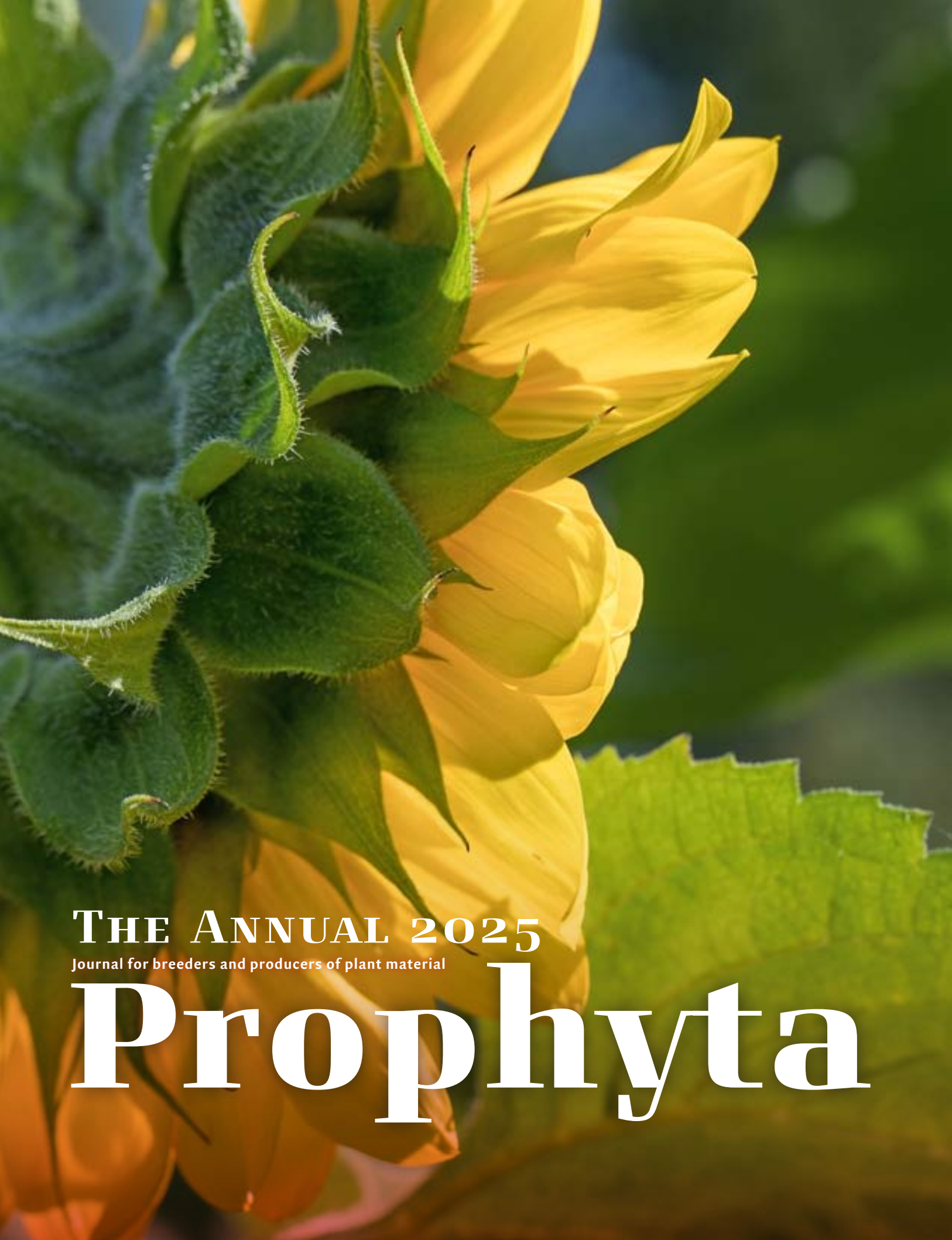

The Annual 2025

Journal for breeders and producers of plant material

Prophyta

Prophyta – The Annual 2025
A publication of the Prophyta Foundation

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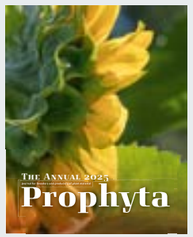


ON THE COVER: The most favourite snack in Türkiye is sunflower seeds. Half of the total market for nuts, seeds and kernels are sunflower seeds, followed by peanuts and mixed nuts. That means that the Turkish households spend 4.6 billion euro a year on sunflower seeds alone

THE ANNUAL 2025
Journal for breeders and producers of plant material

Prophyta

Join our Reader Survey and help us to improve!

Dear Prophyta reader,

As you will have read in the previous issue of Prophyta, Monique Krinkels has stepped down as editor-in-chief of the magazine after more than thirty years. She has made Prophyta what it is today, an inspirational magazine for everyone working in our field, both nationally and internationally.

Now that changes are taking place in the editorial team with Steven van Paassen taking over from Monique Krinkels as of August 2025, we are also asking ourselves the question, 'Can we make Prophyta even better?'

Can we ask you something? Who better to answer this question than you, the reader. We are therefore asking you to fill out a short reader survey. You can access the survey by scanning the QR code. It will take only a few minutes to complete and the results of this survey will help us to improve Prophyta and better respond to your interests. Thank you in advance for your cooperation!

Help us to improve. Scan the QR code

First skin-transplant potato variety

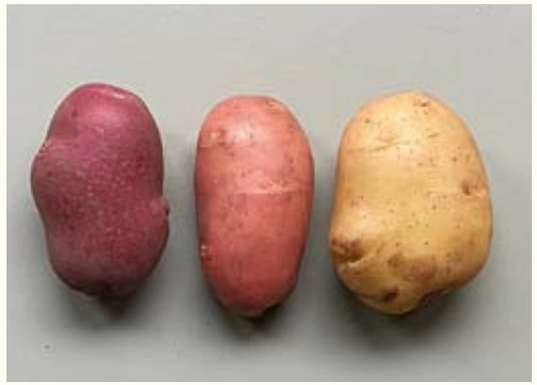
The Board for Plant Varieties in the Netherlands has granted Plant Breeders' Rights to the first skin transplant potato variety. The new variety, named Jeroen KG, was developed by using KeyGene's proprietary 2S1 technique for the development of graft hybrids. The variety was designed to demonstrate the potential of the 2S1 technique to obtain valuable hybrid grafted plants, which combine positive skin traits, such as drought tolerance or insect repellence, from one variety with other positive traits, such as yield, from a different variety.

Jeroen KG plants combine the skin of Pimpernel with the inner cell layers of Bintje. The potatoes of Pimpernel are red, those of Bintje are white. Thanks to the skin-transplant, the potatoes of Jeroen KG potato plants are pink. In the other crop traits scored during the research for plant breeders' rights, such as earliness and yield, Jeroen KG was identical to Bintje.

The combination of Pimpernel skin and Bintje inner cells proved to be stable: after several generations of seed potato production, the seed potatoes, the plants growing from the seed potatoes and the potatoes produced by these plants continued to have their unique combination of cell layers.

The granting of Plant Breeders' Rights by the Board for Plant Varieties in the Netherlands proves that these skin-transplant varieties can be commercialized as new varieties.

Jeroen KG is a 'proof-of-concept'; it shows the innovation potential of KeyGene's 2S1 technique to develop novel varieties that can uniquely combine favourable traits from different parent lines in a cost-efficient way and within a significantly reduced amount of time.



Jeroen KG (middle) combines characteristics of Pimpernel (left) and Bintje

Planasa takes over ABZ

Strawberry breeder ABZ from Andijk, the Netherlands, has been taken over by Planasa (head office in Spain). ABZ was one of the first companies in the 1990s to introduce commercial F1 Hybrid seeds on the professional market. Planasa is a leading company in breeding and propagation of plant material in soft fruits. With this acquisition, Planasa also, like some other companies, enters the rapidly developing domain of seed propagation of soft fruit varieties.

Seed Meets Technology 2025

For the eleventh time, preparations for Seed meets Technology 2025 have begun. This event will take place from 23-25 September 2025 in Zwaagdijk, the Netherlands. Seed meets Technology (SmT for short) is an event where the focus is on innovative seed technology, variety assortment and adding value to horticultural seed. The initiators, together with other companies associated with the seed industry, want to strengthen the programmes of open days in September with themes such as seed treatment, phenotyping, seed processing equipment, breeding support, sustainable crop protection and cultivation systems. Participants are required to actually demonstrate new products or services in the exhibition hall or on the demo field. The set-up with demonstrations, trial fields and meetings should lead to interaction with the visitor. Registration for exhibitors is open; the digital registration form can be found on seedmeetstechnology.com.

New CRISPRs discovered

Researchers at Duke University and North Carolina State University have discovered a handful of new CRISPR-Cas systems that could add to the capabilities of the already transformational gene editing and DNA manipulation toolbox. By scouring thousands of bacterial genomes for new CRISPR-Cas systems, they found, for instance, a bacterium commonly found in dairy cows shows particular promise for human health. Its efficiency is on par with the original and most widely used CRISPR-Cas system, but its small size allows it to be more easily packaged for delivery to human cells. It can also target specific gene sequences that other systems cannot.

"Besides potential for therapeutic applications, we also appreciate that bacteria that have adapted to diverse habitats harbour effectors better suited for various kinds of hosts, with much potential for discovery of systems more suited for plants," says Rodolphe Barrangou, one of the researchers.

The results appear online on 12 March in the Proceedings of the National Academy of Sciences (PNAS).

Enjoy

As you have noticed now having this volume in your hands: our magazine Prophyta will continue to be published! That is good news for the readers, for our supporting advertisers and sponsors and for the writers of the articles.

As always in our Annual, the focus is again on the ISF congress organizing country: this year Türkiye is in the spotlight. You will find articles on the historical development of agriculture, the important position of agriculture in the economy and the ambitions in collaboration, innovation and sustainability of the Turkish organisations that are making this year's ISF congress possible. And many other articles on breeding, tissue culture, PVP, seed treatment, role of ABA in salt tolerance, as well as interesting information on products such as salep, duckweed, sunflower and marigold. So, varied as always! Enjoy reading all this!

Today, we are experiencing extremely challenging and disturbing economic and social developments. Relevant for every person living on the planet. An acceleration of climatic change as temperatures are rising even faster than predicted (and who still cares?). War in Ukraine/Russia and the Israel/Palestine conflict are not likely to stop soon. The break down of multilateral agreements and participation of the USA in international organisations, such as FAO, WHO and WTO. The latest tariff war will have an enormous negative impact on international trade, as others are responding with comparable trade barriers. Autocratic governments neglecting democratic rules of play. Nowadays it is not easy to read the newspapers in the morning and to stay optimistic about our global future...

How will all this affect seed trade and agriculture? More regionalisation, more tariffs and more protection are also likely to seriously affect business and trade in a negative way. The already difficult road towards sustainably feeding ten billion people will be broken up and even covered with mines. Let's hope that the foundation of our international structures is tough enough to withstand these attacks and consequences. Hopefully, people all over the world are wise enough to find ways to keep building a cooperative, sustainable and peaceful future with healthy food for everyone.

John van Ruiten

EU announces new vision on Agriculture

In February, the EU Commission presented its new vision for agriculture and food. The published policy (roadmap) wants agriculture to become more attractive for workers and be more competitive, resilient and future oriented. The EU wants to strengthen innovation and the use of new technology and digital tools such as AI. The Commission: "Plant breeding innovations, including the use of biotechnological tools, such as new genomic techniques (NGTs), are key to accelerating the development of climate-change resilient, resource-saving, nutritious and high-yielding varieties, and thereby contribute to the EU's food security and food sovereignty. NGTs can also yield microorganisms with positive impact on agricultural production, e.g. by reducing the need for synthetic fertilizers."

Status ToBRFV changed to RNQP

Since 1 January 2025, the EU phytosanitary authorities have changed the regulatory framework for Tobrfv (Tomato Brown Rugose Fruit Virus) and removed this virus from the quarantine list. It is now a so-called Regulated Non-Quarantine Pest. No more legal measures (destruction) will have to be applied if tomato growers have an infection of this virus in their crops. For marketing seed and planting material of tomato and non-resistant sweet peppers, the requirement of freedom from the virus continues to apply. The seeds and plants can be marketed in the EU provided that they are tested and found free of or come from a country free of Tobrfv.

Bombs, mines and chemicals ravage Ukraine's soil

To restore agricultural land in Ukraine after the war will cost at least 20 billion euro. Hundreds of thousands of hectares have to be demined, bomb craters filled and chemicals removed. That is the conclusion of Professor Wilfred Dolfsma of Wageningen University & Research, who investigated the damage together with Ukraine universities. He focused on the Kharkiv region where 160,000 hectares have been affected by the war and explosions created 420,000 bomb craters. Furthermore, soil layers have been mixed by explosions, destroying the upper most fertile layers. The Kharkiv Oblast (region) is famous for its fertile 'chernozem' soil, but the production of grains has halved since the start of the Russian invasion in 2022. The actual costs will probably be even higher as the costs of equipment, fuel or labour have not been taken into account, as these factors cannot be estimated accurately. Therefore, it may take many years for Ukraine to restore its agricultural land after the war.

True potato seeds for consumers

F1 hybrid true potato seed breeder Solynta and consumer seed supplier Pieterpik from the Netherlands announced that they are starting a joint venture. Both companies see a growing potential for growing potatoes from true seeds by home gardeners. Seeds will be produced by Solynta in the Netherlands and marketed under various tradenames by Pieterpik in EU countries in small packages.

In Memoriam Professor Rudolf Pierik (1936–2025)

It is with profound respect and deep sorrow that we remember Professor Rudolf Pierik, who passed away on 6 March 2025, at the age of 89. A trailblazer in the field of plant biotechnology, he leaves behind an enduring legacy that has profoundly shaped the scientific community and industry alike. Rudolf Pierik was a pioneer whose contributions to in vitro culture of higher plants remain foundational. His acclaimed handbook on this subject has guided countless researchers and continues to be a cornerstone in plant tissue culture studies. His work demonstrated not only a mastery of his field, but also a vision for its transformative potential.
In 1976, Professor Pierik co-initiated the establishment of the Stichting Bedrijfslaboratorium voor Weefselkweek (SBW), a collaborative endeavour with the business sector. This groundbreaking initiative bridged the gap between academia and industry, fostering innovation in plant tissue culture and cultivating a new era of applied biotechnology. His insights and collaborative spirit were instrumental in the success of this pioneering organization. Beyond his professional achievements, he will be remembered as a dedicated mentor, an inspiring leader and a humble visionary whose work has left an indelible impact on science and society.

As we honour his memory, we celebrate a life devoted to knowledge, progress and the betterment of our world. He will be deeply missed but forever remembered through the seeds of innovation and collaboration he has sown.

Alewijn Broere

Fleuroselect announces Gold Medal winners

The judges of Fleuroselect have awarded two varieties with their coveted Gold Medal. Both breeding breakthroughs obtained an outstanding score in innovation, beauty and garden performance in the annual trial.
'Black Forest Ruby', a *Dahlia pinnata* bred by Takii Europe, is an excellent choice for a combo container and thrives in sunny beds. Growers will find that this new Dahlia is easy to produce and results in highly uniform plants. Retailers will marvel over the attractive flower-leaf colour combination which stands out on the benches. Consumers will welcome the outstanding garden performance as Black Forest Ruby flowers continuously from summer over autumn until the first frost. Dahlias have become increasingly popular over the past few years due to their stunning variety, impressive flower shapes and captivating colours. The latest *Salvia splendens* 'Estella Coral' from Van Hemert & Co fits seamlessly in the current trend of a less formal, more naturalistic looking garden. It is a breeding breakthrough in many ways. This plant innovation shows a fully new habit compared to the known splendens types. 'Estella Coral' is bigger, bushier, well-branched and therefore suitable for wildlife-inspired gardening, large patio containers or landscaping where vigour is required. In addition to its innovative plant shape, the flower colour is completely new in this bushy salvia type from seed. Its large, rose flower spikes bloom all season long, providing splendid colour and texture in the garden.

John van Ruiten: 'Prophyta provides valuable background information for the seed sector'

Steven van Paassen: 'I am happy to continue to dedicate myself to the seed sector'

Prophyta continues!

John van Ruiten

The Prophyta Foundation is very pleased to announce to its readers, sponsors and advertisers that the magazine will continue to be published in the years to come. In our previous edition, we informed you that, due to the retirement of Monique Krinkels, the search for a new editor-in-chief was ongoing. We felt like we were 'hanging by a thread' as they say. Fortunately, we found a successor!

Steven van Paassen, currently still working as communications specialist at Rijk Zwaan vegetable seeds company, enthusiastically agreed to take over this role in the second half of 2025, when he finishes his career at the company. Educated at HAS Green Academy in Den Bosch, the Netherlands, he worked many years as account- and communications manager at Bureau Horticom/Adequaat, Delphy, and since 2005 at Rijk Zwaan. Steven will be responsible for the content and articles in the magazine, supported by an editorial advisory board.
The Prophyta Foundation (represented by John van Ruiten as secretary) will take the responsibility for the making, publishing and spreading the magazine, as well as organizational and financial matters, such as advertisement and subscriptions.

History

Prophyta has a long history - almost 80 years. Started in 1947 as the Dutch seed trade journal 'Zaadbelangen', ever since it has served readers in the Dutch seed business with information on breeding, seed testing, propagation, legislation and policy, science, innovation and interviews. In 1987, the magazine transformed to Prophyta when six organisations (including inspection body NAKG and the five trade organisations NVP, NKB, VHZ, NTZ and CIOPORA (the ornamental and fruit breeders association)) joined forces to further professionalize the journal.
More attention to international (EU) developments and scientific articles appeared. The first editor in chief, Marianne Viersma, did that job for four years, when she was succeeded by Monique Krinkels in June 1991. At that time, Prophyta was published by Reed Business Information and that continued until 2005. Since then, the magazine has been 'independent'. Two international magazines are produced every year and distributed to visitors at ISF and Euroseeds congresses and sent to over 2,000 addressees around the globe, free of charge.

Readers' survey

Prophyta is lucky to have a long list of readers that like to receive the magazine and they are continuously surprised by the wide variety of articles. But going into a new phase now, we would like to better understand what our readers expect from us, which type of information they appreciate most and in which format they would like to receive it. We also want to ask attention to the financial aspect of producing the magazine.
Therefore, you will find a readers' survey in this edition. Please scan the QR code and give us your thoughts and opinions. That will help us to make a magazine that will continue to please you in the coming years!

Ir. J.E.M. van Ruiten is the secretary of the Prophyta Foundation

Innovation and collaboration needed

Steven van Paassen

"By developing resilient and high-yield varieties while preserving biodiversity and, in particular, working harder to remove barriers to seed trade, we can ensure food security and meet the growing demands of the future," says Yıldıray Gençer, one of the two co-organizers of the 2025 ISF Congress in Istanbul, Türkiye.

For the first time in the history of the ISF, the chairmanship of the National Organizing Committee is in the hands of two Presidents: Yıldıray Gençer and Burak Gönen. Gençer is president of the Sub Union of Seed Industrialists and Producers (TSÜAB) and ECOSA, and the companies Metgen Seeds and Pak Fide (vegetable seedling manufacturer). Mr. Gönen is the president of the Turkish Seed Industry Association (TÜRKTED) and AG Seeds, business partner of Enza Zaden bv Holland in Antalya, Türkiye.
"'Seed, a value for today, an investment for tomorrow,' is the motto of Turkish Seed Industries Association of Türkiye, TÜRKTED," says Mr. Gönen, President of TÜRKTED. "The seed sector plays a crucial role in ensuring the food security of Turkish citizens, as well as citizens of neighbouring countries."

'The World Seed Congress 2025 will be unique as it will be organised on two continents, Europe and Asia, as a result of Türkiye's geographical position,' says Yıldıray Gençer

A strategic co-chairmanship

The decision to introduce a co-chairmanship at the ISF Congress stems from the unique legal statuses and overlapping memberships of TSÜAB and TÜRKTED, both of which are ISF members. TÜRKTED operates as a non-profit private association, allowing voluntary membership from individuals and companies in the seed sector. In contrast, TSÜAB is a public sub union organization with mandatory membership for those engaged in seed activities in Türkiye, as per Seed Law number 5553. TÜRKTED was founded in 1985 and celebrates its 40th anniversary this year. TÜRKTED also organised a very successful ISF WSC in 2009 in Antalya, Türkiye, when TSÜAB was at the stage of being established. Mr. Gençer and Mr. Gönen: "This co-chairmanship ensures that the congress benefits from the combined expertise and contributions of both entities, enhancing the planning and execution, while representing the entire Türkiyeish seed sector."

A bridge

Mr. Gönen and Mr. Gençer are both happy that the ISF Congress will be held again in Türkiye and this time in Istanbul. ISF WSC Congresses are organised in a different continent every year. However, ISF WSC in 2025 has also been unique in that it will be organised in two continents at the same time, both in Europe and Asia as a result of Türkiye's geographical location. "Türkiye has made significant progress in seed cultivation in a short time. We have become a country that is self-sufficient and, at the same time, exports seeds. And with Istanbul's position as a bridge between Europe, Asia and the Middle East, this makes the ISF Congress an ideal meeting

Since 5600 B.C grapes are grown on the slopes of Mount Ararat. The Old Testament names the mountain where Noah's ark finally came to rest after the great flood as the first place were wine was produced. It is a compelling thought as it is near the Taurus Mountains where vines (Vitis vinifera sylvestris) grow wild--

point for international stakeholders, facilitating greater participation from neighbouring regions and enhancing networking opportunities in the global seed sector."

Emerging markets

According to Mr. Gençer and Mr. Gönen, there are more opportunities in Türkiye for the seed industry. Türkiye's growing agricultural and seed industry provides global seed companies with direct access to emerging markets in the Middle East, Central Asia and North Africa, which are increasingly important for agricultural trade and investment. Within a four-hour flight from Türkiye, one can reach 40% of the seed markets in the world.
Also, Türkiye's rapidly developing agricultural sector, with significant investments in biotechnology and seed development, will be highlighted, allowing Turkish companies to showcase their innovations and establish international partnerships.
"So, by hosting the congress in Istanbul, Türkiye aims to leverage its strategic location, emerging market potential and cultural richness to create a successful and impactful event for the global seed sector." Both Presidents say that: "We hope that in the future, we will have more business people coming to Türkiye, where there will be cooperation opportunities both on a technical and on a marketing level."

Constant growth

The Türkiyeish agricultural sector has experienced significant growth over the past decade. The average growth rate of the agricultural sector over the past two decades has been about 2.8%. Despite challenges, such as the corona pandemic and drought, the sector continued to develop. The agricultural sectors that have grown the most in Türkiye in recent years are cereals and vegetables. Türkiye is one of the largest producers of various grains, especially wheat and barley. In 2023, the total grain production peaked at 42.2 million tons. The production of fresh vegetables, such as tomatoes, has also experienced constant growth, with a harvest volume of more than 13 million tons in 2023.
As to the certified seed figures: total certified seed production in 2024 was 1.303.000 tons, of which 3.258 tons belong to vegetable species.

In the coming years, Gençer and Gönen also expect further growth of food production in Türkiye, thanks to strong, dynamic and widely supported innovation in the sector. "Here in Türkiye, there is a strong desire to play an important role in the world food supply. Therefore, from government to private enterprises, innovation is being stimulated."
Gençer and Gönen: "The Ministry of Agriculture and public research institutions are supporting innovations through policies, incentives and training programs. Universities develop new varieties, provide internships and research projects for students and researchers. Innovations in new production techniques, ecological/organic farming and providing technical support to farmers are crucial. Also, international organizations and NGOs provide technology transfer and training programs for sustainable agricultural practices."

Future opportunities

Looking ahead, both the presidents see several opportunities for innovations in Türkiye's seed and plant breeding sector. "Presence of a wide range of biodiversity, advances in genetic engineering and biotechnology will play a crucial role in developing new and necessary resilient plant varieties, because developing crops that can withstand changing climate conditions will be essential for future food security. Also, the continued focus on hybrid seeds should improve crop yields and quality."

Artificial Intelligence

Mr. Gönen and Mr. Gençer hope that in the coming years, in Türkiye and globally, increased investments will take place in the technical side of the sector, such as AI. "Artificial Intelligence started to contribute to the agricultural sector, particularly in the breeding, propagation and production of vegetables, fruits and ornamentals.
"Existing research and technological investments indicate that AI will play a crucial role in, for instance, supporting sustainable agriculture, making it a transformative force in the horticultural sector." The integration of AI technologies is expected to bring about significant advancements, also in other key areas, such as precision genetic analysis: "AI enables detailed

'Türkiye's growing agricultural and seed industry provides global seed companies with direct access to emerging markets in the Middle East, Central Asia and North Africa,' adds Burak Gönen

genetic analysis, allowing for the identification of desirable traits and the development of superior plant varieties. And AI-driven models can also optimize propagation methods, improving efficiency and success rates in plant breeding. Furthermore, AI helps in preserving genetic diversity by identifying and cataloguing various plant species and their traits."

We need innovations

AI can also play an important innovative role in the future of the production of fresh food. "AI applications in smart farming, such as automated irrigation and fertilization systems, enhance resource management and crop yields." AI-powered tools can detect and diagnose plant diseases early, enabling timely interventions and reducing chemicals and crop losses. And, also very important, AI can streamline supply chains, ensuring that products reach markets more efficiently and reducing waste."
"And we need all those innovations," Gençer and Gönen agree, "because unpredictable weather patterns and extreme climate events pose significant risks to crop production and sustainability. The same with limited availability of water, arable land and other essential resources which can constrain agricultural productivity."
Despite the promising advancements, several threats could hinder the growth and innovation of the Türkiyeish and global breeding and propagation sector. "What we are afraid will happen is that stringent regulations and varying standards across countries will impede the adoption of new technologies and innovations. Also, economical barriers appear: fluctuations in market demand and prices can affect the stability and profitability of the horticultural sector. And high costs associated with research, development and implementation of new technologies can be prohibitive for smaller enterprises. And don't forget the threat of nature, with drought, floods and diseases. Emerging pests and diseases can devastate crops, necessitating continuous innovation in disease management". Besides technical innovation, the key answer against these threats is, according to Gençer and Gönen, local and global collaboration. "Addressing these threats requires a collaborative effort from governments, research institutions, private companies and international organizations to create a resilient and innovative horticultural industry.

Optimism versus pessimism

The current global landscape is marked by turbulence, raising questions about the future of the breeding and propagation sector. Perspectives vary. In an optimistic view, both presidents see advances in biotechnology, sustainable practices, increasing consumer awareness and international collaborations. Those are positive developments that inspire optimism. But if you are pessimistic, you can see climate change, economic inequality, regulatory barriers and market fluctuations pose significant risks that could hinder progress.

A clear message

Therefore, Gençer's and Gönen's message to the global breeding and propagation sector is clear: prioritize sustainability, innovation and collaboration. By developing resilient and high-yield varieties, while preserving biodiversity, and working to remove barriers to seed trade, we can ensure food security and meet the growing demands of the future."

Hazelnuts play a leading role

John van Ruiten

Türkiye ranks seventh on the global list rating the size of agricultural producers. But even more impressive: worldwide, the country is the biggest producer and exporter of hazelnuts, figs, cherries, apricots, raisins and oregano.

Agriculture contributes to around 7.5% of the gross domestic product (GDP) of Türkiye, and over 15% of the Turkish people work in agriculture. Important agricultural crops are wheat, sugar beets, cotton and sunflower, but especially fruit and vegetables are major products. Although wheat is an important crop, Türkiye still needs to import from Russia and Ukraine.

No wheat exports

Wheat is grown in Central and East Anatolia, where farmers are not allowed to export wheat. Sunflower production is located mainly in Thrace. The total acreage for agricultural production is approximately 28 million hectares (which is 50% of the available land), of which 70,000 hectares is protected cultivation (mainly for vegetable growing) and of which around 8,000 hectares is in modern glasshouses. The Turkish government supports agricultural production of certain crops (cotton, oilseeds, potatoes, sunflower seeds) with subsidies. About 20% of average farm income in 2020 was realized through subsidies.

Corylus colurna is native to southeast Europe and southwest Asia. Türkiye classifies its hazelnuts based on the fat percentage instead of varieties

Fruit and beverage production (27 million tonnes) and vegetable production (32 million tonnes) are very important for the Turkish economy. Not only is the country mainly self-sufficient for its food and feed, but these products are also exported to many countries such as Russia, Iraq, Ukraine, Middle East and EU (25% of the fruit and vegetable exports). Greenhouse production of vegetables (tomatoes, peppers, cucumbers) is mainly located in the Mediterranean area (Antalya, Adana, Mersin).

Hazelnuts

Hazelnuts (*Corylus avellana*) and Turkish hazelnuts (*Corylus colurna*) are cultivated mostly in the northern Black Sea region, between Artvin, Trabzon and Kocaeli. The history of growing these nuts goes back more than 3,000 years. It can still be regarded as a family business and it is estimated that over 400,000 farmer families possess one or more orchards. The average size of an orchard is quite small at 2 hectares. Many orchards are on steep slopes.

One of the reasons that this crop became so important is that, at the beginning of the 1960s, the government launched a 'law on a guarantee of purchase'. Many peasants at that time started cultivation. Traditional cultivation practices with intensive labour are common. However, in the last 15-20 years, techniques have improved and new bigger orchards have been established. And still the total crop acreage continues to expand. More orchards are created and there are concerns about the availability of enough water. The water footprint of hazelnut production is high (10 m3 per 1,000 kg nuts). The expanding area with hazelnut monocultures also threatens biodiversity, according to environmental organisations.

A suitable climate and enough rainfall (or proper irrigation possibilities) are crucial for good tree growth. A mild summer and cool (not too cold) winter are preferred, and that is the reason why the Black Sea area is ideal for this crop, or as it is said: 'hazelnuts are very much in harmony with the region's climate' (800-1000 mm rainfall and temperature of 8-21 °C). The total amount of hazelnuts produced on 700,000 hectares is on average 600,000 tonnes per year, which is by far the most in the world (65-70% of the global production comes from Türkiye). The number two producer, Italy, has an annual production of around 100,000 tonnes. The total value of Turkish hazelnut production is around 1 billion US$. Nuts are exported to over 100 countries.

As in many crops, diseases can lead to huge losses. So-called brown marmorated stink bugs (*Halaomorpha halys*, found nowadays all over Europe in fruit cultivation), green stink bugs (*Chinavia hilaris*), powdery mildew (*Erysiphe polygoni*) and other diseases annually lead to financial damage of around 250 million US$ (25% of the crops' value). Another problem arises with working conditions. Many seasonal workers (also sometimes children) do the harvesting work and many immigrants work long days for low salaries.

But despite these serious problems, Türkiye is an agricultural giant with a broad spectrum of products.

Ir. J.E.M. van Ruiten is the secretary of the Prophyta Foundation

Laboratory could bring **salep** within everybody's reach

Monique Krinkels

With its thick creamy, milky taste, Turkish salep is one of the most fascinating drinks in the world. Unfortunately, its main ingredient are CITES-protected orchid tubers. In Türkiye, around 50 million orchids are – illegally – harvested in the wild each year for the preparation of salep. To prevent extinction, a novel approach is required: in-vitro propagation.

Türkiye possesses more than 170 kinds of orchid species, many of which are endemic. The terrestrial orchids in this country are the main ingredient for salep. The Turkish orchids are, however, protected by the international convention CITES (Convention on International Trade in Endangered Species of Wild Fauna and Flora) which completely prohibits their collection in the wild.

Tradition

The tradition of drinking salep stems from the 8th century. At the time, the Turkish people converted to Islam and, as a consequence, alcoholic beverages were banned. The hot milky drink salep was an alternative to warm people up during cold winter evenings. Until recently, that posed no problems. The traditional gatherers of orchids were wise, collecting only the young tubers, leaving the plants intact so the orchids could start to form new tubers immediately. Unfortunately today, the collecting of tubers has taken off. According to current estimates, around 50 million orchid tubers are illegally harvested each year in the wild for the preparation of the salep drink and dondurma ice cream. The latter is kneaded ice that melts very slowly. It becomes denser and more elastic the longer it is kneaded.

It takes 1,000 to 4,000 orchid plants to make a single kilogram of salep flour. To obtain the flour, the orchid tubers are pulled out of the earth before the plant blooms, boiled in water, left out to dry and processed into a powder. This flour contains glucomannam, a substance that makes watery liquids very thick and viscous. Another characteristic is that glucomannam retains its shape as a gel, even when the temperature or acidity changes.

In Türkiye, the top-quality orchids for salep, *Orchis masculata* (early-purple orchid) and *Orchis purpurea* (lady orchis), have been nearly wiped out by poachers as they do not leave any plants behind. Even the orchids in the surrounding countries are threatened with extinction. Neither park rangers nor conservationists have been able to prevent the sharp decline of the orchids in Türkiye.

Of course, the popularity of the drink stimulated the search for alternative sources for glucomannam. Dr. Oetker, among others, produces an instant Salep powder that does not contain orchid flour,

Recipe Tracing the exact origin of the Ottoman cuisine and its ingredients is almost impossible since the empire's Jewish, Christian and Muslim populations have been exchanging recipes for over twelve centuries. But it is certain that the main ingredient of salep, salep flour, has always been made from the tubers of orchid species found in the wild in Türkiye This beverage contains no caffeine or theine and is associated with various therapeutic properties, such as relieving coughs, soothing the stomach and even promoting healthy sleep due to its calming effects.

but the Turkish owner of a Dutch supermarket misses the typical salep taste. Pascal Lambé came up with another approach: tissue culture of these rare plants. His company, Phytesia, is a spin-off from the University of Liège, Belgium, and a pioneer in in vitro propagation techniques of rare and endangered plants. Today, the annual production of his laboratory has risen to 600,000 young plants of 150 species, mainly meant for garden enthusiasts. Obviously, far too little to replace the orchid bulbs collected in the wild in Türkiye.

The main obstacle for other companies to fill the gap is Access and Benefit-Sharing (ABS), the regulation of access to and utilisation of genetic resources and the sharing of benefits between providers and users. So far, however, no company has succeeded in coming to an agreement with the Turkish authorities. What could have been the lifeline for the Turkish orchids is still not being exploited.

The cradle of agriculture

John van Ruiten

In Türkiye, we are at the crossroads of civilizations. Due to its specific geographical position, especially the southeastern part of nowadays Türkiye (and northern Syria and Iraq) can be seen as a hotspot of historical evidence of early developing agriculture.

Three places in Türkiye are world famous if one is interested in finding remains of ancient civilizations in Eurazia: Cayönü, Catalhoyuk and Göbekli Tepe. From excavations, detailed information about living in these settlements and also about the cradle of agriculture can be found. Written evidence does not exist, of course, as the (Sumerian) nail headed characters (cuneiform) on clay tablets were only developed in the fourth millennium BC.

Hotspot

In the northern part of the so-called Fertile Crescent (Levant) around 10,000 years ago, shortly after the last Ice Age, the neolithic evolution began. I prefer the word evolution instead of revolution as the process of changing from the old hunter-gatherer society to a society with farmers and small villages, as we know now, was not a sudden change, but lasted more than 2500-3000 years.
During many generations, people combined both activities. Domestication of crops such as cereals (wheat, barley, rye) and pulses (peas, lentils and chickpeas) took numerous generations. Ancestors of modern wheat, such as einkorn (Triticum monococcum) and emmer (T. dicoccum), have been found here, as well as wild peas (Pisum humile, P. syriacum and P. fulvum), Cicer reticulatum and Lens orientalis. Here we are in Vavilov's centre of origin 4!

Cattle management

Cayönü Tepesi (near Diyarbakir) is seen as the first agrarian settlement in the Fertile Crescent. People lived there for more than 2000 years in the period 9000-6800 BC. Many traces of settled life and the beginning of agriculture can be found. Inhabitants had dogs and cattle management was developing. Cows, pigs, goats and sheep were kept and the domestication processes started. On the slopes of the mountains, relatively wild cereals (einkorn and emmer) were grown and bread was baked. Early (not yet domesticated) peas and lentils were also grown.
At the same time, the area demarcates the change from the Stone Age to the Metal Ages. At the site, there are ancient copper mines and the earliest known evidence of copper metallurgy were found. Tools and ornaments were made using cold hammering techniques. Excavations are still going on

and the site is also open to the public. Interestingly, in the same region, there are remains of old villages like Göbekli Tepe and Körtik Tepe that existed around 9600-8200 years BC.
In excavations, no findings nor indications have been found that agriculture was practised. Obviously, the region/fields provided enough food for hunter-gatherers to collect. Tools such as grinding stones and mortars suggest cereal processing. It is presumed that these settlements primarily had a religious function for ritual practises. The carvings at Göbekli feature a variety of non-domesticated animals, such as wild boars, snakes, lions, foxes, deer and birds. In the beginning of the 8th millennium BC, Göbekli Tepe lost its importance, probably because agriculture and animal husbandry became the new way of living.

Proto-urban

Another very interesting site, close to Konya, is Catalhöyük. This world heritage site was excavated in the early 1960s and it is regarded as the first Bronze Age settlement. It was inhabited during the period 7500 BC to 5950 BC and it is estimated that, on average, over 1000 people lived in this place (but there could have been years in which there were more than 5000 people). This 'proto- urban' village has only houses. No signs of public or religious buildings or temples have been found. Paintings on walls of animals, especially cattle, have been found. Houses were built like apartments, with no space between them. So people lived in very crowded conditions. Residents came and left their houses through ladders on the roofs. Catalhoyuk has strong evidence of an egalitarian society. Investigations show no or little social distinction based on gender. For men and women, agriculture, including animal husbandry, was important although hunting also continued to be a major source of food. Female figurines have been found on/within bins used for storage. Wheat, barley and peas were grown on fields outside the settlement and fruits, like almond and pistachios and other fruits, were harvested from the surrounding hills. The abundant presence of sheep remains suggest cattle domestication. However, the diet became gradually heavily reliant on grains, leading to health issues, such as dental cavities. Scientists also revealed that overcrowding, infectious diseases, violence and environmental problems started to arise in the small city. It is believed that environmental degradation of the surrounding area and climate change forced community members to move further away from the settlement to farm and find fruits, food and firewood. This probably caused the abandonment of the village around 5950 BC. The first example of a collapse of a civilization.

Catalhoyuk is renowned as the oldest town in the world. With its large Neolithic and Chalcolithic remains, it is the best-preserved city settlement in Cumra, Konya. It was built in about 7500 BC

Ir. J.E.M. van Ruiten is the secretary of the Prophyta Foundation

Santosh Attavar after one year in office

Niels Louwaars

Arthur Santosh Attavar was unanimously elected president of ISF in Rotterdam, May last year. That was no surprise because he had served as vice president the preceding years, showing his worth in the executive committee. This nomination can well be considered the first milestone in ISF's second century, welcoming its first Asian president, which indicates a further acknowledgement that the Federation is truly global.

Santosh Attavar, together with his sister Rashmi Attavar, run Indo-American Hybrid Seeds (India) Pvt. Ltd (also known as INDAM) which was started by their father, Dr. Manmohan Attavar in Bangalore, India in 1965. Everybody who knows him will concur that he is a pleasant person and a good communicator with a broad experience in the seed business, both in terms of crops, geography and operations. Also, during this interview, there were a lot of smiles and informal, personal small talk. He was happy to be interviewed for Prophyta so that we can learn a bit more about the person leading the global seed sector and presiding over the annual General Assembly in Istanbul.

Pioneering family

Santosh grew up in a pioneering family in the Indian seed sector. The Green Revolution had left plant breeding and seed production a government task. There was no obvious space for private initiative, at least not for the major food crops, but due to his background in horticulture, Dr. Manmohan Attavar began hybrid seed production, starting with petunia seed and later extending to hybrid vegetable seed production.

> 'We have so much to offer when the policy environment allows us to do so'

For his vision and contributions to the field, Dr. Manmohan obtained a wide range of awards and recognitions at state, national and global levels. This also earned him an honorary life membership of ISF.

Sixty years later, Indo-American Hybrid Seed (India) Pvt. Ltd. is still carrying out hybrid seed production, for expanding markets in India, on the Arabic peninsula and for the African market, with successful breeding and seed production operations for both vegetables and field crops. It was, however, not a given that Santosh would join his father in the company. He initially opted for studies in landscape architecture, but he soon shifted to horticulture. He ventured into the world, furthering his studies in the USA, to return to India as a seed (production), quality and seed testing specialist after several years. However, by that time, the company was too nice and exciting to let go. He joined his sister and now they are the proud managers of the company which, despite its name, is a wholly Indian-owned family business. When asked about the next generation, he reiterates that there is no pressure on them, and that one of his two daughters currently works in the USA. His other daughter works with him in the family business. However, while family members might not be the best managers, with the diversity of tasks in a seed company that works on a wide range of crops for many different markets, there may well be space for members of the next generation who want to spend their life in the world of seeds.

India

INDAM Seeds, together with a few colleagues, was instrumental in following and shaping the gradual opening of the seed policy environment in India. Today, Indian companies are spreading their wings beyond the borders of the subcontinent in Asia, Africa and further afield. When asked when Indian companies will be challenging the top seed companies in Europe and the EU, Santosh remains diplomatic; "That is a long way for most crops, but a few Indian companies have started operations in several countries. India has a number of clear advantages in terms of seed production, R&D, science is booming, with a private sector and a public sector that is open for collaboration. I expect that we will see some improvements on plant breeders' rights in the not-too-distant future, which are very necessary."

Santosh describes his company with a lot of passion. Diversifying and focusing go hand in hand, he says. Opportunities arise and the competition forces you to choose what you are best at. In the 1990s, INDAM Seeds expanded their portfolio and increased breeding of vegetable crops, along with hybrid paddy and oil seeds. Big successes were obtained both with tomato and okra, but global competition is very different in these two crops, so choices need to be made. Currently, hot pepper, onion, peas, hybrid cabbage and hybrid rice are important products for the company. However, Santosh sees the 'seed replacement rate' for rice increasing to such an extent that also in some regions, OP rice has also provided a good business model for seedsmen. Farmers' rights are especially important in the Indian seed ecosystem, but farmers do have a choice to decide whether to buy seed or save themselves, and that first option is growing steadily, especial due to rising costs and fluctuating climates.

'India has a number of clear advantages in terms of seed production, R&D, science is booming, with a private sector and a public sector that is open for collaboration,' says Santosh Attavar

Serving farmers

His LinkedIn profile gives further evidence of his position in the industry and in society: 'Serving farmers remains the core activity of the seed sector.' Being asked whether he can reach all farmers, he acknowledges that it is difficult for one company to reach 500 million plus farmers in India. But INDAM Seeds spends a lot of energy on extension activities, agronomy and research. "You need to have intimate knowledge of the true challenges that farmers face in order to help solve these through better seeds." The field staff at INDAM Seeds work closely with the public extension offices.

Even though the laboratory work has increased tremendously from its tissue culture origins for multiplying foliage plants to molecular biology in advanced plant breeding, INDAM's vision is to stay close to the farmers and their realities. This could create opportunities within the company to effectively connect the molecular scientists with the staff that are in farmers' fields most of the time. However, Santosh proudly illustrates that this is not necessarily a major issue. A laboratory staff member recently approached him to switch his role to breeding in the field, which allowed him to better position his role in the lab in the company - such instances are encouraging.

Associations

Overlooking the policy developments in India, Santosh is well positioned to see the value of associations. "The voice of the sector needs to be heard. We have so much to offer when the policy environment allows us to do so. There are still many instances when policies are made without sufficient scientific basis." Associations are important to convey the necessary policy options to the administrators. They have a much better licence to connect with them than individual companies. Involvement in policy debates also provides an opportunity to discuss certain aspects of the seed sector with the people and organizations that are critical.

Spending time and energy on the associations is essential and it is important that companies continue to invest in them! Participating in associations has a lot of benefits for yourself as well – investing time and energy in associations is also a good investment of time. "Travelling and meeting people enrich your views, which benefits both your own life and your company!" It is therefore important for seed industry executives themselves to engage in the associations at national, regional and international levels.

ISF-president

When asked what we can expect from his presidency, he is excited about the new set of key strategic objectives (KSOs) 2026-2030, that have been improved over the first set of KSOs, 2021-2025, so he does not intend to create additional changes. Continuity and focus are important, allowing the

Dr. N. Louwaars is the former director of Plantum, Gouda, the Netherlands

‘Managers don’t need to be the smartest in the room; they need to create a room where the team feels smart’, according to Santosh Attavar

formulation of realistic milestones for the policy work of ISF. He does, however, put some emphasis on three recently formulated general priorities: I) to pursue the roles of the sector towards smallholder farmers; II) to strengthen the awareness of the importance of women, both in farming and in the sector; and III) “we need to talk with the youth before it is too late”; agriculture is not the most popular sector for youngsters to develop their career, but we need them.
Moreover, he considers the relationship between ISF and regional and national seed associations to be essential. Recent travels in Africa and the Americas underline both the recognition that ISF has at those levels, but also the expectations of ISF to support them for their own development. All this, of course, alongside the important policy dossiers that affect the sector, and specifically the various aspects relating to the international movement of seeds. And furthermore, there is the positioning of the sector in the global debates about the future of agriculture and food security in a changing world.

Challenges

At the ISF-management level, there was a financial dip during the Covid period, when we did not have the annual Congresses for two years in a row. “Recently, however, after excellent congress results in Cape Town and Rotterdam, we are upbeat! Innovative ideas are being worked on by the Executive Committee and the Board towards longer-term financial stability and more outreach by our technical leads. The Secretariat works very well and most of the work is done by them under the leadership and guidance of our Secretary General, Michael Keller. Of course, we do face challenges when renowned specialists in a specific area of expertise leave, but it is a good sign that ISF can attract competitive new candidates in a challenging environment.”
Providing answers to the challenges for the organization is not up to the president alone. Santosh recently quoted the following in his LinkedIn account: “Managers don’t need to be the smartest in the room; they need to create a room where the team feels smart.” This reflects his style in his company’s ‘flat’ structure, with the management team taking decisions jointly. This is also his style in the ISF Board and Executive Committee, and with the Secretariat.

Changes

Throughout the interview, the word change comes up. Policies change and so do generations, opportunities and challenges. So, both companies and associations, including ISF, will have to continually keep looking forward and combine continuity with change to remain proactive in the policy debates and in its support of the member associations and companies. And in all that, there is a need for continuity in the vision and mission of the ISF: “To create the best environment for the global movement of seed and promote plant breeding and innovation in seed” in order to help create “a world where the best quality seed is accessible to all, supporting sustainable agriculture and food security.”

Approved as Novel Food

Does **duckweed hotch-potch** have a future?

Monique Krinkels

Earlier this year, the European Food Safety Authority (EFSA) officially approved duckweed for production and human consumption as a whole plant. This new vegetable – euphemistically called water lentils – is the smallest flowering plant in existence and combines high productivity with a high level of protein on fresh weight. The result: it is six times more efficient in production than soy beans and, moreover, a tasty addition to the menu.

It has taken Ingrid van der Meer, senior researcher and manager Bioscience at Wageningen University & Research, almost a decade to get approval for the introduction of duckweed as a new vegetable on the European market. “According to EU-regulations, all food that was not commonly eaten in the EU before 1997 should be considered novel foods,” she explains. “Despite the fact that duckweed (although other species) is a well-known crop in, for instance, Asia. That is why we had to submit a novel food dossier to EFSA in which we demonstrated that duckweed can be grown in a hygienic and controlled way and that the vegetable is healthy and safe for human consumption.”


© Wageningen University & Research

A water lentil hotchpotch is at least as tasty as the spinach containing alternative

Tasty alternative

“Duckweed contains many beneficial substances, such as anti-oxidants, vitamins and minerals, besides a high protein content. As a bonus, the plants score high on all essential amino acids compared to other vegetables.” In the study, the effects on the human body were examined. The test subjects ate large amounts of ‘water lentils’ (the word duckweed evokes disgust) to find out whether the proteins were properly digested and absorbed and what the effects were on health. In addition, the researchers wanted to know whether duckweed has a future as a vegetable. The test subjects were presented with a variety of dishes, such as soups, quiches and hotchpotches, prepared with spinach or duckweed. According to the participants, duckweed has a slightly nutty flavour. Others mention that the taste can be compared to garden cress when eaten raw in a salad.

Breeding

Breeding activity in duckweed is limited. One of the problems is that, although duckweed can reproduce via flowering, it mainly reproduces asexually. It does so, however, at an incredible speed, doubling a colony of plants in four to five days. New varieties are therefore primarily originating from selections.
Up to now, duckweed was a product sometimes used as feed. According to the Naktuinbouw Variety Testing Department, there have been nine applications for DUS testing of duckweed since 2009, eight *Lemna minor* varieties and one *Landoltia punctata* x *Lemna minor* hybrid. “When we receive a request for such a new species, we look at the taxonomy and the propagation and we collect relevant reference varieties from the wild,” says DUS specialist Judith Meijles.
She names a number of selection criteria upon which breeders can concentrate, such as the size of adult plants, maximum green colour (and therefore maximum chlorophyll), low light requirement (allowing growth in vertical farms), good absorption of nutrients by the roots and salt tolerance.

Next step

Question is: who will be the first to adopt ‘water lentils’. “It is not due to a lack of possibilities,” concludes Ingrid van der Meer. “It is mainly a matter of the food industry taking it further, but I have every hope that it will work out. Fortunately, I notice a lot of enthusiasm, although also caution. Growers, producers and supermarkets are looking at each other: ‘Who dares to take the first step?’ But a number of growers are testing it and some chefs are already experimenting with dishes in restaurants, so it is going faster than we initially expected. It would be wonderful if water lentils were on the supermarket shelves in about two years.”

A critical part of **crop protection**

Robert Gaffney

The agricultural landscape is rapidly evolving, with growers facing increasing pressure to produce high-quality crops while embracing sustainable practices. Biological seed treatments are emerging as a solution amid this shift, offering growers innovative solutions to enhance crop protection and soil health. This article explores the growing role of biologicals in seed treatment, highlighting their benefits, the science behind their development and their potential to advance crop protection strategies.

Biological seed treatments have been used as a natural crop protection method for centuries. While BASF released Poncho® Votivo®, the top-selling corn seed treatment in the USA, in 2010, the history of biological seed treatments can be traced all the way back to the early Egyptian and Roman periods. These treatments, derived from natural organisms, offer a compelling alternative or complement to traditional chemical solutions, helping farmers navigate challenges related to sustainability, pest resistance and crop health. Beyond their attractiveness as a natural solution, biologicals provide strong benefits beyond basic crop protection, including playing a critical role in nutrient management. One key example in seed treatments is the use of biologicals as inoculants to promote nitrogen fixation during the growing season.

Biological seed treatments promote more efficient water use, enhance nitrogen capture and conservation and reduce reliance on conventional spray and furrow treatments

Grower adoption

Even with their rich history, biological solutions like biological seed treatments are only recently seeing wider grower adoption. The slower integration can be attributed to a lack of understanding and knowledge of how biologicals perform, including limited grower knowledge on the natural variance in the efficacy of biologicals due to geography, climate conditions and soil type and grower expectations of biologicals in comparison to conventional methods.

In recent decades, the use of biological seed treatments has rapidly expanded, providing growers with an expanded toolbox of crop protection solutions. The increase in popularity can be attributed to several key factors:

- Growers know that meeting the food needs of a growing population will require new and inventive ways to increase crop yields.
- As they rely on the land for their livelihoods, growers also understand that better yields cannot come at the expense of the environment.
- With crop threats evolving at a rapid rate, growers need innovative management solutions that are both stable, sustainable and effective.
- While basic crop protection remains a necessity, soil and plant health are of equal importance. Modern solutions must balance effective protection with properties that strengthen the plant and maximize the capabilities of the soil.

The pressure on growers to produce high-quality, environmentally conscious products will only continue to increase. Biological seed treatments may be the key to meeting this challenge, providing both an alternative and a complement to conventional crop protection methods. These solutions balance sustainability with efficacy, helping growers navigate the evolving landscape of modern agriculture.

Modern agriculture

In its modern form, biological control - the use of living organisms and substances derived from nature to manage pests and diseases, improve crop protection management and support plants throughout their life cycle - has quickly grown into a burgeoning industry segment. Due to their nature and their positive environmental profile, biologicals are naturally tied to sustainable farming practices. Biological seed treatments are a prime example of these contributions in action. They promote more efficient water use, enhance nitrogen capture and conservation and reduce reliance on conventional spray and furrow treatments for crop protection. However, the growing role of biologicals in seed treatments goes beyond their sustainability benefits. These products deliver real value to growers in three key areas:

Complementary power: Biologicals are most effectively used as part of an integrated portfolio of solutions, including seeds, traits, crop protection, digital tools and sustainability approaches. Due to their benefits, compatibility and cost-effectiveness, biologicals will only continue to grow in importance as a component of a grower's portfolio.

Plant health: Biologicals, including biological seed treatments, are designed to target specific areas of the spectrum and perform a unique function, which can fill in key gaps in the current chemistry portfolio. Two powerful benefits beyond basic protection from pests and diseases are the impact of biologicals on the structure of the roots and, importantly, the soil itself. Within the soil, biologicals can improve nutrient uptake and cycling while reducing nutrient loss through plant-microbe-soil interactions. They can also foster the activity and diversity of beneficial soil, improve soil aggregation, reduce erosion and break down pollutants.

Value-added advantages: While chemical treatments provide proven protection, biologicals bring unique advantages that complement or go beyond conventional solutions. These include reduced residue levels, better resistance management and enhanced stress tolerance. Biologicals also extend the windows of pest and disease protection, offer more flexibility in harvest timing and improve nitrogen uptake—critical factors for achieving higher yields.

Key elements

Biologicals are made up of an ever-growing portfolio of fungicides, insecticides, seed treatments, beneficial nematodes and agricultural pheromones. Using BASF as an example, the following key elements show how biological seed treatments have become a consistent, reliable and effective option for growers around the world.

A rigorous development process: Biologicals come to life through a comprehensive creation process that takes a minimum of six years, start to finish. The process for biologicals, including the timeline, mirrors the process for chemical solutions in many ways. The first step, composed of initial and lab screenings by our global R&D team, is completed in approximately one year. Products that show promise are then field-tested for at least two years. Even if a product is showing consistently positive results in the first year of field testing, it is still tested for consistency in that second year.

At that point, the team begins work on formulation. The formulation may be a combination of a biological and chemical treatment, or the biological may be formulated as a standalone product. In parallel, we also assess regional interest in the products at this time, as well as beginning the regulatory work required for products to be approved, including outlining and initiating all possible paths to registration. As a result, by the time a product has passed through this process, it is eminently ready to come to market.

Ensuring efficacy and safety: One of the challenges in creating biologicals is ensuring that the products are stable and effective under varying environmental conditions, while also being safe for humans and beneficials. To do this, we prioritize extensive testing and quality control in all aspects of our process. Every product undergoes safety and compatibility testing with the goal of making sure there is no impact on the seed itself and that the solution will work

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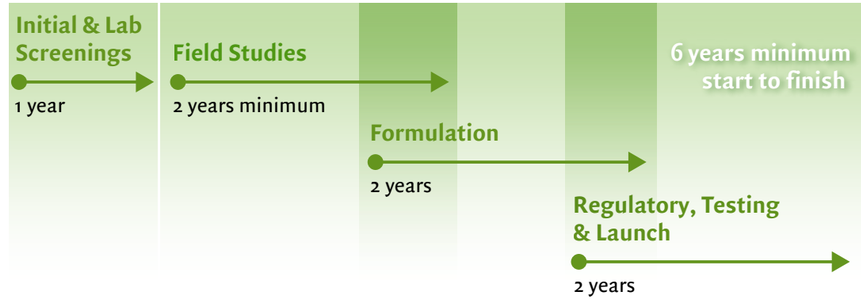
Biological seed treatment provides both an alternative and a complement to conventional crop protection methods



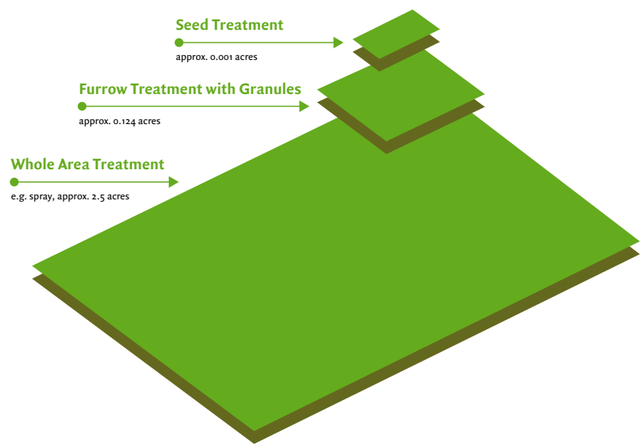
BASF biological seed treatment development process

Research and Support Teams involved throughout the full proces

effectively with other seed treatments. Compatibility is critically important in seed products, as multiple products often need to coexist on a single seed.
As with the R&D process, we design our multi-year testing around gathering consistent efficacy data. Because all of our biologicals are produced and quality-controlled in-house, we ensure that they meet all label claims. As grower and applicator safety will always be paramount, we are also focused on promoting good stewardship practices and investing in education globally.

Barriers to growth

As knowledge about biologicals has increased and more growers have seen the benefits in practice, adoption has grown steadily in the U.S., with Europe, Asia and other parts of the world close behind. The key barriers to accelerated growth for biologicals are the continuing misconceptions about the solutions and the potential for legislative changes that impact availability and use.
The most effective way to combat misconceptions is through a concerted, industry-wide commitment to education on the makeup, workings, uses and benefits of biologicals. The educational push should focus on the top misconceptions about biologicals: consistency and quality.
These concerns are particularly common because they have some historical merit; not all biologicals that have made their way to market have reached the standards set by conventional tools. However, many companies are committed to ensuring that biologicals are held to the highest standards of quality and consistency.
Because we have the expertise and infrastructure to perform scientific background checks, enforce quality control and complete multi-year testing, our products are held to an extremely high standard. We treat our biologicals with the same rigor and consistency as our chemical products, ensuring we get it right every time. Additionally, we always support our customers by addressing any questions or concerns they may have.
As with any solution, legislation can complicate the approval and acceptance of biologicals. As each region has its own unique regulatory framework, it is critical that organizations bringing biologicals to market prepare with that market diversity in mind. Ongoing communication between companies and regulatory bodies will be essential to address any concern and these processes should be activated as early as possible in the development process.



Benefits of seed treatment: smaller treated area

What is next

The future of biologicals in agriculture is extremely promising. Biologicals already provide a viable and valuable option for comprehensive and sustainable approaches to pest management and plant health, with many more innovations to come. As an industry, our goal should be to ensure that growers can produce high-yielding, quality crops and meet environmental and regulatory standards at a reasonable cost. We can achieve this goal through education, continued innovation and ongoing collective stewardship.

Tagetes erecta

The broad usability of **marigold**

Steven van Paassen

We are all familiar with the Tagetes yet may not fully appreciate its significance to the people of Thailand, India, Indonesia and Mexico. Tagetes flowers are deeply woven into the spiritual lives of these communities. "Don't call it Tagetes," says Jan Lippstreu, Group Crop Manager at East West. "The beauty of the flowers is better expressed by the name marigold."

Broad medicinal use

Since pre-Hispanic times, the *Tagetes erecta* has been used for medicinal purposes. The pigments of the Tagetes are due to the presence of carotenoids, of which the main one is lutein, which is associated with the prevention of the development of age-related eye diseases, such as cataracts and macular degeneration.
The most intense orange tones of the flowers are related to a higher content of carotenoids, especially xanthophyll. Some studies indicate the effectiveness of the latter in the prevention of coronary artery disease, heart attacks, immune response, old age and cancer.
In some regions of Mexico, it is used for digestive ailments, such as stomach pain, as well as diarrhoea, colic, liver problems, bile, vomiting and indigestion.
The plant also has a history of use against intestinal parasites and worms, with one study indicating that it has a different mechanism than the anthelmintic drug levamisole. Other uses include respiratory diseases such as colds, flu, bronchitis and nasal congestion, as well as gynaecological problems. Antioxidant activity has been discovered in the essential oil of this plant, although less than that of α-Tocopherol, possibly attributable to the presence of camphor and methyl eugenol.

Source: Eloidogy

In business, marigold is the common name for the *Tagetes erecta*, a business that spans different market segments. The main segment is what you can call the religious or spiritual use. "Especially in the Asian Hindu and Buddhist countries like Sri Lanka, Thailand, India, and the Indonesian island Bali, the marigold is very connected with those religions and praying in everyday life. Marigold flowers are used to decorate temples, to honour the spirits, and to colour celebrations," Soraya Jaranyanon explains. She is the owner/manager of Aga Agro, based in Thailand, and among other activities focused on breeding and selling marigold seeds. "And in Mexico, where the marigold originated, the marigold is very important during the Day of the Dead, when Mexicans pay their respects and remember friends and family members who have died."

Incredibly versatile plant

"In addition to its religious use, the marigold is an incredibly versatile plant," Mrs. Jaranyanon explains. "There is the pigment extraction, used in human pharmaceuticals, cosmetics and even to colour animal feed." These markets are mostly situated in China, India and Mexico. "Marigold is also globally used as a pot and bedding plant in landscaping. With their striking gold, orange and yellow hues, they are highly decorative," Mr. Lippstreu adds. "And marigold is also a very tough plant. This is really a key characteristic. As one of the few ornamentals, marigold can grow very well in the tropics as well as in continental climates. Rain, drought, heat, cold, high or low humidity; the marigold thrives equally well along the beach of Thailand and on balconies in Germany," Lippstreu laughs.

Natural resilience

For growers in Asian countries, marigold is also a practical product. Mrs. Jaranyanon says, "Marigold is easy to grow. It has a short growing period of about three months between sowing and harvesting. In general, only the flowers are harvested, yielding about 20 tons per hectare per growing period. That is a quick win. And with three growing periods, a grower can make an interesting amount of money."
Another benefit of marigold is its natural resilience. The plant is more or less resistant to common plant diseases. No pesticides are necessary for having a successful crop. "Therefore," Lippstreu states, "there is no economic sense in finding genes and/or markets for any extra resistance."

Especially in the Asian Hindu and Buddhist countries like Sri Lanka, Thailand, India, and the Indonesian island Bali, the marigold is very connected with those religions and praying in everyday life

Nightmare

Then why is marigold not a huge product in the world of seed and plant production? Some estimates suggest a world turnover at the farmer level of 400 million US$ for the flowers and about 150 million for the pot and bedding plants. Lippstreu explains: "Seed production of marigold is a nightmare. Its stigma is carefully concealed within the petals. To pollinate, you need a brush and a lot of time. If you are lucky, the pollination of the stigma is successful. One stigma is one seed. Each flower contains approximately 200 to 300 hidden stigmas. So it requires a lot of work, and the forecast of the amount of harvested seeds is of low reliability. Couple this with the challenging quality of the pollen, and it becomes clear why the economic margins for breeding and producing Marigolds are so narrow."

As one of the few ornamentals, marigold can grow very well in the tropics as well as in continental climates

Three multinationals

The global breeding of marigold is controlled by three internationals: PanAmerican Seed (part of the Ball Horticultural Co.), Syngenta Flowers and East-West Seed. Additionally, there are many more nationally and locally oriented companies active in Asia, including Aga Agro (part of the Ball Horticultural Company). These companies either produce their seeds themselves or outsource this to external contractors. Major production locations are in tropical areas, including Guatemala, Tanzania, and, of course, Asia itself.

Colour and yield

Regarding innovations in marigold, whose varieties are 99% hybrids, the views of Jaranyanon and Lippstreu differ slightly. Lippstreu says: "There are very few innovations in marigold breeding. Flowers mainly mean colour and shape. For pot and bed-

There are 3 species of Tagetes for commercial use

Tagetes erecta: Grows up to 25 cm (pot types) up to 120 cm (cut flower types); larger blooms; for flowers, cultural and religious purposes; all hybrids;
Tagetes patula: Grows up to 15-45 cm; more delicate blooms; for pot- and bedding; all open pollinated;
Tagetes tenuifolia: Very compact plants; small but abundant blooms; edible.

Jan Lippstreu and Soraya Jaranyanon with a basket of beautiful marigold flowers

ding plants, the focus is primarily on new colours, with white being one of them. The market share of white marigold is rapidly increasing. The demand and breeding of the cut flower market develops from spherical towards ball shaped flowers." For example: Floranova (part of Syngenta) has a reasonable new series of white Marigold named WhiteGold.
Jaranyanon is more enthusiastic: "Flower colour is indeed important, but we also focus on the post-harvest quality of the flower. How can it remain beautiful for longer during long-distance transport? Additionally, we focus on the growers' needs, particularly higher yields in terms of the number of kilograms of flowers per hectare."
This also contributes to a solid foundation for local marigold flower production. While it may not be very impressive worldwide, it is of great economic importance to many growers and wholesalers in Asia and of even greater cultural significance to its inhabitants.

Tagetes for nematode control

Even before nematodes were identified as damage-causing plant pathogens in India, the effectiveness of Marigold as soil improvers was already known. Sowing Tagetes patula or Tagetes erecta as a rotational crop on fields that are (heavily) infected with root lesion nematodes (Pratylenchus spp) or root knot nematodes (eloidogyne spp) can really help to greatly reduce the amount of plant parasitic nematodes. No full eradication will be possible but it is especially important in tropical regions. This 'Marigold treatment' allows for the cultivation of susceptible crops once more.
Sowing Marigolds in between other crops (intercropping) is not very effective, due to the fact that nematodes are not moving longer distances in the field. Nematode suppression comes from the specific compound alpha-terthienyl, present in Marigolds. This is excreted by the roots of the plants and it affects (kills) nearby nematodes and inhibits the hatching of nematode eggs. Being near UV light inactivates alpha-terthienyl. That is also the reason that there is no effect or benefit in using Marigold extracts.
The Tagetes crop normally has to grow a period of 3-5 months to 'do its work' in the period that the nematodes are active. Sowing in northern temperate regions is normally done in the month of June. Sowing must be done quite densitively to have roots everywhere in the soil. *T. patula* seems to be a little more effective than *T. erecta*. Specific varieties of especially *Tagetes patula* have been developed for nematode suppression, such as 'Ground Control', 'Nema Gone', 'Tangerine' and 'Cracker Jack'. The marigold biomass produced (on average around 100 tons of fresh biomass per hectare) is added as organic matter to the field and it has good long term benefits for improving the soil structure.

Sow to Grow

Sow to Grow is a so-called 'experience centre' where people can learn more about plant breeding and seed production. It is based on self-discovery learning, for instance by making changes in a giant DNA string to develop a healthy, red coloured sweet pepper, made visible on a large screen. Besides the regular visitors, the museum also receives school groups for a one-morning experience. Another activity is a 6-week course for new employees in the seed industry to learn about plant breeding, seed production and regulatory aspects
Contact: Sow to Grow, Westerstraat 111, 1601 AD Enkhuizen, the Netherlands, www.sowtogrow.nl, info@sowtogrow.nl

The experience centre Sow to Grow, in the Netherlands, inherited a vast collection of historical objects from the former national seed museum, Saet & Cruyt. From seed machines, plaster models, photographs, a library and watercolours, to the rare botanical books of the Weinmann collection. In this edition of Prophyta, the treasurer reveals another one of his favourites: the clipper.

The Saet & Cruyt collection contains a clipper from the early 1900s. It is a relatively small one, as nowadays, models are sometimes as tall as houses

Spotlight on

The clipper

Ramon Papa

In 1869, John E. Smith, after serving as a captain during the American Civil War, decided to change tack and bought a steam-powered flour mill in Shiloh, Ohio. In order to sift his flour better and save money, he made a small machine that he later sold commercially as a seed cleaning machine under the name 'The Clipper'. The name refers to the fast movement and low pressure on the product, properties it shares with the icy clipper storms in the region. The name 'The Clipper' does however not match what the device does: it is in fact an 'airscreen' (air for wind cleaning and screen for the sieve part).
Smith is often seen as the inventor of the first fine seed cleaning machine. He was, however, merely good at copying. As early as 1784, the Scottish mechanical engineer Andrew Meikle was at the cradle of the threshing machine, a device that pulls the dried ears apart and then pre-cleans them with sieves and air. Smith made a handy smaller and simplified version of it by removing the mangle part, the part that breaks and pulls the ears, from his machine. With finer sieves and the shaking system from the threshing machine - an improvement on a winnowing mill - he could deliver a better pre-cleaned product. He made a machine and concept that still stands today.
Although Smith is the founder, his former employee, Albert T. Ferrel, really made it a worldwide success. Where inventor Smith sold 200 machines between 1879 and 1891, Ferrel sold over 16,000 by 1946, when the first copies appeared. Even today, the A.T. Ferrel company produces many 'Clippers'. It is the most important machine ever built in the field of cleaning of all kinds of products. Not only for cleaning grain and seeds, the device is used at waste processors to separate our waste, but also at scrap metal dealers, in the plastic industry, the chemical sector and even in the gold industry.

PVP Toolbox Development Program

Sharing **expertise** across the globe

Muhammad Moazzam

The PVP Toolbox Program is a great example of what international collaboration and shared expertise can achieve. From policy guidance and technical training to hands-on capacity building, the comprehensive approach has led to meaningful improvements in plant variety protection systems across countries.

In today's rapidly changing agricultural world, ensuring food security and supporting innovation in plant breeding is more critical than ever. With rising economic pressures, climate change, shrinking resources and increasing health challenges, systems are needed that are both robust and adaptable to protect and advance plant breeding. To combat these challenges, the PVP Toolbox Development Program was launched in 2016. It is funded by the Dutch Ministry of Agriculture, Fisheries, Food Security and Nature (LVVN).

The PVP Toolbox brings Dutch expertise and best practices to countries across the globe. By aligning local procedures with internationally recognised standards, especially the UPOV model, the program not only boosts innovation and promotes Plant Breeders' Rights, but also ensures that farmers everywhere have access to high-quality plant propagating material.

Program overview

The PVP Toolbox Program is focused on sharing knowledge and building capacity. By emphasizing harmonisation and best practices, the PVP Toolbox supports countries in improving their plant variety protection (PVP) systems. It provides structured support that covers administrative procedures, technical training such as DUS (Distinctness, Uniformity, Stability) trials, high-level policy discussions and stakeholder engagement. These initiatives help national authorities and industry professionals to enhance their Plant Breeders' Rights (PBR) systems, which in turn contributes to a more secure food supply by making sure farmers can grow resilient, improved plant varieties.

This year's ISF Congress in Türkiye is a timely opportunity to reflect on the international impact of the Toolbox. Under a project with Türkiye back in 2018, a Dutch delegation visited Türkiye to exchange insights on Plant Breeders' Rights, compare administrative and technical procedures, and explore ways to adopt local reporting practices. Dutch experts shared the PBR framework of the Netherlands, including DNA techniques, GMOs and CRISPR-Cas methods, while Turkish counterparts shared their methods for seed registration, plant variety protection and DUS testing. This visit not only provided a clear understanding of Türkiye's variety testing landscape, but also fostered a practical exchange of ideas between experts from both sides.

Global engagement

Since 2016, in addition to Türkiye, the PVP Toolbox Program has supported the strengthening of PVP systems in more than 35 countries including Algeria, Argentina, Azerbaijan, Belarus, Bolivia, Bulgaria, Canada, Chile, China, Cuba, Dominican Republic, Ecuador, Egypt, Ethiopia, Ghana, Guatemala, India, Indonesia, Iran, Ivory Coast, Japan, Jordan, Kazakhstan, Malaysia, Mexico, Mongolia, Myanmar, Nigeria, Peru, Philippines, Senegal, Suriname, Switzerland, Taiwan, Tanzania, Thailand, Ukraine, Vietnam and United States of America.

A few examples:

PBR Training Course: Over the past 10 years, more than 45 experts from 21 different countries have participated in the Plant Breeders' Rights course for Food Security and Economic Development, with financial support via the PVP Toolbox. The course provides in-depth knowledge on plant variety protection, DUS testing and legal frameworks, equipping participants with the expertise to strengthen PVP systems in their respective countries.

Armenia: After joining UPOV in 2023, a series of initiatives, such as DUS training sessions and participation in Naktuinbouw's online PBR course, coupled with study visits to the Netherlands, were organized via the PVP Toolbox. In 2025, there is a plan for further DUS training in Armenia.

Ghana: Since 2022, Ghanaian experts have participated in both online and in-person courses on PBR and DUS training, along with seminars highlighting the benefits of these systems. An online session on denominations was held in 2024, and a five-day study visit to Naktuinbouw was organized. In 2025, another DUS training session will be organized in Ghana as well.

Japan: In 2024, a visit by Japanese experts to the Netherlands took place. The visit was focused on exchanging DNA data for tomatoes, potatoes and strawberries. It is a technical collaboration aimed at boosting infringement control.

Kazakhstan: Targeted activities in Kazakhstan have taken place during the past 6 years. In 2022, a training course was organized on Plant Breeders' Rights and variety testing, focused on potatoes and fruit crops. In 2023, PVP Toolbox supported an awareness-raising seminar and participation in the Dutch Business Week event. Additionally, a visit by Kazakhstani high-level officials to Naktuinbouw in 2023 and a visit by Kazakhstani parliament members in 2024 were organized, further strengthening bilateral cooperation.

Mexico: The focus has been on strengthening enforcement mechanisms. A forum in 2021 on Plant Breeders' Rights for ornamental varieties laid the groundwork for a 2022 initiative designed to boost local capacities for infringement verification. In 2023, a Mexican expert participated in Naktuinbouw's online PBR course, and an enforcement workshop was organized to further support local authorities.

These diverse examples from Türkiye, Armenia, Ghana, Japan, Kazakhstan and Mexico, as well as the participation in the PBR course, highlight the broad international outreach of the PVP Toolbox Program. The activities showcase the commitment to strengthen plant variety protection through tailored capacity-building and technical cooperation that truly makes a difference.

Program structure

One of the secrets behind the success of the PVP Toolbox Program is its streamlined, flexible approach. Unlike many long-term projects affected by bureaucracy, administrative or political hurdles, the PVP Toolbox operates within a short, targeted cycle that is efficient, direct and time-saving. Additionally, it achieves a significant impact while operating within a limited budget, making it a cost-effective tool. Such an approach is helpful in delivering timely interventions that address immediate needs.

The Dutch Ministry of Agriculture, Fisheries, Food Security and Nature (LVVN) has entrusted Naktuinbouw with the full responsibility of managing the PVP Toolbox Program. Naktuinbouw is the Netherlands Inspection Service for Horticulture and the entrusted and official body to carry out the DUS test for Variety Registration and Plant Breeders' Rights designated by the Dutch Ministry of Agriculture (LVVN), the Dutch Board for Plant Varieties and the European Union.

The PVP Toolbox applications open in September each year using a standardized application form. These applications are evaluated by Advisory and Steering Committees to ensure alignment with program objectives. Naktuinbouw oversees the entire process - from receiving applications, to coordinating evaluations, to informing and collaborating with participating countries. The successful applicants are notified in January of the following year.

Naktuinbouw facilitates the implementation of activities, closely monitors progress and financial expenditures and reports to the Ministry. Naktuinbouw utilizes its in-house expertise and national and international network to organize administrative and technical training, seminars, conferences and workshops, as well as providing policy support.

Committed to sharing its knowledge and experience, Naktuinbouw aims to strengthen global PVP systems and promote internationally harmonized standards.

Conclusion

As challenges in agriculture continue to evolve, the program stands ready to adapt, ensuring that farmers worldwide can rely on a secure and sustainable future. In a world where every seed counts, the PVP Toolbox Program is committed to nurturing innovation, protecting the rights of breeders and, ultimately, feeding the future.

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Photo: Naktuinbouw

A seminar in Tanzania highlighted the benefits of Plant Breeders' Rights and the DUS training

The **unexpected** role of ABA

Jeroen Balemans

As climate change intensifies, high salt levels in soils are a growing threat to agricultural productivity and global food security. While some plants can tolerate saline conditions, the underlying mechanisms that grant this resilience are not yet fully understood. Jasper Lamers and his colleagues at Wageningen University & Research have now discovered that the plant hormone abscisic acid (ABA) plays a previously unknown and vital role. This knowledge could serve as a basis for developing more salt-tolerant crops.

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Plants growing in saline soils must contend with both water scarcity (osmotic stress) and the toxic buildup of sodium ions (ionic stress). But why are some plants more tolerant of salt stress, while others are severely affected? This question is gaining urgency, as nearly a quarter of the world's irrigated agricultural land is now impacted by salinization. Climate change – through rising sea levels, prolonged droughts and increasing temperatures – is intensifying the problem, especially in regions where irrigation is widely used. Consequently, there is a growing need for crop varieties that can better withstand salt stress.

Researchers from the Laboratory of Plant Physiology at Wageningen University & Research (WUR) have recently uncovered new insights into this issue, revealing that the plant hormone abscisic acid (ABA), long known for its role in drought response, also plays a critical and previously unrecognized role in suppressing sodium-induced damage. The study, published in PNAS, focused on the plant's response in the first hours after salt exposure, a period often overlooked. Jasper Lamers, lead author of the study, shares his insights about the findings and their implications for plant breeding and the seed industry.

'The hormone abscisic acid (ABA) appears to dampen the sodium-specific reaction, helping to protect the plant from damage,' says Jasper Lamers

Your study focused on the early stages of salt stress, which is less common in research. Why did you take this approach?

"Most studies on salt stress look at the effects after several days or even weeks. We wanted to understand what happens immediately after salt exposure. Our hypothesis was that important molecular and cellular events occur within hours, and by focusing on this early time window – especially the first six hours – we discovered sodium-specific responses that are transient and were gone after 24 hours. These responses have thus always remained hidden in other studies. We show that early responses are critical for the plant's survival and offer valuable insights into early stress responses and adaptation."

What model did you use for this research, and how did you distinguish sodium-specific stress from general osmotic stress?

"We used *Arabidopsis thaliana*, a widely accepted model plant. To differentiate the effects of osmotic stress from sodium toxicity, we exposed seedlings to sodium chloride (NaCl) and compared the responses to treatments with sugars, which only induce osmotic stress, and with other salts. This allowed us to pinpoint which responses were specifically triggered by sodium ions and which were general stress reactions. The sodium-specific effects were particularly pronounced in the first hours and diminished later on, which highlights how crucial timing is when studying stress responses."

Your experiment also identifies a unique cluster of genes. What makes these genes stand out?

"We examined which genes in the plant were switched on or off in response to salt stress. We identified a cluster of genes that responded strongly to sodium stress but not to osmotic stress or other salts. What makes these genes special is that they are not controlled by the previously published sodium-sensing mechanism MOCA1. This suggests that plants might have multiple, independent ways to detect sodium. Even more surprisingly, ABA suppressed the activity of these sodium-responsive genes, which goes against the conventional view that ABA always promotes stress responses. Instead, ABA appears to dampen this sodium-specific reaction, helping to protect the plant from damage."

1. No salt and no ABA
2. Salt only
3. ABA only
4. Salt and ABA

The four images show how plant roots respond differently when exposed to salt and or pre-treated with ABA. These images show the halotropism response of the root, in which plants are grown for 5 days under sterile conditions on normal medium. Then, the lower part of the medium is removed under an angle of 45 degrees and replaced by medium with either control (normal medium) or medium with NaCl (Image 1 & 2). The black marks indicate the root tip at the removal of the medium. The NaCl in the lower part will diffuse into the old medium and will form a gradient. This gradient is sensed by the roots, which then respond by redirecting their root growth to avoid the high salt concentrations (Image 2). Here we have also shown that plants that were pretreated with ABA for 12 hours, followed by the introduction of the NaCl gradient did not redirect their root growth (Fig. 4). The plants treated with ABA alone (no NaCl) are not behaving differently than the control conditions

One of your key findings was that ABA suppresses sodium-induced stress. That seems unexpected?

"Yes, it was quite surprising. ABA is well known for its role in drought stress – it helps plants conserve water, for example, by closing stomata. But we found that ABA also plays a protective role in salt stress, specifically by suppressing the damage caused by sodium ions. This was especially evident in the root tip, which seems to be very sensitive to salt stress. When we pre-treated plants with ABA before salt exposure, we observed a near-complete suppression of cellular damage and sodium-induced changes in gene expression."

How did you determine that ABA was directly responsible for this effect?

"We conducted a series of experiments. First, we applied ABA before salt stress and observed both physiological and molecular responses. The ABA-treated plants showed intact root cells, no visible damage and a lack of sodium-specific gene activation. However, the application of exogenous ABA is very artificial and might not reflect the natural ABA levels. Therefore, we studied salt stress responses in mutants that are insensitive to ABA – these plants showed prolonged sodium-induced gene expression, more root damage, and more severe cell swelling under high salinity. This confirmed that ABA actively suppresses sodium-induced stress responses."

That challenges the prevailing view of ABA's role in stress responses, doesn't it?

"Exactly. Our study broadens our knowledge of the role of ABA during stress responses. Previously, ABA has mostly been studied as an inhibitor of germination or as a regulator of the plant water balance. Our findings show that under salt stress, ABA plays additional roles, like the mitigation of sodium-specific responses. While the exact mechanisms remain unknown, this novel role for ABA is important for both basic science and practical applications, as it shifts how we think about using ABA pathways in breeding or biotechnology."

How can this knowledge contribute to developing salt-tolerant crops?

"Understanding the early stages of salt stress gives breeders and researchers new targets. If we can enhance ABA signaling in specific tissues that are prone to salt stress – like the root tip –we might reduce sodium-induced damage without triggering the negative side effects of systemic ABA activation, like growth inhibition. There's potential here for tissue-specific gene editing, selective breeding for ABA responsiveness."

You mentioned the root tip as the most sensitive area. Why is that?

"The root tip is a zone of active growth, with rapidly dividing and elongating cells. This causes a mechanical conflict, as the increasing turgor pressure – required for rapid cell elongation – must be balanced by the cell wall. Our lab has previously published that cell walls are weakened by sodium ions and I hypothesize that the weakened cell wall cannot balance the increasing turgor pressure, which leads to cell damage. Somehow ABA's protective effect was most prominent in this area, possibly by altering cell elongation, or altering cell wall properties, suggesting that targeting this region in breeding or treatment strategies could yield significant benefits."

Finally, what's next for you and the team?

"I'm now working in WUR's Biochemistry department, focusing on how plants respond to mechanical stress caused by physical forces. My colleagues in Plant Physiology are continuing research into localized ABA signaling and how we might harness it for crop resilience. More broadly, I think that the research focus will shift towards early stress detection, as the way plants perceive their environment is largely unknown. If we can understand and influence how plants sense and respond to stress, we could make a big difference in agriculture's ability to cope with climate challenges."

A versatile **eyecatcher** cheers everyone up

Monique Krinkels

It can be feed or a snack, a food ingredient, a cosmetic ointment or used for frying, and it is also highly valued as an eye-catching ornamental - in the garden with a flower far above one's head, as a potted plant on the patio or in a vase on the coffee table. The sunflower is one of the most versatile plants you can imagine.

The most famous sunflowers are undoubtedly the ones Vincent van Gogh created. They are the most expensive too, as the estimated value of one painting of a vase with sunflowers is over 85 million euro. Van Gogh painted five large canvases of sunflowers, with three shades of yellow 'and nothing else'. In this way, he showed that it was possible to create a representation with many variations of one colour without losing any of its expressiveness. Van Gogh painted them in Arles, France, in 1888 and 1889. For him, the flowers were the symbol of inspiration, friendship and gratitude. Today, most consumers in northwestern Europe will associate sunflowers with cheerfulness, whether in a field in France as an oil producing crop or as an ornamental at home.

Museum

The words Sunflower, Van Gogh, Van Gogh Museum are almost automatically followed by Takii. For the last ten years, the museum and the plant breeding company have been cooperating in fun activities to mark the start of the sunflower season. "It all started in 2015, when the new entrance of the museum in Amsterdam was officially opened," says Harm Custers, head of product strategy at Takii Europe. "With 25 trucks filled with 125,000 sunflowers, we decorated the Museum Square with a giant Sunflower labyrinth. It attracted a lot of publicity; a photograph even made it to the frontpage of the New York Times. Since that event, Takii is official Partner of the Van Gogh Museum. We organise a sunflower happening every year at the start of the summer."

Takii was one of the first seed companies that added ornamental sunflower breeding into its portfolio. Today, the company is the market leader when it comes to sunflowers for cut flower. "It is our most important ornamental product. In Europe, it is mainly grown and marketed in the Netherlands, Germany and the UK." Around 1990, the first F1 hybrid Sunrich Orange was introduced. "It is still a very popular cut flower with professional growers as well as consumers. It is well-known, robust, pollen-free, has a long vase-life and a beautiful yellow-orange colour."

Sunrich has become a brand name, as Sunrich Orange was followed by Sunrich Lemon, Sunrich Gold, Sunrich Limoncello and more. "We have about 15 varieties for professional growers and 30 for the amateur market. In addition, we have a gigantic gene pool, consisting not only of the sunflowers Takii collected over the years, but also the collection Kees Sahin gathered. Sahin Seeds was taken over by Takii in 2007 and today is a brand name for the home garden market for pot and bedding plants, cut flowers, vegetables and herbs."

The gene pool is used, among other things, to introduce resistances against diseases. "Several of our varieties are resistant to downy mildew, but our R&D department does not sit still. Breeders are focussing on several fungi resistances, but I cannot reveal which ones, as yet." Crosses of Helianthus annuus with other Helianthus species enrich the possibilities.

The future of the sunflower looks sunny, according to Harm Custers. "It is a highly valued flower in northwestern Europe, as well as in the USA and Canada and many Asian countries. Of course, mainly in the regions where there are no farms with oil producing sunflowers. In the south of France, sunflower fields are too common for people to appreciate the crop." Furthermore, it is produced locally, does not require much input and is relatively easy to grow, making it an ecological friendly product. "The area with sunflowers is more or less stable and growers receive a reasonable price for the flowers. And with a vase life of ten days, consumers are eager to buy a bouquet with sunflowers. It is a flower that makes everyone happy."

Potted varieties

At Evanthia, the hybrid Sunsation series is one of its prominent products. They are compact pollen-free varieties in colours varying from lemon to deep yellow to bicolours. "We have been breeding sunflowers for over twenty years," says product manager Peter van Noort. "We have created a strong brand with Sunsation. With a height of 35 cm, the latest varieties are genetically compact, so no plant growth regulators, dry cycles or high EC levels are needed to keep the plants small. Regular watering and an EC of 1.2 is sufficient. With these varieties, we have created an answer to the worldwide demand for products that can be grown PGR (plant growth regulator) free."

Evanthia is the plant breeding division belonging to Nico Grootendorst, who started in 1993 with Combifleur. Evanthia is focused entirely on the breeding of cut flowers, pot and bedding plants, the propagation of tropical plants and seed optimization. The company has over 12,000 varieties in total.

If it is to be placed in a vase, most European consumers prefer a single yellow/orange sunflower with a brown heart, but in their gardens branched varieties in a diversity of colours steal the show

No new kid

One would almost say 'a new kid on the block' if it was not for the fact that Henk van der Velde started breeding sunflowers in 1996. Initially as a breeder at Combifleur. Later he founded his own company, H.W. van der Velde, which he sold to W. Atlee Burpee & Company in 2015. The latter company decided last year to concentrate its activities in the USA. "All in all, I have been breeding ornamental sunflowers for 29 years. This April, I started a new company, named 4C Genetics, together with my daughter Cille. We focus primarily on cut flower varieties for the professional market, but of course pot plants and the amateur market will not be forgotten," he explains.

"My first variety at Combifleur was Choco Sun, a compact potted sunflower with a branching plant structure. It was the very first ornamental sunflower that received European Plant Breeders' Rights and is still available." In 2003, Van der Velde developed Sunsation. "This variety is still the number one worldwide in the field of pot sunflowers from seed for the smaller pot segment (up to 15 cm)."

When he started his own company in 2006, Henk van der Velde focussed on cut sunflowers for the professional market with, for instance, the F1 hybrids Jua Maya and Jua Inca as a result. "We improved the production time with these fast-growing varieties. It takes only 60 days from seed to vase." At Burpee, he worked on the garden varieties, such as the Fleuroselect Gold Medal winner Desire Red. The Fleuroselect jury members praised it as 'a sensational dwarf Helianthus variety which dazzles consumers with its innovative, unique russet flowers. The deep, rich red colour makes it just perfect for the late summer range. This high performer is an early, profusely flowering variety - new blooms form continuously on its multiple branches well into autumn, and blend wonderfully with its dark green foliage'.

At 4C Genetics, Van der Velde is starting his activities with the super compact Petisol, which he bred three years ago and took over from Burpee. "It is a future-proof, sustainable variety because it does not need any plant growth regulators. This variety also requires less water." He continues to breed at the former Burpee facilities in Ridderkerk, the Netherlands. "The cut sunflower market is mega big and it is still expanding. Of course, resistance against downy mildew is a focal point, but we also concentrate on tolerance against the changing climate and daylength neutral varieties. And we want to use the abundance of genetic variation sunflowers have - colours, branching habit, length, leaves - there is much to choose from. European consumers are a bit conservative when it comes to cut sunflowers: yellow/orange with a brown centre is generally the preference. Not so for Asian and American consumers, who are more adventurous."

Henk van der Velde hopes to cooperate with the many friends he has made over the years. "I want to acquire a gene pool of varieties that are for sale, or from genebanks and institutes, and then create sunflowers that do not exist yet."

Adapting a plant to beneficial **soil organisms**

Monique Krinkels

The relation between soil microbiome and plant breeding has long been a 'too complicated for words' dossier. It looks like artificial intelligence might be able to change that. If it were possible to create enough data points, breeders might be able to develop plant varieties that make better use of the positive microorganisms.

The soil is a rich source of microbes. A single teaspoon of soil contains billions of microorganisms, such as bacteria and fungi. They break down organic material and make nutrients available to plants, they help plants withstand stresses, such as droughts or diseases, but can also cause diseases. The plant microbiome is a complex ecosystem where plants and unicellular organisms have evolved together. At Utrecht University in the Netherlands, biologists, among whom Dr. Yang Song and Dr. Roeland Berendsen, are studying the interactions between plants and microbes.

Early this year, Utrecht University presented its latest research. Using an AI tool, they were able to predict how well seed potatoes would grow into healthy potato plants. The AI tool was developed by biologists from Utrecht University in collaboration with Delft University of Technology and two potato breeding companies.

In their struggle with soilborne pathogens, plants have evolved to rely on microbial defenders that are assembled as part of the plant holobiont, the discrete ecological unit that comprises the plant and the microorganisms that associate and have coevolved with the plant

Although the plants grown in the potato field were of the same variety and genetically identical, they differed significantly in size, yield and resilience. In an article in *Nature Microbiology*, Yang Song and a team of researchers led by Roeland Berendsen show that bacteria and fungi on the surface of seed potatoes play a key role in these differences. The AI model used combined two types of data: genetic data from microbes living on the seed potatoes and drone images of potato plants that emerged from the seed potatoes. By analysing these two data sources together, the AI model uncovered patterns that help identify which microbes lead to the healthiest potato growth. "By combining these data points using AI, we could pinpoint the microbes that are the best predicators of potato growth," says Yang Song. "Some bacteria, including a *Streptomyces* species, are consistently associated with above average growth. Others, however, were conversely connected to poorly performing potato plants."

This research opens the door to a deeper understanding of how microbes influence crop growth. "By expanding the AI model with even more data, we can zoom in further to study how microbes and crops interact," Berendsen explained.

Boosting crops

Plants are colonised by microbes from seed, soil and air. They are able to selectively shape a microbiome with root exudates, which creates a microenvironment where certain microorganisms thrive. It helps plants, for instance, to protect themselves from pathogens. A 'cry for help' recruits beneficial microbes to increase resistance against the disease. It even helps the next generations as the soil is enriched with these disease-suppressive organisms, which prevent an outbreak in the future.

In the future, scientists might identify the perfect mix of microbes for specific crops – not just potatoes. "We could coat seed potatoes or seeds with these beneficial microbes," expects Berendsen. "Or even engineer plants to attract and retain the ideal microbes." It has been proven that plant genetics govern the assembly of disease-suppressive microbiomes. In addition, plant genetics can determine to what extent the plant can profit from beneficial functions in the microbiome. An improved understanding of how plants govern microbiome assembly and are sensitive to beneficial effects from the microbiome could ultimately form a foundation for the breeding of plant varieties that make better use of the unicellular organisms that surround them.

The benefits of this breakthrough go beyond higher yields. Healthier and more resilient crops mean fewer failed harvests, reduced waste and less need for chemical pesticides. This makes farming more sustainable while boosting productivity.

Evolving relationship with NPPOs

Katherine Delbridge, Jack Metzelaar, Cheni Filios and Rose Souza Richards

In recent years, the relationship between NPPOs and the seed industry has shifted from strict regulatory enforcement to a more collaborative partnership. Through the adoption of science-based risk assessment tools and the harmonising of international standards, NPPOs and the seed sector are collaboratively working toward solutions that safeguard plant health while facilitating the efficient movement of seed across borders.

Katherine Delbridge, Chief Executive Officer at the Australian Seed Federation, Jack Metzelaar, Director of Industry Relations at Limagrain Group, Cheni Filios, Compliance Manager at PanAmerican Seed, a division of Ball Horticultural Company and Rose Souza Richards, Phytosanitary Affairs Manager ISF, Nyon, Switzerland, R.SouzaRichards@worldseed.org

The global movement of seed is essential for modern agriculture, allowing farmers access to high-quality, diverse and resilient varieties. However, phytosanitary regulations, which are designed to prevent the spread of plant pests, can also pose challenges to seed trade efficiency and predictability. National Plant Protection Organisations (NPPOs) are responsible for implementing these regulations, but their timing and approaches vary widely across countries, sometimes resulting in trade barriers.

One of the most promising developments in this space is the Systems Approach for Seed, developed by the International Seed Federation (ISF). This approach moves beyond end-point inspections and seed health testing, focusing instead on comprehensive quality management throughout the production process, which has been standard practice within the seed sector for many years. Additionally, science-based regulatory approaches can increasingly guide NPPO decisions, ensuring that phytosanitary measures are based on verified risks rather than hypothetical concerns.

This article explores the evolving role of NPPOs, the challenges of phytosanitary regulations and the opportunities for greater harmonisation and collaboration in international seed trade.

Complex trade landscape

Traditionally, NPPOs have focused on strict enforcement of phytosanitary regulations, ensuring that imported and exported seeds meet national plant health standards. However, as the seed trade has expanded and become more globally integrated, so has the complexity of these regulations. No single country can independently supply its farmers with all the seed they require, in terms of both quantity and quality. Seed companies operate breeding, production and trialling programs across multiple locations worldwide to manage climate risks, enhance varietal performance and maintain year-round production cycles.

This global supply chain requires consistent and predictable regulatory measures. However, NPPOs often impose pest-specific requirements that vary across countries, creating logistical and financial burdens for the industry. For example:

– Lack of uniformity in phytosanitary certificate requirements forces seed companies to navigate a maze of country-specific regulations
– Sudden introduction of new regulations leaves exporters scrambling to meet unexpected testing or treatment requirements, considering that seed production requires at least six months from sowing, with some crops requiring up to 24 months
– Some NPPOs regulate pests without scientific evidence of seed transmission, resulting in unnecessary trade barriers

To address these challenges, NPPOs and the seed sector are increasingly working together to develop science-based, globally harmonised approaches that balance plant health protection with efficient seed movement, ensuring that regulatory measures do not become unintended trade barriers.

Harmonisation

The International Plant Protection Convention (IPPC) provides global guidance for phytosanitary measures, and two key standards - ISPM 38 (International Movement of Seeds) and ISPM 11 (Pest Risk Analysis for Quarantine Pests) - play a crucial role in shaping modern seed trade regulations.

ISPM 38: A blueprint for science-based seed trade: ISPM 38 acknowledges that seed is a unique commodity in international trade as it is often stored for extended periods, traded multiple times and subject to rigorous quality controls. The standard emphasises the need for science-based assessments of whether a pest is truly seed-transmitted before imposing regulations. However, many NPPOs continue to apply overly cautious regulations, sometimes including pests in import requirements, even when there is no scientific evidence to support seed as a transmission pathway. This contradicts ISPM 38's principles and creates unnecessary trade barriers that impact seed movement and availability.

ISPM 11: The importance of science-based decision-making: ISPM 11 provides guidance on pest risk analysis (PRA), emphasising that zero-risk is not a reasonable expectation in plant health regulation. It calls for a proportionate regulatory response based on the actual risk posed by a pest.

Despite this, some NPPOs impose overly restrictive measures such as:

– Requiring pest-free status, which is often impractical
– Implementing prescriptive testing methods, without considering equally effective alternatives
– Mandating treatments, even when other risk-mitigation strategies could be applied

These requirements create bottlenecks across the seed supply chain, increasing costs and delaying shipments. Farmers bear the ultimate impact, as delayed seed imports can lead to missed planting windows, lower yields and reduced access to high-quality varieties. In cases where overly cautious regulations limit seed availability, growers may be forced to use older, lower-performing varieties, ultimately affecting food security, prices and agricultural competitiveness.

Seed producers face additional testing and compliance costs, while seed companies must navigate complex and sometimes conflicting regulations across different markets. The costs of rigid phytosanitary measures ripple throughout the industry, reinforcing the need for a science-based, risk-proportionate approach that protects plant health while ensuring trade efficiency.

Left: Seed is a unique commodity in international trade

Right: Phytosanitary systems underwent a digital transformation

Photo's: Semillas PanAmerican Chile Ltda., Chile

A science-based assessment is needed to determine whether a pest is truly seed-transmitted

Based on science

To ensure science-based decision-making, phytosanitary regulations should:

– Rely on validated scientific data to determine whether a pest is seed-transmitted before imposing regulatory measures
– Adopt a science-based approach that aligns with international standards, such as ISPM 38 and ISPM 11
– Incorporate alternative mitigation strategies, such as the Systems Approach for Seed, instead of relying solely on end-point testing
– Encourage harmonisation among NPPOs to reduce inconsistencies in seed trade requirements

To support regulators in making science-driven phytosanitary decisions, industry stakeholders provide access to scientific databases and risk assessment tools. One such resource is the ISF Regulated Pest List Initiative (RPLI), which compiles scientific literature, industry expertise and regulatory data to assess whether pests are seed transmitted. This resource can be accessed at the ISF Pest List Database.

ISF's vision is to establish collaborative partnerships with NPPOs to develop a Systems Approach for Seed - a regulatory model that focuses on comprehensive risk management throughout the seed production process, rather than relying solely on end-point testing.

There are four key components of a Systems Approach for Seed:

– Seed production under NPPO-approved quality management systems
– Continuous monitoring and auditing of production sites
– Integration of multiple phytosanitary actions, such as field inspections, resistant varieties and seed treatments
– Incorporation of industry best practices in pest risk mitigation

This science-based approach offers an efficient alternative to prescriptive testing and rigid phytosanitary certification. Rather than testing for individual pests at the point of export, a Systems Approach monitors and controls pest risks throughout the entire seed production process, providing a science-based, efficient alternative to traditional phytosanitary certification.

Looking ahead

The future of phytosanitary regulation depends on a balanced approach that safeguards plant health protection while enabling the smooth and efficient movement of seed across borders. By embracing:

– science-driven risk assessment
– regulatory harmonisation
– innovative phytosanitary models, like Systems Approach for Seed

NPPOs and the seed sector can create a more resilient, efficient and sustainable global seed trade system. Collaboration and transparency between NPPOs and the seed industry will be essential in shaping a regulatory landscape that is both effective and practical. By working together, NPPOs and the seed industry can ensure that high-quality seed moves efficiently across borders, supporting farmers, food security and agricultural sustainability worldwide.

Pursuing more efficient **photosynthesis**

Hidde Jansen

Photosynthesis is one of the key factors influencing crop yield. In practice, however, we find that the efficiency of photosynthesis in modern varieties is far from optimal. Based on field studies, researchers from the Jan IngenHousz Institute (JII) are exploring the role that genetic variation and environmental conditions play on the efficiency of photosynthesis. As part of their research, they are developing advanced sensors and data science tools. Collaboration with other universities and breeders is crucial in this, says JII research fellow Tom Theeuwen. "We really want to see what's happening with photosynthesis in crops while they are in the field."

Climate change and population growth are putting increasing pressure on food security. To be able to feed the world whilst limiting the negative impact of food production on the environment, it is vitally important that crops are cultivated as effectively as possible. Photosynthesis – the process by which plants use sunlight to convert water and CO_2 into oxygen and sugars – plays an important role in this. The more efficient the photosynthesis, the higher the crop yield.

But the relationship between photosynthesis and yield is extremely complex, and that makes improving photosynthesis a huge challenge, says research fellow Tom Theeuwen. "The efficiency of photosynthesis in a crop is determined by various processes in the plant, which in turn are influenced by various genes – for which also variation exist. These processes are also dependent on external conditions like light and temperature, and the influence of these conditions also varies for each crop, genotype and growth phase."

Jan IngenHousz Institute

Understanding and improving photosynthesis is the key focus of the Jan IngenHousz Institute (JII). JII is an independent institute that was founded in 2022 by the philanthropic Photosynthesis 2.0 Research Fund and Wageningen University & Research (WUR), and is led by well-known photosynthesis researcher David Kramer. Scientists from many different disciplines are working on understanding, controlling and improving photosynthesis.

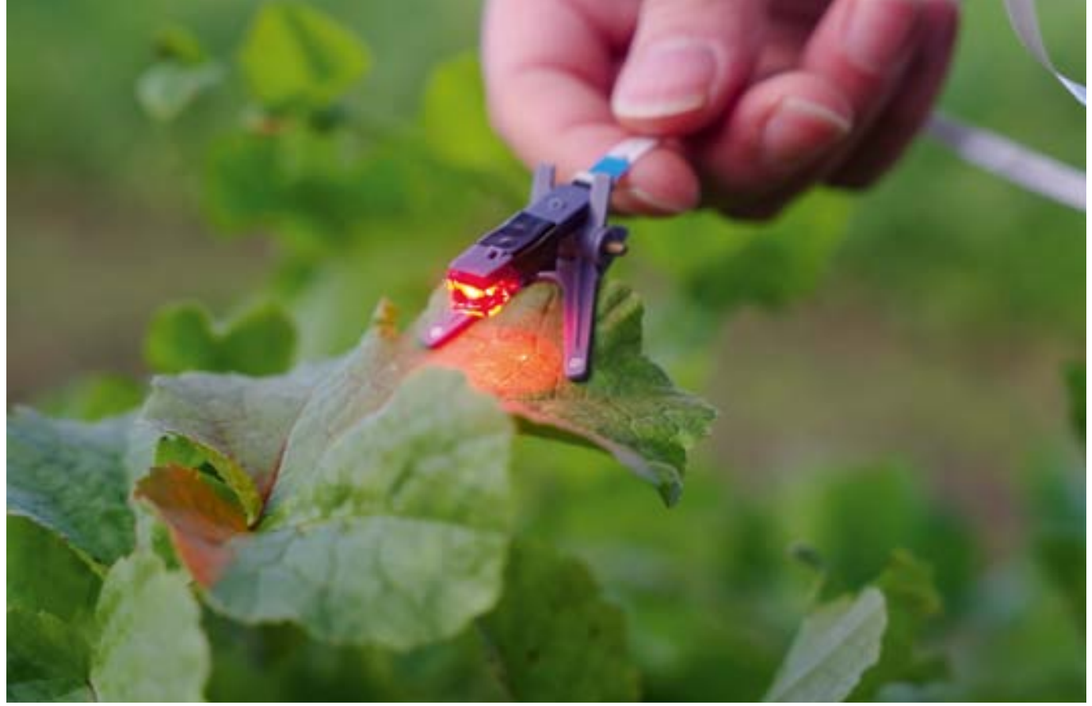
Theeuwen: "Much of the existing research into photosynthesis consists of individual projects, which requires finding new funding for each project. Through our institute, we can invest more broadly and long-term and put high-risk research on the map, ultimately creating more impact. That does not mean the end of photosynthesis research at WUR. We really are complementary, so the idea is that JII and WUR will collaborate on many projects and share knowledge. We will do this by aligning with existing research, as well as setting up new projects ourselves."

Research into making photosynthesis more efficient is not new, says Theeuwen. "But what distinguishes JII is our focus on genetic variation in crops and the use of large-scale field research. Currently, a lot of research is lab-based. That produces valuable knowledge, but these are controlled conditions, while many processes are influenced by conditions in the environment. And that environment is incredibly dynamic, which is impossible to simulate. Sunlight can change in a second, the temperature is constantly fluctuating, and a gust of wind blowing through a crop affects the humidity. These are all elements that influence photosynthesis. In view of the complexity of genetic variation and the influence of the environment, we really need to go into the field to gain insight into the real-life limiting factors for the efficiency of photosynthesis in relation to the crop yield."

Tom Theeuwen in the growth chamber of Netherlands Plant Eco-phenotyping Centre (NPEC), another collaborator of JII

Improve photosynthesis

To develop these insights, the researchers at JII use advanced sensors and data science tools. Theeuwen: "Good equipment to measure photosynthesis is available, but expensive. Moreover, the manual operation requires a lot of human involvement. That is a considerable limitation for any study, because a team of researchers can only measure a hundred plants per day. And it produces just one measurement per plant. What we want is to measure photosynthesis for thousands of plants continuously.



Prototype of a new sensor to make continuous photosynthesis measurements, developed by JII together with Michigan State University

So, one of the first things we did, in collaboration with Michigan State University, was develop a new sensor with the idea that we can then follow the photosynthesis of a plant from germination to harvesting."

This means that you don't need to go into the field every day, and you can monitor the photosynthesis of thousands of genotypes simultaneously and continuously, says Theeuwen. "The ability to continuously measure photosynthesis in detail outside really signifies a major step forward. We will then be able to link crop yield to the data about how photosynthesis responds to field conditions. We can measure crop development and yield by flying drones over the field a couple of times a week. By linking this data, we will hopefully discover which genotypes contain interesting photosynthesis properties and – even more importantly – under which conditions these properties are limiting for crop yield. You can then use these insights for plant breeding. Our ultimate goal is to provide breeders with the tools to improve photosynthesis."

Accurate and continuous measurements also produce a new challenge: a huge flow of data. Theeuwen: "A sensor measures twenty photosynthesis parameters and ten environmental factors on each plant. We receive those data, for example, ten times a second. Multiply that by a couple of thousand plants and several months. That's a lot of data! So we need to develop tools and methods to process all this data

Genetic variation

In addition to plant cell nuclei, DNA is also found in organelles. These are small, specialised compartments with specific functions, like chloroplasts and mitochondria. Both chloroplasts and mitochondria contain 100–150 genes that code for proteins essential to their function. For plants to function properly, optimal coordination between chromosomal, chloroplastic and mitochondrial genes is essential. Until now, however, little was known about the significance of organellar genetic variation and how it influences plant performance.

In a November 2024 paper from his PhD, supervised by Mark Aarts of Plant Genetics, Tom Theeuwen is changing that. In PNAS, the researchers demonstrate that genetic variation in chloroplast and mitochondrial DNA plays a key role in the variation in photosynthesis among Arabidopsis thaliana plants.

For their research, the authors developed a new method for generating so-called *cybrids* on a large scale. In a cybrid, the original chloroplasts and mitochondria are replaced by those from another plant. "By combining the chromosomes of one of four different Arabidopsis plants with the chloroplasts and mitochondria of one of 60 other Arabidopsis plants, we were able to create 240 unique cybrids," says Aarts.

This is the first time such a large set of cybrids has been produced, and it indicates that this approach could also be applied to agricultural crops, bringing a similar method within reach for plant breeding companies.

"In the past, it was very complicated and time consuming to study the contribution of chloroplastic and mitochondrial variation to energy production and photosynthesis in plants—but now it is feasible." According to Mark Aarts, this discovery expands the possibilities for plant scientists and breeders to explore and enhance energy production and photosynthesis.

A JII researcher in the field, working with the MultispeQ, a sensor developed by JII's scientific director David Kramer

Jan IngenHousz

The Jan IngenHousz Institute takes its name from the 18th-century Dutch physician and chemist Jan IngenHousz. Born in Breda, he studied medicine at the University of Leuven and moved to England soon after graduating.
With his idea of using inoculation against smallpox not individually but in groups, he became an important force behind the immunisation campaign. He treated George III's court, but also the village of Hertfordshire. As a mark of gratitude, he became the King's personal physician. He later travelled to Vienna to inoculate the family of the Austrian Empress Maria Theresa and subsequently served as court physician.
After his rise to fame, IngenHousz had plenty of time to do research. Among other things, IngenHousz discovered that the green parts of plants use light energy for growth, thereby laying the foundation for photosynthesis research.
Collaboration, diligence and integrity were important values for IngenHousz. Today, he is remembered as an open and critical global citizen, a social man with an international outlook. These are the values on which the Jan IngenHousz Institute aims to build further.

and link it to genetics and yield. To do this, we work together with data scientists from WUR. Due to the huge amount of data, we are also looking at solutions using artificial intelligence (AI). However, we need to use AI carefully. AI is incredibly useful for processing and making data-based predictions. But if you leave too much to AI, you will still not properly understand the extent to which photosynthesis is limiting for crop yield. Because you can't really see what's going on. And that's exactly what we do want to know."

Working together where it counts

Around the campus in Wageningen, preparations for the first field trials are underway. But JII is hoping to also do experiments using living labs in other regions. Theeuwen: "Also in places where food security-related challenges are a daily issue, like in Africa. Despite being based in Wageningen, we won't limit ourselves to WUR. The research fellows at JII are the linking pin in the various collaborative projects. You should see JII as a sort of club house where all the knowledge and innovation relating to photosynthesis comes together and cross-pollinates."
In its photosynthesis research, JII not only joins forces with knowledge institutes, but also with breeders. According to Theeuwen, that collaboration is very important for several reasons. "On the one hand because we need input, such as information about the current plant breeding practices and the genetic material, but also because we want our knowledge to be taken up in practise as much as possible. Breeders are ultimately the ones that market those new varieties. Therefore we see our role as gathering knowledge and developing sensors and methods for data analysis and interpretation, which can then be used in breeding programmes in which photosynthesis can serve as a marker. To ensure optimal alignment, we need to work together from the beginning. This means setting up field trials with businesses, for example, and we really encourage agriculturalists to get in touch with us."
The fact that JII embarks on collaborations with agriculturalists does not mean that the knowledge acquired will not be widely available, Theeuwen emphasises. "On the contrary, we follow the open science philosophy. Obviously, there is an element of confidentiality in proprietary information, but for us it's ultimately about the insights it delivers. We are currently building an open science platform on which photosynthesis measurements from our research can be viewed and used by others. In addition, we will use insights that we obtain in research projects to develop new sensors that we can then make available to other universities, institutes and businesses for further research or practical applications. We will be a global knowledge and innovation hub for photosynthesis research."

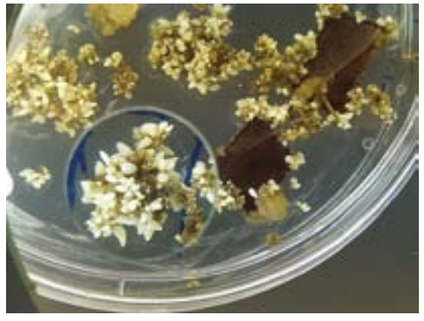
Revolutionary Plant Propagation

TIB system proves transformative potential

Alewijn Broere

SBW do Brasil stands as a testament to the success and scalability of a groundbreaking project. Through the development and implementation of TIB protocols, SBW do Brasil has transformed plant propagation across multiple sectors, including flowers, fruits and bio-energy crops.

Innovation in plant tissue culture took centre stage in 2007 when SBW International, alongside industry partners JHL Young Plants, Micro Cultures and Naktuinbouw, was recognized with the prestigious horticultural enterprise award. Their groundbreaking achievement? The Temporary Immersion in Bioreactors (TIB) system - a novel approach to producing high-quality, bacteriologically-tested plant materials for global markets. Initially designed for ornamental flowers in the Netherlands, the technology quickly found new applications in tropical fruit cultivation in Brazil, signalling a shift towards more cost-effective tissue culture methods.



Somatic embryos of Coffea arabica

Efficiency

Over the past eight years, SBW do Brasil has experienced exponential growth. Annual production has surged from 5 million plants supported by 60 employees to an extraordinary 50 million plants managed by a streamlined team of just 50 - a clear demonstration of the efficiency enabled by the TIB system. This success is largely attributed to the labour-saving benefits of TIB protocols, particularly evident in the final stages of propagation. Here, elongation and rooting processes are seamlessly combined, significantly reducing manual labour requirements while enhancing cost-effectiveness.
Moreover, the replacement of traditional agar growth mediums with advanced alternatives further promotes healthier plant growth, minimizes stress, lowers mutation rates and boosts survival rates during greenhouse transplantation. This synergy of optimized production phases represents a transformative milestone in tissue culture technology, delivering both savings and scalability to growers worldwide.

Agave plantlets in final stage of the TIB system

Science

At the heart of the TIB system lies a commitment to precision and innovation. While the physical components are relatively simple, the real breakthroughs lie in the enhanced growth mediums and carefully calibrated air circulation systems. These refinements minimize contamination and vitrification, ensuring robust plant development. The result? Healthier, more resilient plants that have drawn the attention of propagation companies worldwide.
Automation plays a pivotal role in SBW do Brasil's operations. Plants propagated through the TIB system are transitioned to trays via TTA-ISO planting machines and subsequently rooted in vertical farming systems. This streamlined approach not only reduces manual labour, but also optimizes logistics, allowing up to 40,000 plants to be shipped per cubic metre. The technology's adaptability is underscored by ongoing trials for eucalyptus production and the imminent release of sugarcane plants propagated in mini plugs.

Impacts

Extensive cost analyses demonstrate the economic viability of the TIB system for growers in Western Europe, where maintaining control over planning and production processes is paramount. By streamlining operations and eliminating logistical complexities, growers can effectively oversee the entire production chain, ensuring efficiency and cost savings.
In Brazil, SBW do Brasil has made a significant impact, not only by creating job opportunities, but also by driving advancements in domestic agriculture. Through its work, the company has contributed to the cultivation of high-quality plant varieties tailored to the Brazilian market, fostering both economic growth and agricultural innovation.

Alewijn Broere is director of SBW do Brasil, Holabra, Brazil, a.broere@sbwbrasil.com.br

Trials in vertical farming applying several types of LED illumination

Each of the five TIB Rooms at SBW do Brasil is 70m2 with a total of 3,000 vessels with plants

Introduction of our sugarcane vertical farming micro plug plantlets into the Brazilian market

New frontiers

Somatic embryogenesis represents a groundbreaking advancement in plant tissue culture, reprogramming somatic (non-reproductive) cells into embryonic cells capable of developing into complete plants - without the need for a seed stage. This sophisticated process offers a multitude of advantages, making it a game-changer in the field of agriculture and horticulture:
Rapid multiplication: Large quantities of uniform plants can be cultivated in a relatively short time, boosting efficiency for growers.
Genetic stability: The risk of mutations is significantly reduced compared to traditional propagation methods, ensuring consistent and high-quality results.
Broad applicability: This technique has been successfully applied to ornamental crops, tropical fruits, and bio-energy crops, extending its impact across diverse sectors.
At SBW do Brasil, somatic embryogenesis is employed to produce crops with high economic and environmental value, such as coffee, cacao, agave and various palm species used for biodiesel (SAF). By combining this innovative method with the TIB system and vertical farming practices, SBW do Brasil achieves a synergistic approach that further enhances efficiency, scalability and overall plant quality.
The integration of somatic embryogenesis within SBW do Brasil's operations not only reinforces its leadership in innovation, but also underscores the transformative potential of modern tissue culture techniques in addressing global agricultural challenges.

Future

With seven propagation companies licensed to utilize the TIB system and expectations for this number to double by 2025, SBW do Brasil is poised to shape the future of plant propagation. The company's journey highlights how collaboration and innovation can redefine global agriculture and horticulture, paving the way for a more sustainable future.

Celebrating 70 years of **onion breeding**

John van Ruiten

Onions, or Allium. One of the most important food crops in the world. Staple food and main ingredient of meals for many. Nowadays also an essential ingredient of an incredible number of dishes in kitchens. The Dutch world market leader De Groot en Slot was founded 70 years ago and is developing new onion varieties together with partner company Bejo. Time for an outline of the development of the onion crop, the breeding of new varieties and the company celebrating its anniversary.

Onions originate from Western Asia (Turkmenistan, Uzbekistan, Pakistan) and the Middle East. This region is still the source of great genetic diversity.
Once domesticated, man dispersed the onion from the Orient across the world. Subsequently, natural selection led to genetic adaptations to day length and climate conditions, and thereby to the development of a wide range of varieties.
The onion was an important foodstuff as far back as Babylonian times and the time of the ancient Egyptians. And moreover, the product kept well. Reputedly, a specific onion was a specialty in the Philistine city of Ashkelon. The name of the city is said to be the origin for the naming of the shallot (Allium cepa var ascalonicum). On tablets written in Cuneiform, recipes that contain onion, garlic and leek have already been recorded. Egyptians also considered the onion to be a symbol of eternal life and onions were taken into the tombs of pharaohs.

History

From around 500 BC, the Greeks, and later the Romans, distributed the appetizing crop throughout the Great Roman Empire. Onions were associated with strength and Olympic athletes, so the story goes, are said to have eaten copious amounts of them.
Not until the Middle Ages did the onion reach the more northerly regions of Europe. European colonists brought onions to Africa and South/Central America. The Pilgrim Fathers brought selections of the bulbous onion to North America. It is well known that also the Native Americans were already eating wild onion (Allium tricoccum). From the 15th century onwards, we see the onion appear in European recipes.
In several cultures (Hindus, Brahmins, Buddhists) onions were once considered to be unclean food.

Partnerships

DGS invests in partnerships aimed at, among other things, making production more sustainable. Also with particular attention to serving the organic market. In addition to the 50-year association with Bejo and Broer (onion sets), in 2025 an interest was acquired in De Groene Vlieg Bio Control (active in, among other things, breeding sterile insects to control onion fly).

Ir. J.E.M. van Ruiten is the secretary of the Prophyta Foundation

They were already used for their healing properties and for curing illnesses. Onions and garlic contain alliin, sulphuric acid-like compounds and have an antibacterial effect. There are plenty of health claims. The onions (and the peels) can also be used as a natural dye. But onions and garlic are also known for their smell and bad breath after eating them.
In the 16th century, famous botanists/artists such as Leonard Fuchs and Rembert Dodoens included images of onions in their books. They cite the healing properties, but also suggest that if you eat too many onions “your head becomes heavy and you become sleepy”. Onions played an important role in literature and artwork.

Current world position

India and China currently account for the largest production and consumption of onions by a considerable way. The current total world production is estimated by the Food and Agriculture Organisation (FAO) to be almost 95 billion kilograms (an average of more than 10 kg per person) per year.
In Europe, the Netherlands is the largest producer (approximately 30,000 hectares; with 1.5 billion kg production). A very large proportion of this is exported to countries such as Senegal, Ivory Coast, Great Britain and Indonesia. The global scale of cultivation and consumption of onions is still growing by around 5% per year.

Varieties

There are some 800 Allium species. The subgenus Cepa has 5 species, including *Allium cepa*, which in turn consists of two groups: the common onion and the aggregatum group, the cluster-forming onions, including the shallot. The cultivated onion is a biennial crop. In the first year the bulb is formed, then the flower stem in the second year. Onions flower when the temperature has been sufficiently low.
The bulb formation of onions is very dependent on the day length and the temperature. For the northern regions, in particular Europe, so-called very long day varieties have been developed, which generally also store very well. In addition, there are varieties for long day, medium day and short day (relevant in the regions roughly between the tropics).
Onion is a primarily cross-pollinating crop. As a result of selection, thousands of (local) varieties have been created with a large range of shapes, colours (mainly white, yellow, red) and flavours.
In the Netherlands, the selection of onions has been taking place since the 16th century. Many selections were created of which the Rijnsburger types, Zeelandic brown types and the North Holland straw yellow (flat) and blood red types were the most well-known. Targeted breeding in onion crops started around 100 years ago. In the first variety list of vegetables in the Netherlands (1943), varieties were mentioned such as Primeur, Galathee and Favoriet (all Rijnsburger type onions), Bola and Record (North Holland types) and Perijka, Wevo and Oranje as Zeelandic types.

Honey bees are the champion pollinators

Celebration of DGS anniversary

In November 2025, DGS will be 20 years old. This will be celebrated throughout the year with various activities. A tear-off calendar with history, facts, puzzles and recipes has been created. There is an open day for relations in November, an Award with a cash prize will be presented to an innovation that advances the onion sector and there will be a cultivation competition ‘The Biggest Onion’ for growers as well as children and hobbyists (the heaviest onion in 2024 weighed no less than 3055 grams)

These have always been open-pollinated varieties. Until hybrids were also developed around 1950. Nowadays, hybrids have become dominant for professional cultivation (both plant onions and seed onions). In the Netherlands, hybrids accounts for approximately 90% of this market.

De Groot en Slot

One of the companies that started to focus on the selection of food crops in the Dutch West Friesland region was the family business De Groot en Slot in Broek op Langedijk. At the beginning of the 20th century, Cornelis de Groot started crop selection. His father-in-law Cornelis Meurs passed on the tricks of the art of breeding and selection, as well as an onion variety developed by Meurs. Cornelis’ sons later created the Grobol onion variety, which appeared on the variety list in 1951. This successful variety was for them the start of further professionalization of breeding. In 1955, a collaboration with their brother-in-law Jan Slot led to the new company De Groot en Slot [DGS]. In 2025, the company will celebrate its 70th anniversary (*see* box).
In the Netherlands, the more targeted breeding of vegetable crops was given a major boost shortly after WW II, partly as a result of the establishment of the IVT (Instituut Veredeling Tuinbouwgewassen - Institute for Horticultural Plant Breeding) in 1943.

The total world production of onions is estimated by the FAO to be almost 95 billion kilograms

Resistance breeding has become more and more important

This also included the knowledge and technology of hybrid breeding. Seed companies picked all of this up. Including De Groot en Slot. Their first hybrid onion variety (Hygro) was introduced in 1968 and appeared on the variety list in 1973.
In the 1960s, seed cultivation of onions also started in Italy and France; later also in Spain. In collaboration with Firma Jacob Jong (Bejo Zaden from 1978), the company became one of the most important suppliers of seeds of onion varieties in Western Europe in the 1970s. More genetic material became available as a result of this merger, which in turn led to a breeding boost. Both companies also consolidated their sales organisation. Nowadays, the range consists of more than 200 varieties of onion, shallot, garlic and spring onion.
De Groot en Slot as a company can be considered as the pioneer in the development of seed shallots. In addition to varieties of the traditional shallot, which is propagated vegetatively, the company introduced an F1 seed variety in the early nineties. Varieties such as Creation, Ambition, Matador and Conservor came onto the market.
Hybridisation also ensured the cultivation and processing of a more uniform product. Subsequent hybrid varieties were launched onto the market.
And especially the major global growth of the onion cultivation area in the last 25 years ensured a stimulus for this crop. Open-pollinated varieties largely disappeared from the variety list for professional companies. And besides market leader DGS, other large onion breeders such as Hazera, Enza, Nunhems and Takii are now also active on the European and world market with their hybrid varieties.

Breeding goals

Breeding onion crops is a lengthy process. After initial crossbreeding, it is expected to take easily 10-15 years before the variety can be released on the market. Historically, properties such as storability, skin quality, thinner neck, earliness, uniformity and yield have been the important breeding goals and variety characteristics. Since the turn of the century, resistance breeding has also become more and more important. Major cultivation problems with downy mildew, leaf spot disease and Fusarium and the increased costs and reduced availability of crop protection products are the cause of this. Varieties with disease resistance are also attractive for the organic market and are widely used there.
In 2010, DGS introduced the Hylander variety, which has a high resistance to downy mildew, followed by Hysky in 2015, which is resistant against Fusarium. The search for resistances to various diseases is a major challenge.
In addition, the team of breeders at DGS is also working together with breeders from Bejo on, among other things, varieties with a stronger root system that are more resistant to drought and varieties that are suited to other cultivation climates and day length zones. Potential new varieties are being tested in 34 countries. Breeder Jesper Lam: “There is a shift underway towards robust varieties. New varieties must be able to be sown relatively late, be heat and drought resistant, but have enough of a wax layer to absorb rain. The foliage may also be greener in order to be less affected by thrips, a pest that is constantly on the increase. The changing climate also brings about a shift in diseases and pests, such as pinkroot and Stemphyllium.”
Ex-colleague breeder Jan Slot adds: “Another challenge for the team is the expectation that the approval for a sprout inhibitor will disappear. These sprout inhibitors are still badly needed to prevent sprouting, particularly during international transport of 6-8 weeks.” There is also especially a lot of focus on developing short day varieties for cultivation in countries near the equator. Asian and African countries around the equator are a growing market. That is a region where there is a shortage of good onion and shallot varieties that suit local markets, according to DGS.
For resistance breeding, natural resistances present in (wild) allium species are used. There is no work with GMOs. Both conventional and modern/new techniques are applied.

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