The key to success is interdisciplinarity,” says Walter Guerra. Agronomists with expertise in fruit growing, engineers who develop the applications, and IT professionals who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4

1 Agricultural scientist *Elias Holzknecht* can apply plant protection products in the LIDO orchard at the touch of a button: he keeps an eye on the 19 rows of trees on the monitor while fixed sprinklers spray the trees.

2+3 Precision *water management*: Elias Holzknecht attaches clips with sensors to the undersides of leaves. Trees normally transpire via their leaves; in drought conditions, this process stops. The system recognizes this and initiates drip irrigation.

4 The system currently “only” works with automation. Possibilities for the future include harvest forecasts by algorithms, *artificial intelligence* to identify diseases, and robotic arms to thin out fruits and prune trees.

ipoma

The human factor is central and should remain so.

transfer and process the massive amounts of data. Together, they brainstorm a wide variety of ideas.

One such idea is an image recognition system that provides information about each tree's individual needs, which should make thinning the blossoms much more precise in the future. Eventually, robotic arms linked to this system could handle the thinning directly. There could also be arms that can precision spray and prune the trees – or even take over the picking. At LIDO, power and broadband reach directly into the orchard. "In the future, this could be used to charge an electric mulching system for mowing the orchard or for under-vine maintenance," says Guerra.

Last year, 500 visitors from various continents came to LIDO to get a first-hand impression of these developments. Guerra and his team are at the forefront of research with other institutes worldwide, making a major contribution to the apple orchard of tomorrow (more examples on p. 24). In New Zealand, for instance, researchers are creating a virtual version of the apple orchard using "digital twins" to simulate various future scenarios.

And yet, Walter Guerra admits that he sometimes struggles with the term "artificial intelligence." "It has become a buzzword," he says. The fixed spraying system that Elias Holzknecht just used to demonstrate pesticide application currently still falls under automation. "If it is combined with detection of a possible outbreak of fungus X and we apply plant protection product Y at time Z based on this information, then we are increasingly moving towards the realms of AI," Guerra says.

The goal is the integrated digital orchard. This is also the meaning of the name LIDO: Laimburg Integrated Digital Orchard. A place where various pieces of information are combined to assist the farmer in decision-making. A place where information about each individual tree is available. A place where knowledge is securely stored – unlike before, or in addition to the farmer's memory. Achieving this goal will require perseverance.

"With the new agricultural technologies, we will inspire young farmers for agriculture again and create generational change," Guerra says with conviction. For this to happen, apple growing must be made more attractive and modernized. South Tyrol provides good conditions for this. The local fruit-growing area has full LoRaWAN (Long Range Wide Area Network) coverage, a network offering cheap and energy-efficient data transmission.

So are the developments exclusively positive? Or do they also pose risks? "We must not rely solely on them and keep our eyes glued to our phones or computers," warns Guerra. "The human factor is central and should remain so." Nobody is aiming for full automation. It's about maximizing the productivity and quality of the apple orchard while minimizing its environmental impact. And ultimately, significantly easing the work of fruit growers.

Elias Holzknecht nods. He is fascinated by the potential of the new technologies to save resources and costs in order to address future challenges: the shortage of specialized labor, climate change, resource scarcity, and better sustainability. "Thanks to digitalization, we will be able to keep agricultural enterprises economically viable," he says. Agriculture will become more cost-effective, more efficient, and more energy-saving. "But ultimately, it is the farmer who produces our food, with the help of nature," says Holzknecht. Not artificial intelligence. **BB**

Interdisciplinarity as a key to success. Walter Guerra (left) and Elias Holzknecht show **ipoma** reporter Barbara Bachmann around the LIDO trial orchard.

Technology in the Orchard

Around the world, efforts are being made to develop the orchard of the future. Three experts from different regions share their progress.

Tree monitoring with 3D data

3D scanning of orchards with LiDAR (Light Detection and Ranging) systems not only provides data on the height and thickness of tree canopies but also on their porosity, leaf surface area, and space utilization. “We use these data to identify differences in growth and adapt our management measures accordingly,” explains **Alex Escolà**, coordinator of the AgroICT and Precision Agriculture Research Group at the University of Lleida and the CERCA Center for Research in Agrotechnology in Catalonia, Spain. Mobile terrestrial laser scanning provides farmers and their advisors with very precise information about the tree canopies in their orchards.

Smart yield and quality recognition

Research manager **Ian Goodwin** and his team at the Tatura SmartFarm in Victoria, Australia, have been collaborating with commercial companies to develop sensor systems to monitor fruit yield and quality. They have designed high-speed cameras that capture images of fruit trees to provide data on the number of fruits, their size, and color. “Fruit growers use these data to predict yields and quality parameters, such as thinning in certain areas or the targeted use of reflective mulch to improve fruit color,” Goodwin explains.

Shift towards two-dimensional systems

At the Center of Excellence for Fruit Production in the Lake Constance Region (KOB), head of Yield Physiology **Konni Biegert** and her team are developing models for predicting storage quality and the effectiveness of fruit thinning based on sensor data from the orchard. They are also investigating the suitability of 2D systems for fruit production. Two-dimensional systems with narrow fruit walls reduce the use of plant protection products and could increase water usage efficiency. They represent the future, “supported by new rootstocks that increase resistance to climate change and fill the stand space more quickly,” says Biegert. The quality is produced in the orchard, she adds. The combination of data from apple growing and storage will enable better management decisions to be made on production and storage in the future.

01

Appearance: With a diameter of 70 to 90 mm, Honeycrisp is a medium to large apple with a *round to oblate shape* and a *medium stem length*.

02

Color: The skin color is 60 to 90 percent *mottled red-orange flecked in pink*. The green background turns yellow as the fruit ripens.

03

USP: The special feature of this apple is the *crisp, juicy texture* of its ivory to white flesh. Its secret? Honeycrisp has *larger cells* than other varieties, which literally burst as you bite into them, releasing masses of juice.

04

Origin: Bred at the University of Minnesota in 1960, Honeycrisp was long thought to be a cross between Macoun and Honeygold. However, genetic tests have shown that its actual parents are *Keepsake and MN1627*, a variety from the University of Minnesota that has never been released.

05

Impact: The slow but resounding success of Honeycrisp marked the end of the dominance of Red and Golden Delicious and established an extensive process of *varietal renewal*.

Sweet Honey

Initially discarded, this apple variety went on to become the starting point of a market revolution. Adored by consumers, notoriously difficult to grow: This is the story of *Honeycrisp*, the apple that redefined texture.

By Susanne Pitro
Photography by Oliver Childs/iStock

What makes an apple a good apple? Most fruit fans will say it must be juicy and crisp. When David Bedford was starting out in his career, *crisp* was synonymous with *crunchy*: a firm, hard texture. But then the apple breeder and Senior Research Fellow at the University of Minnesota bit into an apple that should no longer have existed. The experience gave rise to a new definition of *crisp*.

So, what sparked this flavor revolution? Honeycrisp – probably the most influential apple of recent decades, raising the quality bar for premium apples to a whole new level. It's number one on the US market in terms of revenue and has recently taken third place in terms of cultivation volume, just behind Gala and Red Delicious. Once you've eaten a Honeycrisp, they say, you won't want to go back to the previous standard Golden or Red Delicious. The apple owes its crisp effect to its particularly large cells. When you bite into them, they burst open instead of separating, as happens with many other varieties. The result is a completely new, explosive, crispy-juicy bite experience that has become the gold standard for a new generation of apples today.

“Sometimes genetics can surprise us and produce qualities that we didn’t realize were possible.”

David Bedford, *apple breeder and Senior Research Fellow at the University of Minnesota*

Yet, Honeycrisp’s success story got off to anything but a promising start. The variety comes from Minnesota, a state that is considered the coldest region in the United States after Alaska and was deemed unsuitable for growing apples until well into the 20th century. That a crossbreeding in the early 1960s ultimately resulting in what would be called Honeycrisp even happened at all is thanks to the determination and persistence of a team at the University of Minnesota who, over many decades, worked on a breeding program for cold-resistant varieties that also offered quality.

One of the countless trees that emerged from this gene pool made it to the testing phase under the number MN1711, only to fail fifteen years later. When the original tree showed signs of cold injury from the winter of 1977, the verdict was: unsuitable, discard! Two years later, the task of disposing of four trees that had been propagated from the original tree was given to a recently hired apple breeder. His name was David Bedford.

But the young breeder took another look at the documentation of MN1711 and began to question the verdict. In 1977, Minnesota had experienced its harshest winter in decades, and the original trial tree had been planted in a very poor site. “So I decided to give the newly repropagated young trees another chance,” Bedford recalls almost 50 years later. In 1983, MN1711 proved that it deserved that chance. The four trees bore fruits for the first time – and when Bedford tasted them, he was astounded. “I immediately realized that these apples were different from anything I had known before. At first, the texture was so different that I wasn’t sure whether that was good or bad.” However, Bedford and the breeding program’s research lead Jim Luby decided to reintroduce MN1711 into the program. The variety was patented in 1988. In 1991, the apple was launched on the market as Honeycrisp.

The rest is history. But it wasn’t all smooth sailing: the public’s favorite turned out to be a nightmare for growers. “50 percent of producers lose money with Honeycrisp, 50 percent earn money” is the rule of thumb when growing this labor-intensive variety. Heat sensitivity, susceptibility to bruising, bitter pit (a physiological disorder that causes dark spots on the skin of the fruit), sharp stems that leave puncture holes in the thin skin when stacked: There’s a long list of troubles that make Honeycrisp more expensive to grow and store than most other apple varieties. Its great popularity and premium prices have nevertheless pushed production steadily upwards, at least in the United States.

Slowly but surely, however, this fruity best seller is facing competition from its own children. Honeycrisp has inspired new varieties not only in Minnesota itself, but in almost all renowned breeding programs. “I would estimate that approximately half of the new varieties introduced in the US today are based on Honeycrisp breeding,” says David Bedford. That includes the celebrated Cosmic Crisp®, a cross between Honeycrisp and Enterprise from Washington State University, which is also grown on almost 800 hectares in South Tyrol. At the University of Minnesota, four Honeycrisp offspring – SweeTango®, Rave®/First Kiss®, Triumph®, and, most recently, Kudos® – have been brought into the apple world. The next generation is now on the scene and the children of the successful variety are being crossed with one another, Bedford reveals. The aim is to make them easier to care for, more surprising in flavor, and more resistant to the consequences of climate change. Although there is not a lot of emphasis on trying to improve the texture itself, says Bedford. “Sometimes genetics can surprise us and produce qualities that we didn’t realize were possible. And that’s exactly what happened with Honeycrisp.” **SP**

David Bedford has been an apple breeder and research scientist at the University of Minnesota for 45 years. He has been involved in the development and introduction of multiple apple and other fruit varieties. His job requires him to taste up to 500 apples per day in order to evaluate the up to 20,000 apple trees generated by the university’s apple breeding program.

AUDIO STORY

Genetic Evolution

New Breeding Techniques, or NBTs for short, could be the future of apple breeding: a silver bullet against new pathogens and the climate crisis. Our *dossier* explains what NBTs are all about and why they are the subject of tough negotiations in the European Commission.

By Christian Heinrich
Photography by Michael Pezzei, Patrick Schwienbacher

The research community sees *New Breeding Techniques* as a promising third option alongside time-consuming conventional breeding, which can take decades, and the sometimes controversial classic genetic engineering methods that involve inserting foreign genes into plants.

“NBTs bring about changes that happen in nature – only faster and targeted better.”

Dr. Thomas Letschka, *head of the Breeding Genomics working group at the Laimburg Research Centre*

Trial and error is the principle of evolution. Whatever threats await animals and plants, nature usually finds a way. But this takes time – a lot of time. Through the mixing of parent species and natural mutations, offspring are produced that are all slightly different from one another. Those with an advantage in the face of current threats will prevail over the others. This also applies in agriculture, but only to a limited extent: after all, what use is an apple that is resistant to scab but has a mealy texture and not much flavor? It is still rejected – by humans.

In apple growing, humans have always gently influenced fruit development. The apples that succeed are the juicy, flavorsome ones that appeal to buyers. “So consumer taste has – quite naturally – become an important selection characteristic. And that’s a good thing: after all, the entire apple industry is based on it,” says Dr. Thomas Letschka, head of the Institute of Agricultural Chemistry and Food Quality and head of the Breeding Genomics working group at the Laimburg Research Centre near Bolzano. But conventional breeding is a complex, protracted process. For example, a Gala apple may be painstakingly crossed with a variety that is resistant to the bacterium *Erwinia amylovora*, which causes the dreaded fire blight. Only a fraction of the offspring will then have a degree of resilience against the disease. But the ones that do may have lost their great Gala flavor. And that only comes to light after five or six years of cultivation. Back to the drawing board!

Apple breeders who start at a young age have often retired by the time a new and acceptable variety has been created. Breeding is not a matter of years but often of many decades. That’s because the way the genes mix when two apple varieties are crossed is purely random.

The 1980s saw the introduction of technical methods that made breeding a little more targeted. But only a little, and that’s the problem. These conventional genetic engineering methods – the best known of which is transgenesis, often used nowadays as a synonym for all conventional genetic engineering methods – involve the delivery of foreign genes into a plant. The plant then becomes a transgenic plant: a genetically modified organism, or GMO for short.

Exactly where in the plant’s genome the new genes are inserted, however, is again largely random. Sometimes the gene comes from a completely different species. A gene from a frog could be inserted into a tomato to make it less mushy, for example. But even if we succeed in improving the tomato, we don’t know what else in it changes because the insertion is too imprecise. “Consumers are uncomfortable with this, of course. So it’s no surprise that these crossings are often referred to as ‘Frankenfoods’,” Letschka notes. On top of that, the authorization process is highly complex; which is one of the reasons why you still don’t find apples on sale in Europe that have been modified using conventional genetic methods.

So, back to traditional time-consuming breeding, then? In fact, there are other options on the horizon. A third approach – New Breeding Techniques, or NBTs for short – is seen as promising by researchers and many breeders. “There is a clear dividing line between these new techniques and conventional genetic engineering methods,” explains Letschka. “Basically, the aim is to quickly bring about very precise changes in the genome that take decades to achieve naturally through traditional breeding.” NBTs therefore still involve intervening in the apple genome, but instead of introducing foreign genes, you are only changing as much as nature itself would. “And we can control this very precisely, which is one of the main differences between these methods and conventional genetic engineering. We can make minimal changes to a very specific gene at the exact spot where the best effect is achieved,” says Letschka.

The most common method used for NBTs is CRISPR/Cas. CRISPR/Cas is an enzyme produced by a bacterium and is often referred to as genetic scissors, because it can cut very precisely – down to DNA building block level – and can therefore make highly selective changes. The potential of genetic

Glossary

Transgenesis:
Conventional genetic engineering method. Foreign genes are transferred from one organism to another, e.g., to a plant. Today, the term is often used as a synonym for all conventional genetic engineering methods. Transgenically modified plant species authorized for cultivation so far include soy, maize, cotton, and rapeseed. This method is often rejected by consumers, especially in Europe, where transgenic plants – genetically modified organisms, or GMOs for short – must be labeled as such.

New Breeding Techniques (NBTs):
New methods of genetic engineering. The best known is CRISPR/Cas, which involves intervening in specific parts of DNA in exactly the same way as spontaneous mutations that occur in nature. This distinguishes NBTs from conventional genetic engineering methods (transgenesis). The EU is therefore currently leaning toward not equating NBTs with conventional GMO methods.


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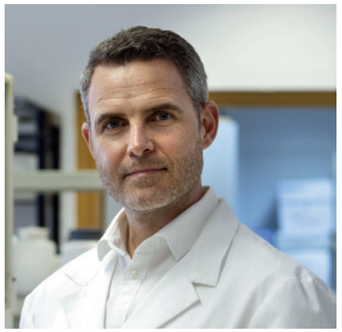
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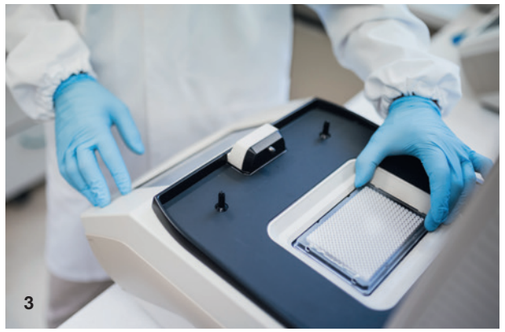
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1 The most common method in NBTs uses so-called *CRISPR/Cas genetic scissors*: an enzyme produced by a bacterium that can cut DNA building blocks with great precision.

2 “With NBTs, we can make minimal, highly targeted changes to specific genes,” explains *Thomas Letschka*. An intervention in the genome that doesn’t involve inserting foreign genes.

3 Discussions are currently underway in the *European Commission* as to whether NBT-bred apples should be classified as conventionally bred apples, as the risks are said to be just as low.

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1 The EU is discussing *compulsory labeling* for NBT-modified plants – like with classic genetic engineering.

2+3 It is impossible to establish retrospectively whether plants have been modified using CRISPR/Cas or by natural mutation. This makes *tracing and checking* difficult.

4 In Zurich, *Giovanni Broggini* is researching a specific gene that makes Gala apples more resistant to fire blight.

“We are attempting to turn off genes that make apples susceptible to disease.”

Dr. Giovanni Broggini, *researcher in molecular plant breeding at ETH Zurich*

scissors was first described in the journal *Science* in 2012, earning their discoverers Emmanuelle Charpentier and Jennifer A. Doudna the Nobel Prize in Chemistry in 2020. In medicine, scientists are currently researching new therapies using CRISPR/Cas. And in agriculture, the hope is that this will significantly speed up breeding, revolutionizing it in the process.

In Switzerland, chemist Dr. Giovanni Broggini is running greenhouse trials to improve the disease resistance of well-known apple varieties. The researcher in molecular plant breeding in the Department of Environmental System Science at ETH Zurich wants to introduce a special gene into Gala apples to improve their resistance to fire blight. “And in other experiments we don’t introduce a resistance gene at all, but instead switch off specific genes – the ones that make an apple susceptible to certain diseases or pathogens. When we switch them off, the apple is less susceptible,” Broggini says.

Is that still natural? An apple modified with the CRISPR/Cas genetic scissors still goes through a laboratory process. To cut the apple genome using CRISPR/Cas, DNA from the bacterium that produces the genetic scissors must be introduced. This DNA ensures that CRISPR/Cas is produced in the apple plant and can then function. Afterwards, the elements containing the genes for CRISPR/Cas are cut out again. But these intermediate steps could be skipped in the future: Broggini is already investigating how to produce CRISPR/Cas artificially in the lab and introduce it directly into the plant cell, ensuring that the intervention only targets the specific location in the apple genome.

However, it is not yet possible to determine whether plants have been selectively edited with CRISPR/Cas. “It is impossible to establish retrospectively whether the change was the result of a natural mutation or intervention using CRISPR/Cas,” Letschka declares. “This makes tracing and checking difficult. But it does highlight the fact that we can target the kinds of changes that can also occur naturally through mutations.”

So, is CRISPR/Cas a step forward in apple breeding? Some of the most popular varieties like Gala and Golden Delicious are susceptible to pests. CRISPR/Cas could be used to increase their resistance, as Broggini is currently trialing in a greenhouse in Zurich. However, no-one in Europe has yet applied for authorization for an apple that has been improved using CRISPR/Cas. That is because in the EU, apples bred with NBTs are currently treated in the same way as GMO

Glossary

Genome Editing:
Generic term for all technological methods used to edit the genome without adding foreign genes. These include NBTs such as CRISPR/Cas.

CRISPR/Cas:
An enzyme produced by bacteria that can make cuts at specific points in DNA, also known as “genetic scissors.” It can be used either to switch off individual genes such as a susceptibility gene that makes plants more susceptible to certain diseases, or to insert specific genes such as a gene from a related apple variety to make the apple more resistant to certain fungi without changing it significantly in any other way.

Cisgenesis:
If a plant is cisgenically modified, only genes from plants of the same species are inserted, either using conventional genetic engineering methods or NBTs. They must come from a biologically compatible species, e.g., from a wild apple whose gene is transferred into a variety of the domestic apple.
If an apple receives a gene from a tomato, it is no longer a cisgenic plant.

NBTs: Facts & Figures

11

FIELD TRIALS WITH GENETICALLY MODIFIED PLANTS IN THE EU (2023)

742,000,000

BASE PAIRS, THE APPROXIMATE LENGTH OF THE GENOME OF A CULTIVATED APPLE. IT CONTAINS ABOUT 42,000 GENES.

50 %

REDUCTION IN PESTICIDE USE BY 2030 TARGETED BY THE EUROPEAN COMMISSION. NBTs ARE EXPECTED TO INCREASE PLANT RESISTANCE.

300,000

APPLE AND PEAR TREES CLEARED IN SWITZERLAND (2000–2014) DUE TO FIRE BLIGHT. NBTs ARE BEING USED TO RESEARCH RESISTANCE GENES.

17 %

DROP IN REVENUES DUE TO CLIMATE CHANGE BY 2050

45

APPLE PROPERTIES CAN BE CHANGED THROUGH BREEDING

97 %

OF CRISPR/CAS PROJECTS DO NOT INVOLVE FOREIGN DNA

90 %

OF CRISPR/CAS APPLICATIONS ARE KNOCK-OUT PLANTS (GENES ARE SWITCHED OFF)

7.5 million

PEOPLE IN GERMANY ARE ALLERGIC TO APPLES. NBTs COULD HELP REMEDY THIS.

Foods bred with NBTs are already widely authorized outside Europe.

apples. And this puts breeders off, given the enormously complex and costly testing and studies needed to obtain authorization.

But that is about to change. The European Commission is currently deliberating whether apples bred using NBTs should be classified as normal apples bred without genetic intervention. As NBTs can be equated to a natural breeding process, the risks are equally as low, the argument goes. Therefore, additional genetic engineering legislation is being drawn up that would treat foods edited with CRISPR/Cas in almost the same way as conventionally bred foods. They would then face much lower authorization hurdles than GMO foods.

"If this legislation is actually implemented across the EU, this could be a breakthrough for NBTs in Europe," Letschka remarks. The technology is already widely authorized outside Europe.

The fact that the normally strict European Commission, which follows the precautionary principle, is seeking a more lenient approach to NBTs lies in the goals it has set itself. One of these is to halve the use of chemical pesticides through the European Green Deal. NBTs could play a key role in this: a more resistant apple variety needs fewer pesticides.

But there are also critics. "A comprehensive risk assessment must be undertaken before CRISPR/Cas is authorized. And in the current drafts of the EU legislation, this isn't provided for: it's simply skipped. That is irresponsible," warns Jan Plagge, president of the organic grower's organization Bioland.

Another hotly debated topic is compulsory labeling. If plants bred using NBTs had to be labeled, this would push up costs, and could potentially result in consumers rejecting the new method. On the other hand, proponents argue that consumers must have the freedom to choose not to buy apples bred with NBTs. "I expect a decision on the treatment of NBTs and whether labeling will be made compulsory in 2025," says Letschka.

How a simplified authorization procedure for NBTs would change apple breeding is difficult to say. The first marketing authorizations have already been granted in other parts of the world. In Japan, there is a tomato that contains healthy amino acids, a functional food designed with CRISPR/Cas. And in the United States, the first apple modified with CRISPR/Cas to prevent browning after cutting is already on the market under the Arctic® brand (see next page).

But for now, the main issue for the apple industry is to make apples more resistant to pests. Some of these traits can be achieved with individual gene edits. This option would increase the competitiveness of the European apple industry. But whether apples treated with CRISPR/Cas will really catch on is largely down to the consumer. CH

Glossary

Precautionary principle:
This principle sets the direction for legislation on genetic engineering in Europe. It not only looks at the end product but also at the processes that led to the creation of the product.

Principle of substantial equivalence:
Unlike the precautionary principle, this principle primarily focuses on the end product, the processes that led to its creation being inconsequential. This principle assumes that a newly developed food is just as safe as an existing one if it has the same composition. The principle is widely applied in places such as North and South America.

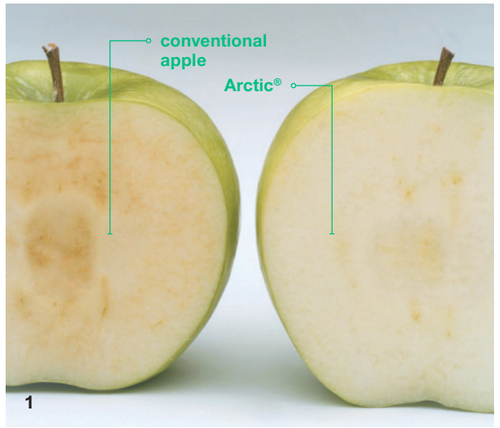
The pioneer: Arctic®

A new chapter in apple growing started in 2017 with the launch of genetically modified apple varieties under the Arctic® brand, whose juicy apple slices in snack packs don't turn brown as soon as you open the pack.

Every week, two to three million snack packs of Golden Delicious, Granny Smith, and Fuji apple slices and cubes are sold to consumers and restaurants in the United States and Canada. Their special feature? Even when the pack is opened, the apple slices stay white for hours – just like the Arctic ice that gave the popular snack its name. Arctic® apples are the world's first genetically modified apples whose flesh doesn't immediately turn brown when cut open.

The brains behind them are Canadian husband-and-wife team Neal and Louisa Carter. When they joined the apple business in the mid-1990s, the apple market was stagnating. Yet the convenience food market segment was really gaining momentum. But sales of ready-to-eat apple slices were being hindered by an enzyme called polyphenol oxidase (PPO). This enzyme is responsible for the oxidation process that turns apple flesh brown on contact with oxygen.

Having come from the biotech industry, Neal Carter sensed an opportunity. In Australia, a research group had recently succeeded in switching off the PPO gene in potatoes. Encouraged by their success, the Carters founded the biotech startup Okanagan Specialty Fruits. The Australian approach only works to a limited extent in apples, but the Canadians eventually succeeded in switching off a total of four genes that control the PPO enzyme in apples. Initial field trials confirmed the success of the process, and after five years of meticulously documenting the growing of these apples, they were finally granted approval for Golden Delicious and Granny Smith by a total of five authorities in the US and Canada. By 2015, five years down the line, everyone had given the green light and marketing could begin.



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Today, Okanagan Specialty Fruits is a vertically integrated company specializing in biotech research, growing, processing, packaging, and marketing. The company is currently preparing for the market launch of Arctic® Gala, Neal Carter reveals. Approval preparations are also underway for Honeycrisp and Cripps Pink, while research continues into other fruits and resistance to plant diseases.

Initial concerns around genetically modified fruits have largely subsided, the Okanagan CEO says: "For most consumers, it's more important to have an apple that stays fresh for a long time and retains its flavor without having to be chemically treated." Avoiding food waste is also very important at Okanagan. Over 40 percent of normal apples are thrown away, mostly because they have turned brown. That's the argument behind the slogan "Less Waste & More Taste." By switching off four genes, this can be avoided. SP


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1 The enzyme *polyphenol oxidase (PPO)* causes apple flesh to turn brown. In Arctic® apples, the genes responsible for this have been deactivated.

2 In the 1990s, *Louisa and Neal Carter* spotted the potential of breeding non-browning apples based on biotech. Today, they grow on 500 hectares.

3+4 The GM apple is available in the varieties Granny Smith, Fuji, and Golden Delicious; Gala, Honeycrisp, and Cripps Pink are set to follow. It is also in demand in the *foodservice sector*: for schools, canteens, and restaurants.

Risk or Gain?

New Breeding Techniques hold great promise – and give rise to equally great concerns. A lively discussion on NBTs between *Jan Plagge*, CEO of the organic farming association Bioland, and *Philippe Binard*, Secretary General of the Freshfel Europe association.

Interview by Christian Heinrich
Photography by Franziska Gilli

1 *Jan Plagge* is CEO of the Bioland farming association, which represents more than 10,000 organic farms across Europe. Before joining Bioland, the agricultural engineer was a food production consultant for many years. Plagge also chairs the European umbrella organization for organic farming, IFOAM Organics Europe.
bioland.de

2 *Philippe Binard* is Secretary General of Freshfel Europe, an association representing the interests of the fruit industry. A lawyer by profession, Binard is also general secretary of WAPA (World Apple and Pear Association) and SHAFFE (Southern Hemisphere Fresh Fruit Exporters) and general manager of WCO (World Citrus Organisation), collaboration partners of Freshfel Europe.
freshfel.org

Deliberations are currently underway in the EU as to whether and how new breeding techniques, or NBTs for short, should be regulated by law. The apple industry is closely following and contributing to the discussions. What potential gains are to be made by lowering the barriers to the use of NBTs in Europe?
Philippe Binard: Easier access to NBTs is essential for the European apple industry, so that it can hold its own against global competition. Apple producers in China and the United States already have comparatively low-threshold access to NBTs. Because apples have a long shelf life and can be exported, global competition is stiff. This is why it is increasingly important to achieve the best possible yields and quality. NBTs give us the opportunity to boost yields and productivity: we will be able to grow apples that are more resilient to extreme weather events such as storms or periods


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“You have to be careful not to raise hopes with NBTs that can’t be fulfilled later on.”

Jan Plagge, *CEO of the Bioland farming association*

of heat and more resistant to pests. This also allows us to reduce our use of pesticides. And of course we can also work on further improving flavor and nutritional value.
Jan Plagge: It remains to be seen how many of these promises can be fulfilled and how far we can reduce our pesticide use. Some scientists see the potential of NBTs as much more limited. In an article in the science journal *Nature* last year, scientists raised a note of caution on the hype surrounding genetic modification: “Stop overselling it!”[1] You have to be careful not to raise hopes that can’t even begin to be fulfilled later on.

Mr. Plagge, how do you view the risks of breeding with new methods such as CRISPR/Cas?
Plagge: First of all, it is an intervention in the genome. And that can entail risks …
Binard: … but you do need to differentiate between this and conventional genetic engineering methods, which give you much less control. Interventions using CRISPR/Cas are highly targeted and controlled. And most importantly, they are at a level that can also occur in nature. CRISPR/Cas is merely an acceleration of a natural development: breeding and waiting for suitable mutations.
Plagge: Sure, CRISPR/Cas takes a different approach than conventional genetic engineering methods. But that certainly doesn’t make it risk-free. A study by ANSES, the French Agency for Food, Environmental and Occupational Health & Safety, came to this conclusion.[2] It points out that foods manipulated using new methods such as CRISPR/Cas can cause allergies and toxicity problems, and that the new composition could have potential health risks. And of course, there are also risks to the environment: if plants manipulated with CRISPR/Cas are given the green light to be grown outdoors in Europe, they could spread and affect other plants.

How should we deal with these risks?
Plagge: Quite simply, with a comprehensive risk analysis so that we can better assess the dangers. No-one is saying that plants modified using CRISPR/Cas will turn into monster plants. Some of the warnings may well prove to be unfounded. But you can only find that out by conducting a risk analysis. And yet there is no mention of this anywhere in the EU drafts: the risk analysis is simply skipped.
Binard: If a risk analysis is needed, I’m the last person to stand in its way. But just don’t go overboard with it. There are already plenty of findings from authorization processes in other countries. A risk analysis that takes years slows down the process, which is not particularly quick in the EU anyway. CRISPR/Cas is very precise and controlled; this fact should be taken on board in the authorization processes, and NBTs should therefore be treated differently from conventional genetic engineering methods.

What role do consumers play in the decision for or against NBTs?
Binard: A key role, of course! So it’s all the more important to keep consumers well-informed about the arguments for and against NBTs. And to explain to them that NBTs can have a positive impact on the environment and help reduce pesticide usage, which is something the EU has set out to do in the Green Deal. It’s also crucial to explain what the risks inherent in NBTs are and that they are being considered. We need to win consumers’ trust by providing them with facts so that they can make a fact-based decision. Otherwise the debate risks drifting into emotional territory.
Plagge: I agree, the facts should be center stage. Labeling is compulsory for conventional GMO foods. This enables consumers to choose whether to buy them or not. For NBTs, it is being debated whether the labeling requirement should be dropped. For me that isn’t an ideal approach. Put bluntly, you could say it’s a way to sidestep consumer concerns by taking away their option to avoid NBT-modified foods. We need practical coexistence measures, too, including clear labeling in the field, to prevent any mixing. This is the only way to guarantee freedom of choice for farmers, food manufacturers, and consumers.

Mr. Binard, where do you stand on this?
Binard: I agree that anything that has been modified using conventional genetic engineering methods should still be labeled – although at present, no fruit and vegetables are produced using conventional GMO methods in Europe anyway. When it comes to CRISPR/Cas, it is important to remember that this only involves processes that can also occur in nature. After all, we don’t label plants that have been bred conventionally; that also involves human intervention to select specific traits.
Plagge: Except with NBTs, you are not just selecting specific traits, you are making changes, and that means the plant is no longer natural. Scientists also see risks in this, and those are not just plucked out of thin air. They are backed up by case studies and intensive research. What’s more, the EU currently has set no limit on the number of bases [the protein molecules that make up a large part of DNA – Ed.] that are changed; as long as it is done using CRISPR/Cas, it falls under NBTs. This means that more extensive changes would also simply be passed off as NBTs.

Mr. Plagge, what is the best way for the process of regulating NBTs to move forward?
Plagge: The most important thing is for the EU to first carry out a sensible risk assessment before simplifying the authorization process. I don’t want NBTs to be banned outright or for the authorization process to be particularly complicated.

Jan Plagge (l.) calls for a comprehensive *risk analysis* before NBTs are authorized in Europe. Philippe Binard refers to existing findings from abroad and fears that too lengthy a process will harm the apple industry.

[1] Nature 621, 470–473 (2023) doi.org/10.1038/d41586-023-02895-w
[2] anses.fr/en/content/ntg-en

“Europe’s apple industry needs access to NBTs to compete globally.”

Philippe Binard, *Secretary General of Freshfel Europe*

Compulsory labeling, risk analysis, environmental risks: in the **ipoma** head-to-head on NBTs, *Philippe Binard* (top), Freshfel Secretary General in Brussels, and Bioland CEO *Jan Plagge* disagree on many points. But both are in favor of a discussion based on scientific facts rather than emotions.

We just need to know what we’re letting ourselves in for. And not only on account of human health, but also for the environment: Europe is densely populated; we have sensitive ecosystems and enough to do already to stabilize these in the future. That’s why it makes sense to analyze the risks involved in plants modified with NBT before we plant them and lose control, potentially at huge ecological cost. And finally, compulsory labeling for foods modified with NBTs is a must.

Mr. Binard, how do you think NBTs should be regulated?

Binard: Many things are debated in depth in the EU, and with so many Member States each with their own interests, it’s not always easy to make a decision or find a compromise. But the process always ends at a point at which everyone can agree – and then it’s usually a good outcome. And that’s also what will happen with the regulation of NBTs: the key will be to ensure that once initiated, the process doesn’t get bogged down but moves forward in a focused way – based on facts and science, not emotions.

What happens if agreement can’t ultimately be reached?

Binard: It is essential that agreement be reached. Whatever form NBT regulation ultimately takes, it should apply to the whole of Europe, otherwise it won’t be effective because there won’t be a real internal market. And the EU needs to take what is happening in the rest of the world on board in its decision-making. Then it will be able to play a leading role and keep production competitive and innovative. I believe we need to take cognizance of that in the future debate on NBT regulation. **CH**

In the *terraXcube extreme climate simulator* from Eurac Research in Bolzano, apple plants and grapevines are exposed to harsh conditions such as heat and drops in temperature to test how they react, depending on water availability.

ipoma

Climate Change Strategies

As temperatures rise, water becomes scarcer, and extreme weather events happen more frequently, the apple is coming under pressure. In South Tyrol, scientists are looking for solutions – ranging from high-tech sensors to simple measures such as using hail nets or increasing canopy density.

What we can expect

The biggest factors impacting on apple production are higher air temperatures – and therefore also higher soil temperatures –, water scarcity, and increasing unpredictability. In the past, growers have been able to rely on a constant climate: now, deviations from the norm have increased sharply, with sudden severe drops in temperature and heat waves. Rising temperatures at the end of winter lead to early bud burst and earlier blossoming, making the trees more vulnerable in cold spells.

How scientists are responding

In the project AGRITECH, researchers at the Free University of Bolzano and Laimburg Research Centre are investigating the effects of heat on apple growing. Using the terraXcube extreme climate simulator from Eurac Research, they are testing how apple plants behave in heat waves, depending on the availability of water. Similar studies have already been conducted on vines. By following the high temperatures with simulated rainfall, they can examine how the plants regain their functionality after a heat wave.

Strategies for water scarcity ...

Apples are usually grafted onto rootstocks that have very shallow roots. This makes the trees dependent on rain or watering from above. Rootstocks that penetrate through to deeper soil layers will succeed better in these conditions. This is one line of research at Laimburg Research Centre. Hail nets can also indirectly help mitigate drought: they reduce evaporation by around 20 percent. In the future, sensors could be used to indicate when plants need watering, ideally via drip irrigation that only targets part of the root system.

... and for heat

At air temperatures of around 40°C, the fruits can heat up to 50°, which can cause scalding. Hail nets have proven useful for shading in these conditions, too. Another potential solution could be a return to stronger, denser tree canopies. Genetics therefore play a key role in the development of solutions, for example to develop new varieties that color well despite shade or without strong fluctuations between day and night temperatures.

ipoma

Gerhard Baab, 69, worked at the Horticulture Competence Center at the University of Bonn in Klein-Altendorf for many years and has published widely in the field. Since retiring, he has been advising fruit growers in Kazakhstan.

The **Apple Physiologist**

Gerhard Baab is one of the leading experts in his field in Europe, having spent 50 years researching the apple. Today, Baab supports fruit growers in their work – and sees them as his role models.

By Bettina Gartner
Photography by Franziska Gilli

Technically speaking, Gerhard Baab has been retired for four years already. But the 69-year-old's life still revolves around apples. Since he retired in 2020, Baab, who hails from the Palatinate region in Germany, has been advising fruit growers in Kazakhstan. There, in the ancient homeland of the apple, he works for technology company Agroselection. Around four times a year, he visits farms in the greater Almaty region that operate their orchards in the steppe.

As an apple physiologist, Baab understands what trees and farmers need. For decades, he studied the interaction of the factors responsible for both tree growth and fruiting success. How do you combat soil fatigue? What do you do about fungi and bacteria, nutrient deficiencies, and waterlogging – all challenges that arise when a site is used for too long? It was questions like these that drove him.

The son of a fruit grower, Baab studied horticulture in Hanover. He then joined the former National Teaching and Testing Institute for Viticulture, Horticulture, and Agriculture in Bad Neuenahr-Ahrweiler, and later the Horticulture Competence Center (KoGa) in Klein-Altendorf. Baab ran training courses for aspiring fruit growers, provided consultancy services for existing farms, and conducted trials to streamline the workload for apple growers.

"We've always seen ourselves as service providers to fruit growers," says Baab. "Devoting yourself solely to pure science

In Kazakhstan, orchards can extend to as much as 150 hectares, with entire villages involved in the apple business.

doesn't help much if fruit growers never get to read the results or aren't interested in them. It's the practical problems that have always been the driving force in our work."

In Kazakhstan, where Baab shares his knowledge and experience today, the challenges of apple growing are extreme: bone-chilling cold (down to -30°C) in winter and scorching heat (up to 40°C) in summer. It's only thanks to the irrigation systems installed in the Soviet era that fruit farming is possible there at all.

The wide expanses of space in the country offer benefits for local growers. While South Tyrolean fruit growers make do with fields of two or three hectares, apple orchards in Kazakhstan can span as much as 150 hectares. Nevertheless, the workplace environment is very much family-based. It is not uncommon for entire villages to be involved in the apple business. Across the globe, there are increasing numbers of farms covering 2,000 hectares or more. Behind such giants often stand large corporations and banks "who often just want to see numbers," Baab says. "When the time is right for them, they will quickly pull out of the business and turf the staff out onto the street. Politicians should think about this before encouraging even bigger business models."

If small farms get trampled on in the process, it's not only tradition that is lost. According to Baab, many innovations in fruit growing can be attributed to independent, well-trained farm managers. That's because of their eye for detail and their meticulous observation skills.

These qualities are in great demand in these changing times. With weather extremes, frost, and diseases, fruit trees are having to become increasingly robust. At the same time, growers are having to cut back on their use of chemical sprays. It's a balancing act between intrinsic and external qualities, between resistant plants and apple varieties that succeed on the market. As transportation costs rise and export opportunities dwindle, a number of farms – particularly in Eastern Europe – have reverted to growing their own trees in recent years. This requires specialist knowledge and craftsmanship. Apple fairs such as Interpoma are ideal learning venues for this, says Baab. Instead of painstakingly gathering the knowledge you need yourself, it is presented there, neatly packaged, by specialists from all over the world.

Baab is one of these high-ranking experts. Nevertheless, he remains humble, praising others as the true masters. "Fruit growers are my role models," he says, "my second family. They are smart, down-to-earth people, straightforward in their thinking and in their inner attitude. In today's world, they could provide many people with valuable guidance." BG

What does an apple physiologist do?
Physiology is a subfield of apple science that deals with the *balance between vegetative and generative growth*, in other words plant growth and fruit yield. Among the central factors that apple physiologists study are flower formation in plants (flower induction), the fluctuation in fruit yield in a biennial rhythm (alternate bearing), the use of rootstocks, interstem grafting, young tree training, and plant nutrition. In all of this, it is important to see the tree from a holistic perspective, as all fruit growers who live from and with trees do.

New Varieties, New Ideas

More than variety innovation: South Tyrolean marketing organizations VOG and VIP are focusing on innovative retail and consumer engagement projects – and are also reimagining traditional apple varieties.

Until recently, when biting into an apple most consumers would probably not think beyond "sweet" or "sour." The South Tyrolean growing and marketing organizations VOG and VIP are working to completely change this narrow perception of apples, with a clear focus on direct consumer engagement around the launch of new varieties. And with innovative ideas to reprofile traditional varieties as well.

To keep buyers engaged amidst an increasing number of competing offers, the two organizations recognize that variety innovation is key. "We have therefore built a comprehensive brand strategy in recent years to reach consumers on an emotional level," says VOG Head of Marketing Hannes Tauber. In its most recent phase, the eye-catchingly large Giga® (Ipador variety), to which VOG holds exclusive European distribution rights, is marketed as "too good not to share," while little RedPop® (CivM49) targets the snack apple segment. New, exciting varieties are designed to appeal to young buyers and must impress not only in terms of taste but also in presentation. The same goes for the latest superstar Cosmic Crisp® (WA38), which VOG and VIP are currently growing in South Tyrol exclusively for Europe and marketing together.

"But variety innovation alone is not enough," says VIP Head of Marketing Benjamin Laimer. That's why the Vinschgau Producers' Association has launched a category management project, strategically launching new apple varieties on the market at the right moments throughout the year and transparently explaining this seasonality to consumers. "SweeTango® is at its best in September and October, and Cosmic Crisp® remains excellent until summer: it's important to communicate the fact that every apple variety has a time when it's at its best, especially with new varieties, so that consumers can get the best possible taste experience when they try them for the first time," says Laimer. In retail chains, VIP promotes these varieties with tasting events, videos, and information material for consumers that emphasize the sensory experience. And with great success: sales of new varieties have seen a significant uptick.

Launches of new varieties are coupled with *innovative marketing approaches*; they are described in a similar way to wine and presented as premium products.

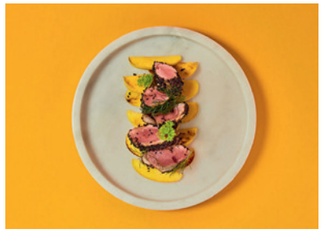
Both marketing organizations are therefore focusing on raising awareness and providing a more immersive consumer experience. On its "Saporeria" platform (derived from sapore, Italian for taste), VIP describes apple varieties using the language of wine and offers them in premium packaging for direct online purchase, giving the apple a whole new level of value. VOG follows a similar approach with its Aroma Wheel, a tool that helps consumers to better understand different flavor profiles. Both associations recommend the perfect variety combinations in the kitchen or for health through food pairing projects (see box). "Consumers today are more informed," says Laimer. "They want to know more than just whether their apple is sweet or sour." VD

1 "Reimagining traditional varieties is *sustainable* – for farmers, too," says VIP Head of Marketing Benjamin Laimer (right, with apple pairing expert Chiara Manzi).

2 "In our variety strategy, we focus on *emotional customer engagement*," says VOG Head of Marketing Hannes Tauber.


1


2



Perfect Pairings.

While the marketing spotlight is on attractive newcomers, what about the time-honored Gala, Golden, and Granny Smith? VOG's and VIP's food pairing projects show how traditional apple varieties can be reimagined. For VOG, three-Michelin-star chef Norbert Niederkofler suggests "Marlene® Apple Pairings" with surprising combinations such as Fuji with grapefruit, Golden Delicious with pork, Royal Gala with blue cheese. Meanwhile VIP's creative "Apple Pairings" by nutritionist and anti-aging expert Dr. Chiara Manzi emphasize the health benefits of the apple: Pinova cubes in green tea, for example, increase the absorption of polyphenols, and fresh tuna on Golden Delicious slices provides omega-3 fatty acids and pectins.

Apple Experts.

The two largest apple marketing organizations in South Tyrol are Europe's foremost producers and marketers of apples. VOG (the Association of South Tyrolean Fruit Cooperatives) represents over **4,000** farmers and markets 600,000 tonnes of apples per year across 75 countries; VIP (the Association of Vinschgau Producers of Fruit and Vegetables) produces around **320,000** tonnes per year with 7 cooperatives.

vog.it
vip.coop

Product Innovation

POST HARVEST (1)

Perfect Precision

With pinpoint accuracy, the robotic arms gently place the apples in the tray pockets – normally one of the most labor-intensive steps in the packing process. The APORO produce packer from the Sorma Group uses a multi-headed pick-and-place robot that handles four apples at once, with each head capable of handling 200 fruits per minute. The packer automatically detects the size of the pockets. Thanks to the integrated cameras, the robotic arms can even deliver perfect retail presentation in the tray, orienting the apples with the stems aligned in one direction and the high-color side of the fruit facing upward. sormagroup.com

APPLE JUICE

Red Rules the Roost

From pastel pink to intense red: the Kissabel® brand brings together several colored-flesh apple varieties developed as part of the IFORED project, an international partnership of 14 of the world's largest apple production and marketing companies. Kissabel® juice is available in Italy, Germany, and France, with each of the authorized partners – VOG Products, Elbe-Obst, and Kookabarra – blending red-fleshed and conventional varieties to match the finished product to local consumer taste. "This opens up new growth and consumption opportunities for the red-fleshed apple segment, and the juice production means that fruits that are unsaleable as dessert apples don't fall victim to food waste," explains Emmanuel de Lapparent, Kissabel® project lead at IFORED. kissabel.com

Auto-mation

POST HARVEST (2)

Well-Weighed

Gentle and automated apple handling, from weighing to packing: That was the goal Sorma Group from Italy had in mind in developing their processing line. The CP814ML electronic weigher gently transports the apples on a rubber cushion with soft brushes, ensuring they remain undamaged. Depending on their weight, it combines the fruits with others to achieve the desired pack weight and then conveys them on belts to the FH210 bagging machine. The machine has a capacity of over 40 packs per minute, intuitive touchscreen operation, and a self-learning system that automatically optimizes productivity. sormagroup.com

BEAUTY

Skincare For The Environment


1

2

Natural cosmetics – apple-based, of course – are the brainchild of the Italian startup NASTE beauty. Their best seller: a light facial serum (2) with vitamin C, hyaluronic acid, and quercetin, an apple polyphenol with an antioxidant effect. The apple extract (1) is sourced according to circular economy principles. A convenient refill pack for the serum avoids unnecessary packaging waste. nastebeauty.com

SUSTAINABLE

Paper Appeel

Premium paper crafted from apple processing waste features in the "Appeel" notebook collection from traditional Italian brand Castelli. Apple peel is mixed with fibers from FSC® recycled paper; the paper is produced exclusively with renewable energy; and the end product is 100 percent biodegradable. castelli1938.com

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Post-Harvest Innovation

The Sorma Group develops automation solutions for handling and packaging.

Sales of more than EUR 600 million in Trentino-Alto Adige alone and a number of healthy growing regions elsewhere in Italy illustrate the importance of the apple industry in the country's fruit and vegetable sector. Against this backdrop, the Sorma Group has always specialized in designing and building post-harvest apple handling machines, making it a strong partner for companies operating in this strategic area.

Headquartered in Cesena, Italy, the group offers a full portfolio of systems for the various post-harvest phases, with practical, efficient, and solid solutions that guarantee excellent performance and a long service life. Sorma's product catalog includes tippers, bin submersion emptying machines, conveyor belts, weighing systems, and filling machines for various formats and types of packaging, from honeycomb cardboard boxes to poly bags. All Sorma systems prioritize gentle fruit handling, combined with a high degree of process automation, precision, and versatility. Among the benefits of Sorma solutions are:

- reduced processing times and increased productivity;
- guaranteed high product quality;
- lower labor costs; and
- fast adaptation to the requirements of international markets.

In addition to its wide product portfolio, the Sorma Group also offers comprehensive, high-quality customer service. Qualified technicians are available throughout its entire catchment area to advise customers personally and help them get the most out of their Sorma solutions.

1 *Smart fruit management* thanks to automation: Features of the APORO bagging machine include cameras that take images of the apples and robotic arms that orient the apples to the side with the most intense color.

2 The Sorma Group's product portfolio also includes packaging solutions and automatic *bagging machines* such as the FH210, which guarantees particularly gentle apple handling.

Asia’s Favorite

Apple growers in New Zealand are going all out for one variety: Dazzle®, bred and developed for the Asian markets and tailored precisely to the preferences of consumers there. Variety manager, grower, and consultant Steve Potbury outlines its success story.

01 How did the idea come about to create a special variety for the Chinese/South-Asian market?

These markets are becoming increasingly important for New Zealand apple growers, with more than 60 percent of exports going there in recent years. They are close, have large populations with a growing middle class, and consumers there appreciate clean, healthy products from New Zealand. The growing importance of these markets means that we need to deliver products that are well-suited to their consumers.

02 What makes Dazzle® so popular in Asia?

Consumers love its red color and stunning looks. Also, its sweet flavor with almost no acidity, crisp texture, and white flesh are precisely what those markets are looking for. What’s more, it handles and stores really well, which makes our customers happy, too. We have been very fortunate that this apple performs exceptionally well all the way through the supply chain. But a lot of effort and resources have also gone into brand development and promotion.

03 The development of Dazzle® dates back more than 20 years, doesn’t it?

Yes, the variety PremA129, which is sold under the trade name Dazzle®, was bred by Plant & Food Research using conventional methods, transferring pollen from the variety Sweetie to flowers of the variety Scired, in 1997. It took many years to grow the trees, produce fruit, and then test the performance of the apple in the orchards, coolstores, and markets. It was only once that had been confirmed that we could start on brand development and commercial production. Now there are 1.5 million trees planted in New Zealand, and production is also underway in the United States.

04 What has the success of Dazzle® meant for apple production in New Zealand?

The variety is performing really well for our apple growers. We have done our best to get the level of production right, with enough to make a splash in the market but not so much that we overstep the demand for it. We are currently selling more than 90 percent of these limited quantities in Asia, but we are beginning to branch out into other markets that like sweet apples. A number of things need to be right to have a successful new apple: great productivity, the ability to store well, quality, characteristics that the market appreciates, excellent branding, strong selling. Of course, everyone in the supply chain needs to do well, but there are two parties we really need to look after: the growers, who underpin the industry with their risk, and the consumers, who are the ultimate judges of a great apple. So far, we seem to have got it right, and we intend to continue doing so. **DL/VD**

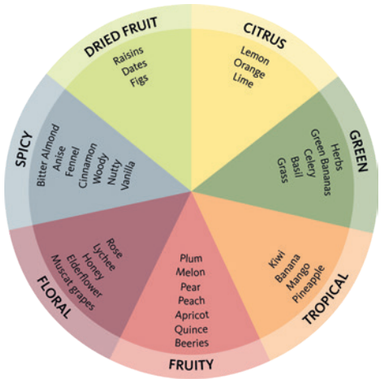
Steve Potbury, who has been in the apple industry for more than 30 years, is general manager of Fruitcraft, a collaboration between three of New Zealand’s largest apple growing and exporting companies, which between them account for around 30 percent of the New Zealand apple industry. Fruitcraft evaluates and develops new apple varieties for those businesses.

Dazzle® is taking Asia by storm, thanks to *intensive marketing* – with in-store promotions (top), market-specific advertising, and sports events for consumers (bottom) in China, Taiwan, and Vietnam.

VIDEO
on sensory analysis tasting: watch here

A New Way of Tasting

The training for apple sommeliers in South Tyrol is the only one of its kind in the world: an intensive course focusing on sensory analysis. Antonia Widmann, coordinator of the South Tyrolean Apple Consortium and apple sommelier, gives us a taste.



01 Ms. Widmann, how does one become an apple sommelier?

The training, which we run in collaboration with the South Tyrolean Farmers' Association, consists of 80 lesson hours on various aspects of apple growing and processing: knowledge of our apple-growing region, breeding and varietal theory, quality control and food safety, crop protection and organic cultivation, legal aspects, nutritional advice, and – an important focal point – sensory analysis training that takes in all the senses: sight, hearing, smell, taste, and feel.

02 What are the aims of the program?

The course is open to a wide audience, and so far, 43 apple sommeliers have qualified. They can now offer apple tastings in hotels or schools, raise awareness of the apple's diversity in the hospitality and food sector, and provide added value at trade shows. Our ultimate aim is to enhance the apple's image as a multifaceted product.

03 Hence the emphasis on sensory analysis and the use of the term "sommelier", which we usually associate with wine?

You've got it! It's all about being able to describe flavors and aroma families in detail: apples are not just sweet or tart, they have floral, tropical, or green flavors, notes of mango, pineapple, aniseed, or fennel. The mouthfeel also plays an important role: the cell structure, the texture, the thickness of the skin. If the apple sommeliers from South Tyrol can convey this to consumers, they will in turn appreciate the diversity of the apple more. This also boosts variety innovation: consumers learn to rate and appreciate new varieties, which always perform extremely well on sensory aspects in blind tastings.

04 What fascinated you as a course participant?

The sensory tastings. Taste arises partly through the perception of smell, and smells are something very personal! A Granny Smith, for example, reminds me of freshly mown grass and playing in a meadow as a child. We can also stir these emotions in consumers by showing them how to recognize and describe the aromas of the apple.

Antonia Widmann, coordinator at the South Tyrolean Apple Consortium, has completed the apple sommelier training herself. What do participants most appreciate about the course? "The light-bulb moments when they suddenly experience the apple in a whole new way – even if they're from the industry themselves," says Widmann.

Apfel - Consortium - Mela

SÜDTIROL

Apples from South Tyrol: top of the range.

SÜDTIROL Marlene® DAUGHTER OF THE ALPS

Südtiroler Apfel g.g.A. SÜDTIROL

VAL VENOSTA Südtirol