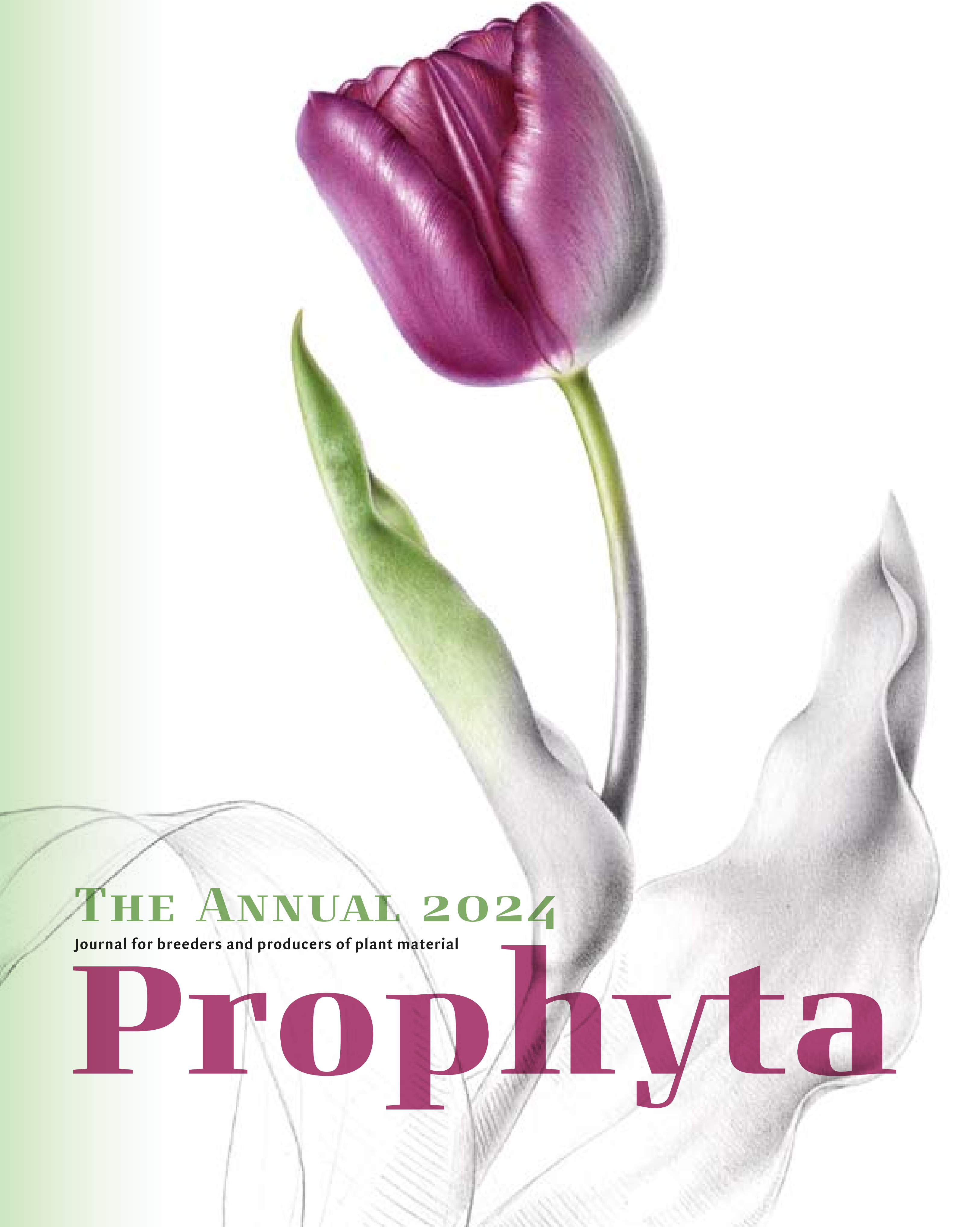

The Annual 2024

Journal for breeders and producers of plant material

Prophyta

Prophyta – The Annual 2024
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ON THE COVER: It is the extraordinary world of plants which inspires botanical artist Esmée Winkel. Plants tell intriguing stories and she aims to capture those stories on paper, sharing the sheer beauty of plants and their enormous variety in form and colour. Her work is on display at: Lindley Library, Royal Horticultural Society, UK; Hunt Institute for Botanical Documentation and New York State Museum, USA; Naturalis Biodiversity Centre and Hortus Botanicus Leiden, the Netherlands.

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Key findings of assessment

Aquaholder keeps seeds moist

Aquaholder anchors water molecules in the 3D structure of the absorbent, creating a hydrogel. When the concentration of water in the environment is lower than in the hydrogel, the water molecules will be released to the treated seeds

The Slovak company, Pewas, has introduced a hydrostimulation treatment of seeds, an innovative superabsorbent seed coating product called Aquaholder. It has been developed as a response to the serious problems of drought in arid or semi-arid regions or soils where the drainage of water into the subsoil prevents germination as the water is out of the reach for the seed. Climate change will cause severe problems for food security worldwide. According to the OECD, 60% of the global population will face water issues by 2050 and up to 50% yield lost is estimated by the same year in some African countries. For that reason, the EU supported the research by Pewas with a grant.

The treatment consists of applying a thin layer of Aquaholder as a film coating onto the seeds. Its active ingredient is a superabsorbent polymer. The coating is activated when the seeds are planted in the soil. There it binds water either from the soil or from precipitation, creating a moisture-retentive hydrogel around seeds, ensuring sustained water availability during germination and the early stages of growth. It functions as a water reservoir that is able to absorb 200-500 times more water than its weight and gradually releases the captured moisture around the seeds in times of drought. Aquaholder has been intensively tested by Eurofins and SGS, proving its value. The crop vitality is higher, germination earlier, the root system improved and the biomass increased. The end result is a considerably improved yield. The latest development is patented technology named Aquaholder Biosafe, a microplastic-free and environmentally friendly alternative of the product. Pewas is a research company focused on innovative applications of superabsorbent polymers in agriculture, the safety sector and railway infrastructure. Besides Aquaholder, the company has developed products and prototypes including flood bags filled with superabsorbents, a hydrogel-based extinguishing agent, 3Dsorbent of oil pollution and biodegradable oils. The team that developed Aquaholder consists of scientists with either chemical-technology or biology background.

Aquaholder was one of the top innovative products presented at Seed meets Technology last year and it has been a Top 2023 Seed Innovation in US according to Seed World Magazine.

Decline in insects induces plant evolution

The pollination of flowers is in a negative spiral

An ongoing convergent evolution of the selfing syndrome threatens plant–pollinator interactions. This is the conclusion of a study by scientists from the CNRS (centre national de la recherche scientifique) and the University of Montpellier. They discovered that flowering plants growing in farmland are increasingly doing without insect pollinators. As reproduction becomes more difficult for them in an environment depleted of pollinating insects, the plants are evolving towards self-fertilisation.

The French scientists used pansies as a model crop. They compared wild pansies currently growing in the Paris region with the same species that used to grow there 30 years ago. The latter were resurrected in the laboratory from seeds gathered between 1992 and 2001. The collected data showed that today's pansies are 10% smaller, have less vibrant colours, produce 20% less nectar and are less visited by pollinators.

This rapid evolution is thought to be due to the decline in pollinator populations in Europe. A study conducted in Germany showed that over 75% of the biomass of flying insects has vanished from protected areas in the last thirty years. The study identified a vicious circle in which the decline in pollinators leads to reduced nectar production by flowers, which could in turn exacerbate the decline of these insects. It underlines the importance of implementing measures to counter this phenomenon as quickly as possible and thus safeguard the interactions between plants and pollinators, which have existed for millions of years.

Plant DNA response to stress

Not all plants have the same overall efficiency of photosynthesis. A recent study proved that the grey mustard plant (*Hirschfeldia incana*), a wild variant of brassica, can maintain much higher photosynthesis rates at high solar irradiances than other plants. This is due to the fact that the plant has copied pieces of DNA that regulate photosynthesis. Plants are capable of adjusting to extreme circumstances by copying or deleting pieces of DNA. Plant researchers call this copy number variation. Sometimes, it consists of tiny pieces of DNA from just fifty base pairs. Sometimes, hundreds of genes are copied. When researchers at Wageningen University & Research compared the grey mustard's genome to that of other brassica species, they discovered that grey mustard had more copies of the genes that drive photosynthesis. Testing the various brassicas in the lab under limited and abundant light revealed that the relevant genes in the grey mustard plants were considerably more active, and the plants continued to grow under bright light. Follow-up research must now determine whether these properties can be transferred to other brassica species.

Corusco Cream-Red

Masterpiece Blue with Eye

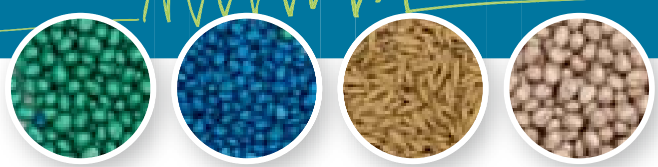
Fleuroselect presents new Gold Medal winners

During last year's annual trial, two breeding breakthroughs obtained an outstanding score in innovation, beauty and garden performance, and convinced our judges to award the Gold Medal. Van Hemert & Co came with an innovative dwarf variety of *Coreopsis tinctoria*, named 'Corusco Cream-Red'. This calliopsis has cream with burgundy-coloured flowers, a compact plant shape, attracts bees and butterflies and is drought tolerant. The plants flower from early spring throughout the summer.
Benary received a Gold Medal for its *Lobelia erinus* F1, named 'Masterpiece Blue with Eye'. It is the first F1 Lobelia from seed on the market that can truly keep up with vegetative F1 hybrids in terms of performance. The jury praised the luminous and eye-catching innovative colour and was impressed by the early flowering. The flexibility of seeds in terms of sowing, combined with the outstanding performance of cutting-raised varieties and intense blue large flowers, is indeed a true breeding achievement

Centenarian

When, in 1924, thirty seedsmen convened in Cambridge, UK, to establish a kind of cooperative, they could not have anticipated what their initiative would lead to. As Mr. E.G. Bell, President of the Agricultural Seed Trade Association of the United Kingdom at the time, put it: "You have material here which can be made to be of the greatest service to each other, and I regret to say you do not use it." Since that date, the FIS (as was the name of the original federation) and Assinsel (the breeders' organisation established in 1938), together today known as the International Seed Federation (ISF), has fundamentally changed the world of agriculture. It formed a foundation for the relationship based on mutual trust and respect between plant breeders and seed producers on the one hand, and farmers on the other. Together with ISTA, the International Seed Testing Association, who also celebrates its centennial this year, ISF has played a key role in ensuring seed availability and quality, and thus food security.
Unfortunately, global food security - defined when all people, at all times, have access to sufficient, safe, affordable and nutritious food for a healthy diet – has still not been reached. Today, as many as 309 million people are facing acute levels of food insecurity in 72 countries. But it could have been far worse, if it was not for an enormous increase in yields. In the past hundred years, the world population has grown from nearly 2 billion in 1924 to over 8 billion in 2024. Every single day, 345,000 babies are added to this number, while 118,000 people die. And each human being needs on average between 1,000 (2 years old child) and 3,000 (adult male labourer) calories each day.
True, the yield increase is not only due to new plant varieties. No doubt that improved agricultural techniques, the use of fertilizers and crop protection measures also had a positive impact. But a triple, or even tenfold, increase all started with better seeds. Plant breeding and quality seed production is a life-saving activity. After a century, it is about time the general public realized how important the sector is. Credit where credit is due.

Monique Krinkels



In Short

FlowerTrials celebrates anniversary

In 2004, a few pot- and bedding plant breeders started a joint promotion activity. They organized open days in the same week in June, to make sure international visitors could efficiently visit the companies, compare new varieties and get an overview of the trends. Today, nearly 60 companies showcase their novelties. In twenty years' time, the occasion has evolved into a key event within the global horticulture community. Participating breeders are spread over the Netherlands and Germany, bringing together leading breeders, growers, retailers and industry stakeholders from around the globe.

From 11 until 14 June, the latest trend in pot- and bedding plants can be discovered at the FlowerTrials. Today's consumers not only demand colourful plants, but also look for plants that are attractive to pollinators and thus feed insects. Furthermore, sustainability, disease resistance and adaptability to changing environmental conditions are high on the agenda.

More information: www.flowertrials.com

From technical insights to inspiration for the trade, professionals come together at the FlowerTrials to shape future trends in floriculture

Spinach helps fight landmines

Engineers of the Massachusetts Institute of Technology designed spinach plants to detect chemical compounds known as nitroaromatics, which are often used in landmines and other explosives. When one of these chemicals is present in the groundwater sampled naturally by the plant, carbon nanotubes embedded in the plant leaves emit a fluorescent signal that can be read with an infrared camera. The camera can be attached to a small computer similar to a smartphone, which then sends an email to the user.

"This is a novel demonstration of how we have overcome the plant/human communication barrier," says Professor Michael Strano. He believes plant power could also be harnessed to warn of pollutants and environmental conditions, such as drought. "Plants are ideally suited for monitoring the environment because they already take in a lot of information from their surroundings. They have an extensive root network in the soil, are constantly sampling groundwater and have a way to self-power the transport of that water up into the leaves."

The experiment is part of a wider field of research which involves engineering electronic components and systems into plants. The technology is known as 'plant nanobionics'.

Royal decoration for John van Ruiten

John van Ruiten provided a contribution of outstanding value to the community, according to His Majesty King Willem-Alexander (Photo: Naktuinbouw)

His Majesty King Willem-Alexander has appointed John van Ruiten to Knight of the Order of Orange-Nassau. It shows his appreciation of the rendered meritorious service of national and international importance. Mayor Astrid Heijstee presented the award during John van Ruiten's farewell as director at Naktuinbouw.

As director of Naktuinbouw and its legal predecessors, John van Ruiten worked with great dedication in the interests of Dutch horticulture for 39 years. In particular in the tree nursery, floristry and vegetable crop sectors. For example, Van Ruiten advocated the introduction of a European system. He helped ensure that phytosanitary and quality regulations, as laid down in various European regulations, were combined in such a way that an efficient system was created for business and (European) trade. Van Ruiten also participated in many projects to draw attention to the importance of a good plant breeders' rights system. And to help set it up. He helped countries in Africa, South America and Asia to take important steps in this complex world. He also used his expertise in agriculture and horticulture for the so-called 'Twinning projects' in former Eastern Europe. The Twinning projects support candidate countries in their accession to the European Union. This included the countries Latvia, Estonia, Lithuania, Poland, Bulgaria and Romania.

Van Ruiten is also active as chairman of the Dutch Association of Botanical Gardens (NVBT). This is an umbrella organization of 27 gardens spread across the Netherlands. He is a board member of the Netherlands Institute of Biology (NIBI). Last, but not least, he is a highly valued member of the Editorial Advisory Board of Prophyta. The journal would not be what it is today without his valuable advice and his many contributions.

100th anniversary celebrated with a book

ISF has published a book on the occasion of its centenary. In '100 Years of the International Seed Federation', several authors look back as to why and how seed companies decided to unite in one single association and collaborate in Cambridge, UK, in 1924, formulating international seed trading and arbitration rules. As Mr. E.G. Bell, President of the Agricultural Seed Trade Association of the United Kingdom at the time, put it: "You have material here which can be made to be of the greatest service to each other, and I regret to say you do not use it." Besides, the book portrays the national and regional seed associations, and give overviews of the Presidents and Secretary Generals from 1924 to 2024, the ISF member countries, the honorary members and the host countries of the congresses in the past hundred years. But it is not only a history book, it also covers the developments since the time of its foundation and what the vision and values of ISF are today. The book ends with an outlook to the future by the present Secretary General, Michael Keller.

A hard copy of the '100 Years of the International Seed Federation' can be ordered by emailing isf@worldseed.org. The price is € 20,00 plus shipping costs. The e-version can be downloaded on the ISF 100 Years website: https://100years.worldseed.org/100-years-of-history.

Gene expression of individual nuclei of pollen grains

An international collaboration has made it possible to perform single-nucleus RNA sequencing (snRNA-seq) successfully. In the collaboration, the transcriptomics technology of Takara Bio in Japan was combined with the nuclei isolation procedure of KeyGene in the Netherlands. Pollen grains contain two types of nuclei: generative and vegetative. The generative nuclei serve to fertilize egg cells. Vegetative nuclei are involved in the growth of the pollen tubes.

KeyGene scientists made suspensions with pollen nuclei, Takara Bio researchers ran their single-cell RNA sequencing technology. Takara Bio specialists also used KeyGene's knowledge about gene expression in pollen to interpret the data. Based on the expression of thousands of 'pollen genes', two groups of nuclei could be distinguished, assumably reflecting the active transcriptomes of the vegetative and generative nuclei.

Protecting the work of plant breeders

Niels Louwaars

It was December 1938 when eight men from France, the Netherlands and Denmark got together in Amsterdam, the Netherlands. They shared a vision to develop rewards for breeders. Their creativity and perseverance led to the introduction of plant breeders' rights, the protection system that breeders still largely depend on today.

Dr. N. Louwaars is managing director at Plantum, Gouda, the Netherlands, n.louwaars@plantum.nl

The founding fathers of what was to become ASSINSEL wanted to develop a business model for their trade. They did not consider the International Federation of Plant Breeders, that had been established thirteen years earlier by breeders (mainly at universities), the right forum to put enough emphasis on the needs of the private sector breeders. ASSINSEL, the International Association of Plant Breeders for the Protection of Plant Varieties, and the visionary people who drove it, can be credited with being the initiators of this internationally harmonized system under UPOV. ASSINSEL merged in the year 2000 with the Federation Internationale de Semences (FIS) into ISF, which celebrates its centennial this year.

Dealing with the problem

An important limitation of plant breeding as a business is that long-term investments in R&D are linked with easy opportunities to copy the product. The first actual plans to include plant varieties in patent law were created in the USA. A 'Bill to amend the laws of patents in the interests of the originators of horticultural products' was proposed in 1892. It was, however, not until 1930 that the Plant Patent Act saw the light. It extends patent protection to asexually reproduced plants, but not for edible roots and tubers, thus mainly protecting breeders of fruit and ornamental crops. Vegetatively propagated varieties are generally uniform and stable in their appearance compared to seed crops, where segregation and introgression occur. Exclusion of edible roots and tubers satisfied the political obstacle that protection could lead to strong controls over food and increased food prices.

Different countries had recognized the importance of breeding for farmers and food security. The Netherlands had created prizes for breeders at the agricultural show, which culminated in a breeders' fund, held by the seed certification agency that granted monetary rewards for breeders based in the acreage under certification. Germany had created a 'breeders' seal' on seed bags, a mark that indicated that the seed originated from the breeder. Danish breeders relied on the publication of the results of variety trials, which provided good promotion of the breeders of the best varieties.

The Amsterdam meeting led to the first ASSINSEL Conference, hosted by the French breeders' association in Paris, eight months later, in July 1939. The importance of this Conference was illustrated by the presence of Inspector General of Agriculture, Lecomte opening the sessions. Invitees from Sweden, Finland and Poland were unable to attend, most likely because of the political and security situation in Europe at the time.

The major issues discussed during the Congress revolved around protection, both mechanisms that existed in different countries and different intellectual property rights in other areas: patents, copyright and trademarks. In any system, the identity is essential. It was proposed to assign Versailles (France) with identity research on wheat, Svalöf (Sweden) on barley

At first, the secretariat of ASSINSEL was located on the Rue Ballu in Paris, France, but it moved to Solothurn, Switzerland, in 1973, to Amsterdam, the Netherlands, in 1978 and to Nyon, Switzerland, in 1981, where the secretariat of ISF is still located

At the ASSINSEL meeting in Nice, France, on 30 May 1957, a British rose breeder declared that, in the UK, sympathy for plant breeders' rights was growing

(Photo: Zaadbelangen)

2,500 years old

The history of intellectual property protection goes back to 500 BC, when the state of Sybaris in Greece granted one-year monopolies to chefs for culinary inventions. Another historic example is Vitrius in 200 BC who was a judge at a literary contest in Alexandria, Egypt. He exposed some competing poets for stealing the words and phrases of others. The false poets were then tried, convicted and disgraced for intellectual property theft. The very first plant variety that was granted intellectual property rights was a climbing rose bred by Henry Bosenberg, New Brunswick, USA, named 'New Dawn', who received Patent #1 in 1931.

and Wageningen (the Netherlands) on potato. The official certification of seed classes was considered essential for the breeder to implement rights, but the farm-saved seed was a reality in most crops as well. Breeders would be called upon to use a standard licence for the contract seed production, which was to be formulated by ASSINSEL.

Resolutions

The Resolutions (in English, summarizing the French report) read as follows:

"The institution of an International Register of names is urgent, and also an International Register of Synonyms with description of racial characters. The conference requests the official and private personalities to collaborate for the establishment of such Registers."

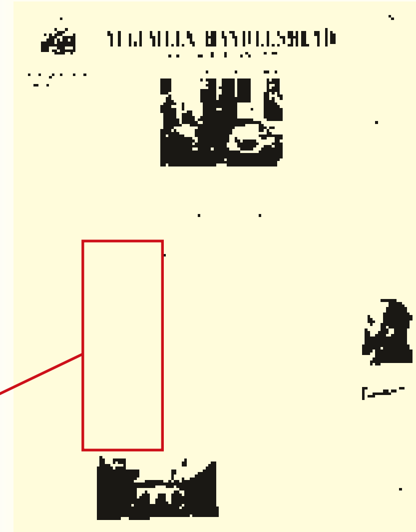
"The Congress requests the same personalities to accept internationally as a way of protection of the products of plant breeding, the Trade Mark Law and adapt the Model-Licence given by ASSINSEL. For each country which does not belong to the Convention of Bern, one is asked to try to obtain a legal form of deposit of marks."

After the Congress, the administrative office moved to Paris, whereas the legal seat in Brussels did not follow suit until 1958. The association had to delay any further activities because of the Second World War. After the inevitable break in activities during the Second World War, eleven people, including (the embassy of) the USA, met in 1946 and two years later 166 people from 14 countries participated in the conference, including representatives of FAO and national authorities. The presence of authorities proved essential later, when the results of the debates culminated in diplomatic conferences, including the one in 1961 that created UPOV.

Legal protection

During an ASSINSEL board meeting in 1950, the patent system was debated in detail with its pros and cons. Lack of stability of a variety was considered a major bottleneck for seed crops. Another was the strength of the right. France had, in its granting of a patent on a rose, decided that the protection only referred to the planting materials and had included a clause that the breeder cannot refuse a request for

In a Dutch newspaper from 31 December 1938, a journalist of Algemeen Handelsblad reported on the first meeting of plant breeders in Amsterdam



International alliance of breeders for the protection of new varieties and breeders' property

We have learned that a meeting took place in Amsterdam between private breeders and selectors of agricultural seeds, originating from various countries, which resulted in the establishment of an International Federation of Professional Breeders, chaired by Mr Ernest Tourneur, scientific breeder in Coulommiers (Pr.). Messrs. P. J. Hylkema and A. R. Zwaan were appointed for the Netherlands, whilst Mr Th. Boersma in Groningen was appointed the provisional secretary of the day-to-day management. The aim of this international organisation will be the protection of new varieties (obtentions végétales) and breeders' property. Mr Tourneur pointed out the desirability of a good relationship between official authorities and individual breeders and expressed the opinion that the task of the official organisations should be restricted to recognizing new varieties (as happens here in this country with the Institute for Plant Breeding in Wageningen), but that once a variety has been recognized, the breeder must remain free to propagate and sell his varieties. Everyone at the meeting was in full agreement with this; a second meeting will be held shortly to determine the work programme. In view of the N.A.K.'s endeavour to keep the original agricultural seeds under its control, the above initiative deserves full attention. It appears that this endeavour is contrary to the intentions of the international breeders and that they are seeking unity in defence of their rights. Undoubtedly, this step will prove significant for the future development of the issue of breeders' property, which is increasingly becoming the centre of attention.

In: Algemeen Handelsblad, 31 December 1938

Vegetable breeder Andries Zwaan was one of the founding fathers of ASSINSEL

a licence. The Dutch delegation responded that the system that had been in operation there since 1941 could be a solution to the remuneration of breeders, without linking it to the patent system.
The Netherlands had established a new form of rights which provided automatic protection on plant reproductive material of each variety duly registered. This system, operated through the seed certification system, basically created a tax on each hectare of seed production, which is used to pay both the breeder and the seed certification procedure. An important prerequisite for this system to work is that all seed trade is done under the registered variety name. In time though, also the Dutch realised some limitations of that system providing a right on remuneration only and moved on to develop an exclusive right in the 1960s.
In 1953, the scope of protection was discussed, notably the importance of the use of a protected variety for further breeding and the protection of harvested materials, specifically cut flowers.

Conciliation and arbitration

From the start, there have been many personal links between ASSINSEL and the International Seed Federation, but a formal connection was discussed in the framework of the ASSINSEL Charter, adopted in 1955, and the Arbitration Chamber proposed by Mr. Roscioni from Italy in that same year. The ASSINSEL Board invited FIS to join this chamber. This proposal made the relationship between breeders and seed traders a bit complex and in 1956 FIS disagreed with the plans of the breeders.
During a meeting in Malmö in 1959, a Conciliation Commission was discussed to resolve issues among breeders and between breeders and producers. In Bologna in 1961, legal counsel, Mr. Noilhan, presented bylaws for the 'Commission of good offices and arbitrage of ASSINSEL', which aimed to settle disputes among members amicably and which could also turn into an arbitral tribunal.

Involvement of officials

During the first meeting after the Second World War in January 1946, ASSINSEL included in its bylaws, among other issues: "to get in touch in every country with the official organisations charged with the acceptance of new varieties, and invite these to participate in the ASSINSEL Committees." This translated in the presence of Mr. van Leeuwen of the Netherlands Inspection Service and Mr. Laclaviere of the French Ministry of Agriculture in several meetings from 1949/1950 onwards to provide legal advice. A special meeting of lawyers from the different countries was called in 1955 to discuss how similar rights could be recognised across these nations. ASSINSEL had to deal with diverse opinions, not just among the countries, but also between agriculture and horticulture. In the 9th congress, in May 1957, in addition to vegetables (initially Zwaan) that had been represented from the start, also prominent ornamental breeders (Meilland, Delbard from France; Taggiasco from Italy) took part, who were less used to government involvement than the field crops breeders.
Mr. Laclaviere had prepared the ground for an international conference that finally took place at the invitation of France in 1957. That same year, ASSINSEL President Tourneur was invited to meet with the FIS office in Amsterdam. The outcome of that meeting: "The recognition of the breeder's right must not create an abusive monopoly in the distribution of the product. Abusive monopoly is understood to mean the setting of a licence fee that is too high, the possibility of creating any organization or creating artificial shortages, to cause an artificial increase in prices or to distort the conditions of free competition and the traditional distribution of products." It made clear that FIS recognized the needs of the breeders, but that the seed traders would require clear boundaries.
Twelve meetings of specialists chaired by Mr. Bustarret, Inspector General in the French ministry, worked to prepare a text, closely monitored by ASSINSEL, whose members approached their national governments for support.

Founding UPOV

This work bore fruit four years later. André Heitz, in his extensive analysis prepared for the occasion of the 25th anniversary of UPOV, adds Ernest Tourneur of ASSINSEL and André de Vilmorin of FIS to the 'founders of the UPOV Convention'. The Convention, presenting harmonised principles for the protection of plant varieties through a 'sui generis' system and establishing the Union for the Protection of New

Founding fathers

The role of effective protection for the diversity of breeding companies is still an important debate. That we can have this debate in ISF, representing directly and indirectly thousands of plant breeders, is to a large extent due to eight individuals back in 1938.

Ernest Tourneur, descendant of a family of cereal breeders and seed producers in Coulommiers, France, close to Paris. He was elected president of the new organization ASSINSEL in 1938. Ernest Tourneur received a Dutch knighthood for this contribution.

Alphonse Bataille stems from a sugar beet and cereals breeding company in Frétin, France. His sugar beet programme was taken over by Florimond Deprez and is now part of SES-Vanderhave.

Jens S. Fruergård was breeder at Pajberg Fonden, an initiative established in 1920 in Denmark, to support breeding of cereals, fodder beet and forages. He was assisted by his compatriots **Henrichsen** and **Larsen**, the latter working on forages at Larsen & Danielsen, later Trifolium and DLF. Neither appeared in later ASSINSEL records.

Jan Pieter Dijkhuis was connected to the established Mansholt family of breeders. He became partner in the trading company Landbouwbureau Wiersum in 1928.

Theunis Boersma joined Wiersum in the 1930s and acquired full ownership in 1946.

Andries Zwaan, a vegetable breeder in Voorburg, the Netherlands, and member of a family involved in several vegetable and field crop seed companies. His company became part of Nickerson-Zwaan, currently Limagrain-Hazera.

In 1956, the FIS Congress took place in The Hague, the Netherlands. One of the highlights was a meeting in the Ridderzaal (Knight's Hall), a 13th century building where King and Parliament convene once a year

(Photo: Zaadbelangen)

Seventy years ago, the delegates at the seed congresses were almost all male, the women in the photo were accompanying persons

Varieties of Plants (UPOV), was signed on 2 December 1961 by Belgium, France, the Federal Republic of Germany, Italy and the Netherlands. It defined, among many other details, the key definition of 'variety' and the criteria of protectability: Distinctiveness, Uniformity (Homogeneity), Stability and Novelty and a suitable Name.

It furthermore defined the scope of protection and the exemptions to the right, notably what became known as the 'breeders' exemption' and the 'farmers' privilege'. These aspects clearly distinguish the right from those conferred by the patent system. Initially, subscribing countries should protect at least five crop species, which should gradually be increased. A minimum duration of 15 years was prescribed (18 years for trees and vines).

Ongoing discussions

Discussions on different aspects of the UPOV Convention started right after its publication, such as the implementation of the farm-saved seed exception, the rules for compulsory licences, the relation between variety names and trademarks (1967), acceptance of DUS-reports from other UPOV members (1972), the duration of protection for crops like potato, the protection of cross pollinating species such as sugar beet (1975), and the protection of inbred lines (1975), followed by debates on the protection of hybrids, and the use of electrophoresis in DUS-testing (1980). That year, the first contacts were made with the CGIAR about the status of their varieties when the Mexican government was intending to claim ownership over its varieties. That discussion went hand in hand with the International Undertaking on Plant Genetic Resources for Food and Agriculture in 1983 and subsequent rules on genetic resources.

The introduction of the PVP Act of 1970 in the USA created quite some discussion. It deviated quite a bit from the UPOV rules, notably regarding the DUS tests and the almost absolute farmers' privilege, but the fact that protection of seed crops would be possible there, was welcomed.

A discussion that would keep ASSINSEL on its toes was started in 1977: the protection of genes. The conclusion that this could block the free access to genetic resources was reconfirmed in 1988. This discussion became more important following the first patenting of a life form (a bacterium) in modern time in the USA in 1980 (Chakrabarty case), which was discussed in ASSINSEL in1982. The patenting of a hybrid maize three years later, fuelled the discussions about the relation of breeders' rights and patents.

The 1989 meeting created a list of positions towards strengthening of the breeders' rights, most of which were included in the revision of the UPOV system in 1991. Major changes were the introduction of the concept of essential derivation and the reformulation of the farmers' privilege. These themes continued to dominate the discussions in ASSINSEL until the association was legally dissolved with the creation of the International Seed Federation.

Dynamics of the sector **redefine** strategies

Niels Louwaars

Associations play an important role in the seed sector, as illustrated by the 100-year existence of the International Seed Federation and the size and relevance of its Congress in Rotterdam. The history of Plantum, the association for seeds and other planting materials in the Netherlands, dates back to 1908 and was built on earlier collaborative structures.

Plantum wishes ISF a great centennial year and a bright future

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Seed and seed quality has been a concern for all farmers since the dawn of agriculture. The production of seeds for planting has commonly been an integral part of the crop production practice since most major food crops - such as cereals, pulses and oil crops - are produced for their seed. This is not so much the case for most vegetables and forage crops that require specific actions to produce seeds. It is for such crops that seed production and trade by specialised people developed early-on. Given its position as a trading nation, a wide variety of Mediterranean, continental and Scandinavian crop seeds were imported and took root in the Netherlands in the 18th century; currently the Netherlands is the largest exporter of seeds and planting materials.

First association

Vegetable seed exports initially went through the distribution channels that were developed by the flower bulb traders, who created their own association AVB (the General Bulb Growers' Association) as early as 1860. Around that time, the vegetable seed sector, with some forty renowned vegetable seed brands and several distributors, developed its own channels. The centre of local seed trade thus moved from Haarlem, in the bulb production region, to Hoorn, where seed producers and traders regularly met in café 'In the Old Seed Market'. The traders were operating in the Netherlands, but several were active in international seed exports as well, with profitable markets as far as Russia and North America.

A court case about damages caused by poor quality lettuce seeds in 1908 was the trigger for seedsmen to develop General Trade Conditions for the sales of (vegetable) seeds in the Netherlands Association of Seed Traders (VNZ), a true predecessor of Plantum. Trade rules and arbitration were to became the first focus of the International Seed Federation when it was established 16 years later. The VNZ soon became an important partner of the Dutch Government when the First World War resulted in a wide range of regulations on production and trade, including seeds.

But not all was good with the initial association. Already in 1914, a number of seed retailers left and created their own association, as they considered the wholesalers and exporters too dominant. In 1919, exporters created a sub-association, and other associations were emerging such as the Association of Netherlands Cereal Seed Traders. Quality was thus a major concern that was to be tackled collectively. The Cereal Seed Association and the VNZ jointly created the General Inspection Institute for Cereal Seeds, Seeds and Seed Potatoes (KIZ) in 1919. KIZ merged in 1932 with inspection services run by provincial farmers' organisations that had been in operation since 1888, to form the current seed inspection service (NAK). The associations were closely involved with 20 the annual negotiations on seed standards at the 1877 created Seed Testing Laboratory in Wageningen, and the first list of recommended varieties which appeared in 1924. In 1928, the Federation of Seed Producers/Traders was created, combining most of the different seed associations, thus forming a strong front for the sector for field crops and vegetable seeds.

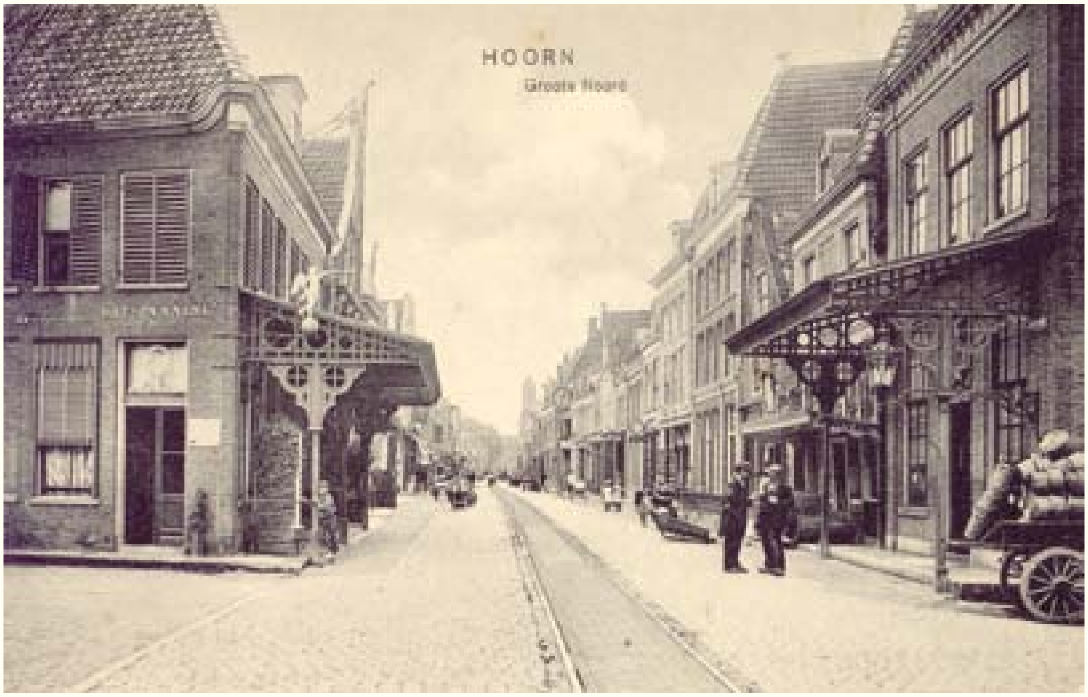
The Breeders Union (Kwekersbond) saw the light in 1927, as a national division of the 'Association Internationale des Sélectionneurs de Plantes de Grande Culture' (International Association of Plant Breeders of Major Food Crops) that was created two years earlier. In this 'union', public and private breeders met, initially speaking about science mainly, but later very much involved with variety testing and registration issues. From 1932 onwards, it acted as an association, independent of the international one, and increasingly connected with the private sector association ASSINSEL, which was created in 1938.

However, it still appeared difficult to merge the interests of the different factions of the seed trade. An important tool for supporting a strong collective spirit in the seed sector was the seeds journal 'Zaadbelangen' which started as a weekly magazine in 1948, published by the vegetable seeds association together with the inspection service for vegetable seeds. In the late 1980s its name was changed to Prophyta, when it developed an international publication for the FIS/ASSINSEL Conferences. Currently, Prophyta is only an English-language journal appearing twice a year at the ISF Congress and the Euroseeds Congress.

Towards the current model

Not until the 1980s were significant changes made. It resulted in a merger of the VHZ, the 'Association of Traders in Field Crop Seeds' with the Breeders' Union

'In de Oude Zaadmarkt' (In the Old Seed Market) on the right is a former seed exchange and café in the Dutch town Hoorn. Between 1807 and 1909, seed traders and vegetable growers met in front of the café to sell and buy seeds. Afterwards, traders came together in café 'In de Oude Zaadmarkt', while the growers retreated to café 'De Witte Engel' (The White Angel) across the road to discuss their purchases. Many seeds were supplied from nearby Andijk and one of the best-known traders was Nanne Jansz. Groot (1771-1855). His descendants founded, amongst others, Sluis & Groot (today part of Syngenta / ChemChina), Royal Sluis (today part of Bayer), Royal van Zanten and East-West Seed (Photograph: Vereniging Oud Hoorn, www.oudhoorn.nl)



into the 'Association of Breeders and Traders of Seeds and Planting Materials' (NZP). In horticulture, similar mergers produced the 'Netherlands Association of Horticultural Seed Companies' (NTZ). Already two years later, in 1992, agriculture and horticulture united to create a stronger representation to the government because many important priority issues, such as those related to the seed law, concern all crops. The new name was NVZP, 'The Netherlands Association for Seeds and Planting Materials'. NVZP also strongly involved itself in the research infrastructure in Wageningen, where the private sector was increasingly looked upon to co-finance projects. Finally, in 2001, a further merger became possible, between NVZP and three other organisations: the ornamental breeders' organisations Ciopora-Nederland, many members of the 'Association of Flowers and Plants Wholesalers' (VGB) and the 'Association of Young Vegetable Plant Raisers' (NVP). The new name became Plantum – a merger of the word Plant and '(U)itgangs(M)ateriaal' (Propagation Material). Plantum thus indeed represents the whole sector – from grass seed to gerbera, and from breeding research through breeding, multiplication, conditioning and young plant production to the trade of plant reproductive materials. Only the trade of seed potatoes and flower bulbs remained connected to their crop associations, whereas the breeders of these crops joined Plantum. This merger further increased the membership base and thus the influence of this broad sector at the national level, as well as enabling staff resources to support the seed associations at the European and global level.

Plantum today

Resources grew with the expansion of the sector, not so much in number of members but in turnover, which has been a strong development particularly in vegetable seeds and seed potatoes. This growth is mainly due to the internationally oriented entrepreneurship in the sector and the knowledge infrastructure in the Netherlands, based on 75 years of public investment and strong public-private partnerships. Another factor of great importance is the effective and efficient institutions for variety release (since 1924), plant breeders' rights (since 1941), and seed quality (testing since 1877; inspection since 1888) and health (since 1899). On innovation policies and effective institutions, Plantum considers itself quite influential. Through the years, Plantum has successfully adapted to changes in the environment. Liberal policies - reducing the size of government - forced Plantum to significantly increase its network at the political level. The ever-increasing complexity of the global phytosanitary environment prompted a significant increase in the staff capacity on that dossier and more effort is put into effective communication, including the involvement with non-governmental organisations and fellow associations in the value chains.
Given the extensive dynamics of the sector and its environment, and the proactive role that the members expect of its association, Plantum continually monitors developments and adapts its activities and services to its members. The current priority fields are sustainability, innovation and markets next to engagement with members, stakeholders and society. Plantum has always contributed significantly to the European (ESA-Euroseeds) and global (ISF) associations and is proud to host the World Seed Conference celebrating the centennial of ISF.

'Naktuinbouw plays a **leading role** globally'

Monique Krinkels

After working for inspection services for almost forty years, 24 of which as director of Naktuinbouw, John van Ruiten has entered a new phase in his life: as of 1 February 2024, he has stepped down as director of strategy and development. In the coming months, he will support his successor, Jan Meiling, and transfer the many files, but after that the future is open to him.

It was in the spring of 1985 when John van Ruiten leafed through the 'Vakblad van de Bloemisterij' (trade journal for the Dutch floricultural industry). That weekend he had travelled from his room in Wageningen to his parents in Roelofarendsveen. Coincidentally, he noticed an advertisement for the NAKS – the Dutch inspection service for ornamental plants – which was looking for a technical director for inspections and for laboratory work. When he read that, it was what John had in mind when he thought about his future. "Although I studied plant breeding, I was less interested in practical cross-fertilisation but more interested in the organizational and administrative issues related to plant breeding and plant pathology and plant production. I had already gained experience in organizational work during my studies at what was then called the Wageningen Agricultural College. Another option, taking over my parents' company, was not my ambition, although I was of course asked to do so as the eldest son," says John van Ruiten. "Eventually, one of my other brothers continued to run the business."

Single job application

His response to the NAKS turned out to be his first and last job application letter. He was invited for interview and was accepted for what would become a long career in the world of quality of seed and plant material. In the 1990s, the NAKS merged with the NAKB – the Dutch inspection service for arboricultural crops – and he became director of NAKB. And at the transition into the new millennium, the merger with the NAKG – the inspection service for vegetable crops – into Naktuinbouw followed in 2000. Together with Nico Koomen, he took over the management of that organization.

At the same time, the words inspection service disappeared from the name and was replaced by quality service, which did more justice to the broad field of work of the organization. "The inspection services have always been about demonstrable quality, which is why they were founded in the 1930's and 40s by producers of plant propagating material for horticulture," so says John van Ruiten. This happened in 1941 for vegetable seeds, in 1943 for fruit and arboricultural crops and in 1947 for ornamental plants. Agricultural crops were there earlier. An inspection service was established for this purpose as early as 1932. Since the end of the 19th century, there have also been all sorts of local inspection initiatives in fruit cultivation and the flower bulb sector.

Naktuinbouw has two directors. "They are two equal functions. One director focuses on the internal organization and the business operations, the other focuses on external activities, inspections, variety research, laboratories, training and quality systems. And then specifically the strategy and development thereof. And the many contacts with stakeholders. The latter was my remit. If we ever had different opinions about how to approach a subject, we would then discuss it as equal partners. Luckily, we always worked it out. I expect that this will be no different for Stef Schuijt and my successor Jan Meiling."

Independence

In contrast to the way this occurred in many other countries, in the Netherlands it was originally not the legislator who was the first to establish requirements for propagating material, but this happened at the beginning of the last century at the initiative of the sector itself. The trade associations thereof decided among themselves that a system needed to be introduced so that gardeners could be assured that the purchased planting material and seed was identifiable, healthy and of good quality. In 1966, the government (in accordance with the then EEC) established legal rules and an affiliation obligation via the Seeds and Planting Materials Act. The control thereof was assigned by the relevant agricultural minister to the already existing private law inspection services. The reason is that "it is in the public interest that the quality of propagating material is determined in an expert, strict, but equitable manner," according to the legislator. The government is not represented on the board, but it does appoint the chairperson. Board decisions about regulations and tariffs must also be approved by the minister before they come into effect. Naktuinbouw is a so-called 'independent administrative body'(ZBO).

"In the Netherlands, when it comes to inspection systems and their further development, there is a great deal of mutual trust between the business community, Naktuinbouw and the Dutch government and that is very valuable. When it comes to European

‘There is a great deal of mutual trust between the business community, Naktuinbouw and the Dutch government and that is very valuable,’ says John van Ruiten
(Photo: Naktuinbouw)

regulations, we are always involved as a quality service by LNV (Ministry of Agriculture, Nature and Food Quality) and the NVWA (Netherlands Food and Consumer Product Safety Authority). We consult a lot with each other and - when there are EU meetings - we are present in Brussels as advisor to our ministry,” says John van Ruiten.

Growing remit

Many tasks have been added during the past two decades, including in the phytosanitary field. The Plant Protection Service became part of the Netherlands Food and Consumer Product Safety Authority. This agency has a broad field of work: it monitors the safety of food and consumer products, animal welfare and protection of nature, as well as plant health. Since 2007, some of its tasks, for example the inspection of propagating material for export, have been assigned to Naktuinbouw and its fellow inspection services. “The health of propagating material is becoming increasingly important throughout the world. Diseases and pests which you used to only see in Mediterranean areas, or even only in other parts of the world, are increasingly found in Northwestern Europe. The reason: both climate change and increasing global trade, which can allow pathogens to spread quickly if you’re not careful.”

Another major expansion of the industry was the implementation of plant breeders’ rights testing for which Naktuinbouw has been responsible since 2006. In the Netherlands, the Board for Plant Varieties registers varieties in the national variety register, both with regard to admission to trading and granting of plant breeder’s rights. For Dutch plant breeders’ rights, the DUS testing was previously carried out in Wageningen by RIVRO (Government Institute for Research on Varieties of Cultivated Plants) and later CGN (Centre for Genetic Resources). The Board for Plant Varieties also moved to Roelofarendsveen. For this purpose, Naktuinbouw has set up the Plant Variety Office which facilitates the procedural and administrative tasks for the Board. Naktuinbouw not only conducts the DUS testing for Dutch plant breeders’ rights, they also conduct this investigation for hundreds of crops for European plant breeders’ rights on behalf of the CPVO. In total, we test around 2,000 new varieties here annually, mainly of vegetable crops, ornamental plants, potatoes and grasses.

What has also increased significantly in recent years is the development of disease testing in the laboratory. The remit became ever broader and the techniques became ever more sensitive and faster. International regulations also require more and more tests to enable fast and reliable diagnoses or to determine that the propagating material is disease-free. We must be ready to make diagnoses quickly before a disease becomes a problem,” says John van Ruiten.

And in variety testing, there are of course protocols to determine which resistances a variety possesses, especially in vegetable varieties. “In my opinion, more attention should be paid to the development and use of resistance tests in glasshouse ornamentals,

BEJO, BREEDER OF VEGETABLE SEEDS FOR THE PROFESSIONAL GROWER

▸ **bejo.com**

Travelling, more cycling and gardening are on his bucket list
(Photo: Naktuinbouw)

perennial plants and arboricultural products. That is not happening as quickly as I had hoped. In addition, proactive development of tests is necessary.

Systematic approach

In addition to propagating material that meets all legal requirements, Naktuinbouw has also developed systems to make extra high quality and health of propagating material more transparent: the so-called Elite systems for a number of ornamental plants and fruit plants, and Select Plant for ornamental plants, onion sets, asparagus and trees. And also the NAL (Naktuinbouw Authorized Laboratories) system now has international appeal and participants. In particular, the freedom from diseases guaranteed and tested by these systems offers added value for both the producer and the user of the plant material. "The systematic way in which we approach matters in the Netherlands is well known worldwide. We do not inspect individual batches of seed and plants, but develop control systems together with the industry, which the companies mainly implement themselves. Naktuinbouw ensures that this is done properly. That works really well and we are happy to promote that to other countries."
The Netherlands also supports foreign governments in developing their own legislation, plant breeders' rights and inspection systems and laboratories. "We transfer our knowledge and provide training. We are active in many countries. Currently, it is mainly African countries, such as Tanzania and Ethiopia, that we are supporting in promoting the quality of propagating material and setting up plant breeder's rights systems. Naktuinbouw also very frequently receives foreign delegations, organizes workshops and offers training courses. There are also projects in India, the Philippines, Nepal and Kazakhstan, to name just a few countries."
Last year, Naktuinbouw helped the Ukrainian Ministry of Agriculture to update the legislation and regulations regarding propagating material. Plant breeders' rights have also been amended in that country. "No, we were not anticipating Ukraine's potential EU membership. It is also a way to encourage the simplification and streamlining of trade between the EU and Ukraine. Prior to that, it was very laborious and required a lot of paperwork." Now, both the import and export of propagating material are better coordinated, with regard to identity, quality and health.
"We are noticing that our many years of practical experience, the knowledge and our approach to sharing it are respected abroad. Naktuinbouw wants to further develop its position as an international centre of expertise and knowledge of seeds and plant material. We have global ambitions in this respect," says John van Ruiten.

Future

After 1 September, John van Ruiten's role at Naktuinbouw will have come to an end. It is not yet clear what the future holds for him. Travelling, more cycling and gardening are on his bucket list. For the time being, his wife is still busy at work, so long holidays will have to wait a little longer. But he also has plenty to do in the Netherlands. For years, he has been on the board of the Friends of the Leiden Hortus Foundation. This foundation supports public activities and projects that should create more awareness of the Hortus Botanicus and highlight the importance of plants and biodiversity. It is the oldest botanical garden in the Netherlands, founded in 1590, and was open to the public from the outset, which was certainly exceptional in the early centuries. The garden now attracts more than 200,000 visitors annually. In addition, he will continue to be the chairman of the board of the NVBT, the Dutch Association of Botanical Gardens. And as of 1 January 2024, he has been appointed chairman of the Central College of Experts of RHP, the growing media (substrates) certification organization.

Corporate Sustainability Reporting Directive

How to go about **sustainability** reporting

Daniël Ende

Plantum, along with 22 of its members, worked with one of the big four accounting firms to jointly identify the most relevant topics in Corporate Sustainability Reporting Directive in general and as a base line from which to draw inspiration when drafting individual reports. What can we learn when looking into the European Sustainability Reporting Standards and interacting with them.

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Most listed and other large seed companies active in the EU are aware by now that they have an obligation to publicly report on the impacts, risks and opportunities regarding their sustainability performance. The obligation comes from the EU Corporate Sustainability Reporting Directive (CSRD). Compliance is to be audited by accountants, alongside their financial auditing. Hordes of consultants are ready and willing to guide companies to become compliant. The European Sustainability Reporting Standards' (ESRS) goal is to define sustainability topics on which companies have to report, or at least provide a long list of possible topics. The grand total of topics is over 1,200. Luckily, companies are allowed to select a smaller set of relevant topics on which to report, provided that they show how they have selected these topics. This selection is a part of the report itself.

Selecting relevant topics

The first step in selecting relevant topics will be to define a company's impacts in the context of sustainability standards for environmental, social and governance (ESG) issues. Impacts can be defined in two ways: the company's positive or negative impact on its surroundings as well as the impact of the surroundings on the company. This is called double materiality. It must be noted that positive and negative impacts do not mutually level out; each one has to be addressed as a singular topic. The second step is to define whether the impact leads to risk (and/) or opportunity to business.

When starting to look for impacts, it will soon become apparent that, in the line of work of plant breeding, multiplication and trade, there are numerous relevant topics to report on. In figure 1, we provide the standards' titles; it will not take much to see that all of them are relevant in some way or other in our line of work. Some examples of things we found relevant:

Environmental topics

Climate change is one of the most important, if not the most important, topics in the standards. Goals set in the Paris agreement regarding combating global warming warrant greenhouse gas emissions to be a priority in sustainability reporting. Emissions from companies' own activities, known as 'scope 1', but also emissions caused elsewhere in order to make companies' activities possible, such as energy production and even emissions making those activities possible, or those that are a consequence of the product in the value chain (scope 2 and scope 3 respectively), have to be taken into account. A positive impact can be made where emissions in the value chain may be reduced. For example, varieties that are easier to harvest or process will reduce fuel consumption.

There are also negative environmental impacts on the company operations; soils may become too dry and/or soil salinity may rise impacting production limits. This is a risk to business operations, but also an opportunity for the development of climate-resilient varieties.

Another important impact relates to pollution. Here too, own operations as well as impacts in the value chain should be considered. The use of or dependency on harmful substances quickly comes to mind. Risks involve environmental damage or impacts on health and safety of workers. Opportunities can be found in the use of non-chemical seed treatment or biodegradable substances, and in the context of plant breeding for abiotic and biotic stress resistances and higher resource use efficiency.

A higher resource use efficiency is also relevant for the topic of water. Lowering impacts of water use in farming can be an important contribution to sustainability. The impact is both on the environment as well as social. At least where water availability is limited, less use in agriculture means more availability for local communities.

Our sector has a very unique relationship with biodiversity; it is one of the resources from which we create new diversity. As far as CSRD goes, it is mostly about reducing possible negative impacts of operational aspects of the business.

Resource use in general is its own topic for reporting. In addition to the topics already mentioned, consider the use of non-renewable resources. Next to the obvious fossil fuels and fresh water, phosphate is a resource to keep in mind.

Social topics

Most professional seed companies will have strong social policies in place. In general, seed companies support their workers well, as compared to other in-

> 'The first step in selecting relevant topics will be to define a company's impacts'

The European Sustainability Reporting Standards cover over a thousand topics

dustries. Since this is case, companies may not need to define impacts for their own workforce. However, the workers form the backbone of seed companies. Their labour, expertise and dedication contribute significantly to the companies' success. Just as seeds are essential for plant growth, workers are vital for the growth and productivity of seed companies. Knowing this, many seed companies will choose to report on their own workforce, health and safety and working conditions.
Workers in the value chain is an important topic, too. In this context, issues around working conditions, as well as the prevention of child labour, should be considered.

Governance

The impacts of business governance are related to all of the above in having policies and plans and living by them. Externally, it also has to do with how to deal with corruption and bribery, invoicing and timely payments of dues, etc. Internally, it is about having policies and maintaining them in company culture in a transparent way.
Part of the reporting obligation involves stakeholders. Stakeholders may be internal staff and external relations, value chain relations and even NGOs or governments. The idea is to explicitly take into account the perspectives of stakeholders when deciding on which impacts the company should report on.

Upstream and downstream

Smaller companies that are not directly obliged to report are likely to still have to contribute to reports. This is because large companies have to include relevant performance of their suppliers and their customers in their own report.
On the defined topics for reporting, the company has to start gathering data to support showing progress made on those topics. In some cases it is quite easy; showing that the company has certain policies, for example. In other cases, choices will have to be made on how to measure. There are many footprinting tools available for measuring various environmental impacts. Which one to choose is a personal preference or may depend on the nature of the company and its production. Sometimes, others in the value chain will demand certain tools to be used in order for them to compare different suppliers.

Collective initiatives

At Plantum, we are on the way to tackling the challenge as a collective with professional support. Many of the topics that different seed companies select will be the same or comparable. Many of the stakeholders are the same as well. It helps to define a subset of topics to report on with a group of like-minded companies to narrow the scope to focus on. Individual companies can still deviate and personalise their own selection of topics, but it can boost confidence knowing that more or less the same topics are relevant in the sector. Interacting with stakeholders also becomes much more efficient when shared stakeholders can be asked once on behalf of many.
As if all of the work described in this article up to this point is not enough, be aware that there is a set of standards still in development. One of these specific standards concerns agriculture and farming.
Also, there are various interactions with other legislation, such as the Corporate Sustainability Due Diligence Directive (CSDDD). Where CSRD is about reporting, the CSDDD is about taking care and taking actions to reduce impacts.

To what end

Sustainability and the ESG topics are and have been important on their own. We will start seeing that industry partners and financial institutions measure sustainability gains in their consideration with whom to do business.

Revitalizing the EDV principle

Edgar Krieger

Essentially Derived Varieties (EDVs) are still an important topic for breeders. It was relevant at the time of the drafting of the UPOV 1991 Act, and it is still important today.

At the end of the 1980s, the discussions about EDV started because of two kinds of varieties: mutations and genetically modified organisms (GMOs). One of the initial instants for the discussion was the so-called Pitica/Kyria decision* by the European Commission on 13 December 1985, about who is the owner of and has control over mutations of protected varieties. Additionally, the rise of GMO gave concern to conventional breeders.

Legal situation

Today, mutations still play a crucial role, particularly in the area of vegetatively reproduced ornamental and fruit varieties. But more and more mutations will enter the area of seed propagated crops, too, namely because of the rise of gene editing technologies.
The discussion about EDV is highly topical because new Explanatory Notes on EDV (EXN on EDV) were adopted by UPOV in October 2023.
This short article shall shed some light on the two main areas around EDV: what is the legal situation of an EDV and what makes a variety an EDV?
We start with some easy facts in respect of the legal situation of an EDV:
– A dispute about EDV can only occur if the Initial Variety is protected by a plant breeders' right. If the Initial Variety is not or is no longer protected by a PBR, there is no case of EDV (anymore).
– A dispute can only occur in territories where the PBR law includes an EDV provision. This is the case in all countries that acceded to the UPOV 1991 Act and in some countries that are bound by the UPOV 1978 Act, but opted to include an EDV provision into their PBR law, such as Columbia and China.
– If a variety is considered to be an EDV in one territory, that does not mean that this variety is an EDV all over the world. And vice versa: if a variety is considered not to be an EDV in one territory, that does not mean that this variety is not an EDV in other territories. In fact, it depends on the wording and interpretation of the EDV provision in each territory concerned.
– An EDV can get PBR protection on its own, like every other variety, if it fulfils the conditions for protection, which are Distinctness, Uniformity and Stability (DUS), Novelty and a suitable Variety Denomination.
– If a variety is not eligible for PBR protection (the conditions for protection are listed in Article 5 of the UPOV 1991 Act), e.g. because it is not clearly distinguishable from any other variety of common knowledge, or not stable enough, it nevertheless can be an EDV. The only conditions in this respect are that it is a variety (the definition of a variety is included in Article 1 (vi) of the UPOV 1991 Act) and that it is distinct from its Initial Variety (not from any other variety of common knowledge).
– If a variety is considered to be an EDV, the title holder of the initial variety has the same rights in respect of the EDV as he has in respect of his protected initial variety, even if the EDV itself is not protected by PBR.

Essentially derived

Now we come to the second, more tricky question: what makes a variety an EDV.
Article 14 (5) (b) of the UPOV 1991 Act says:

"A variety shall be deemed to be essentially derived from another variety ('the initial variety') when
(i) *it is* ***predominantly derived*** *from the initial variety, or from a variety that is itself predominantly derived from the initial variety, while retaining the expression of the essential characteristics that result from the genotype or combination of genotypes of the initial variety,*
(ii) *it is* ***clearly distinguishable*** *from the initial variety and*
(iii) ***except for the differences which result from the act of derivation, it conforms to the initial variety in the expression of the essential characteristics*** *that result from the genotype or combination of genotypes of the initial variety."*

Admittedly, this text is not an example of clear language, in fact it is unclear and even contradictory in itself. Therefore, UPOV has developed the so-called Explanatory Notes.
The new UPOV Explanatory Notes on EDV of October 2023 interpret these rules as follows:
– Varieties with a single parent ('mono-parental' varieties) resulting, for example, from mutations, genetic modification or genome editing are per se predominantly derived from their initial variety.
– The wording of Article 14 (5) (b) (i) requires that the expression of the essential characteristics that result from the genotype or combination of genotypes of the

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Uniting breeders, protecting innovation

CIOPORA is the International Association of Breeders of Asexually Reproduced Horticultural Varieties. Breeders of such varieties account for two-thirds of all Plant Variety Rights (PVR) titles in the world. For almost 62 years, CIOPORA has represented these breeders in all matters of Intellectual Property (IP) protection and aims to foster an environment in which the innovation of these breeders can flourish. CIOPORA is a member-based, non-profit organization. More information: www.ciopora.org.

initial variety is retained.
– Article 14 (5) (b) (iii) does not set an upper limit as to the number of differences which may result from the act of derivation. The number of differences between an EDV and the initial variety is therefore not limited by Article 14 (5) (b) (iii) to one or very few differences, but may vary, taking into account different methods of derivation.
– Article 14 (5) (b) (iii) does not preclude that the differences which result from the act of derivation may also include essential characteristics.

U-turn

This interpretation is almost a U-turn compared to the interpretation of the EDV rules in the previous Explanatory Notes on EDV of 2017. In this EXN, one could read:
– The examples given in Article 14 (5) (c) make clear that the differences which result from the act of derivation should be one or very few.
– The derived variety must retain almost the totality of the genotype of the initial variety and be different from that variety by a very limited number of characteristics.
The new EXN clearly departs from the condition that an EDV must be different from its Initial Variety in only one or very few characteristics.
And this is not all. Most UPOV members and all associations of plant breeders agreed on a text which was even clearer than the one which has been finally adopted. This text said:
– An essentially derived variety typically retains the expression of essential characteristics of the variety from which it is derived, except for those differences resulting from act(s) of derivation, which may also include differences in essential characteristics.
– Article 14 (5) (b) (iii) does not set an upper limit as to the number of differences which may exist where a variety is still considered to be essentially derived. The number of differences between an EDV and the initial variety is therefore not limited to one or very few differences, but may vary taking into account different methods of derivation. The differences may also include essential characteristics.
– Differences resulting from act(s) of derivation are disregarded for the purpose of determining the EDV status of a variety. In that regard, the following clarification is provided: (a) In the case of mono-parental varieties, all differences necessarily result from one or more act(s) of derivation, meaning that all differences are excluded from consideration of the EDV status.
This text was unanimously adopted in the UPOV Working Group on EDV in summer 2021 as well as in the UPOV Administrative and Legal Committee (CAJ) in its Seventy-Eighth Session on 27 October 2021. But then, in 2022, all of a sudden, a handful of UPOV members opposed the text (to which they had agreed in the CAJ) and urged the others to agree on a compromise text, see above.
Nevertheless, the new EXN revitalizes the EDV principle and interprets it in a way that is consistent with the view of the breeders. The main conclusion is that mutants (natural or induced by radioactivity, chemicals or gene editing) are typically EDVs.

*In the Pitica/Kyria case, a rose grower in the South of France found a mutation in a protected variety from a breeder. In their licence contract, the parties had agreed that mutations remain the property of the breeder. The grower challenged this and brought the case to the EU Commission. The EU Commission decided, inter alia, that the agreement to surrender all mutations of protected varieties to the breeder, so that such mutations remain the exclusive property of the breeder, constitutes an infringement of Art 85 (1) of the EEC Treaty

Improving **toolbox** to support evolving needs

Ludivine Thomas, Joyce Woudenberg, Rose Souza Richards

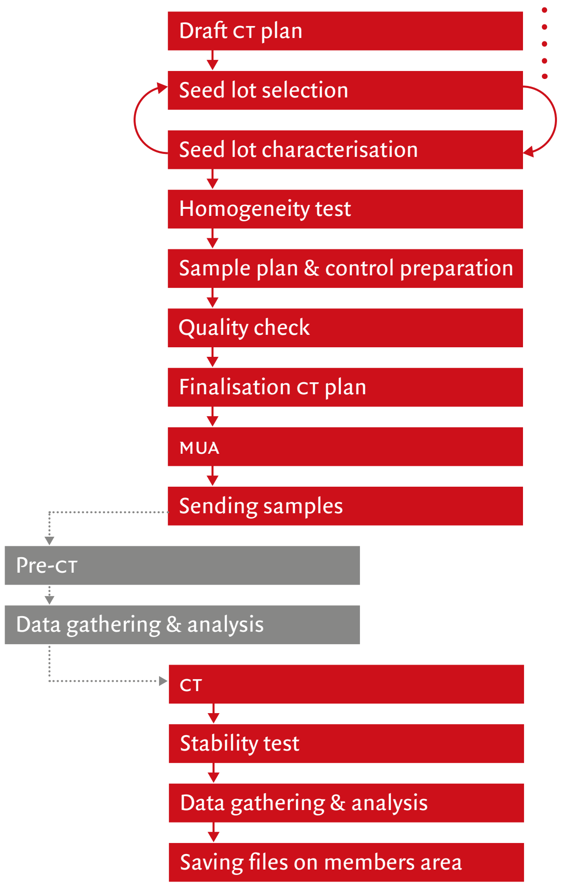
As needs evolve, the International Seed Health Initiative (ISHI) of the International Seed Federation (ISF) is constantly working on improving its 'toolbox' to support and guide its members and the seed health community at large. Besides the development of seed health test protocols with their validation reports, the initiative has developed and published several other documents using the collective expertise and experience of its members.

The development of new documents by the initiative is based on the needs of its members. When such need is identified, ISHI members, who are experts in the topic of interest, will collectively work on the preparation of the document. Before publication, all members of the initiative have the opportunity to provide their feedback on the drafted documents.
These needs are identified through different routes. For example, from a round of interviews with project leaders, the request for more guidance on the organisation of comparative tests has arisen. Alternatively, needs might be identified during meetings, like during the PCR workshop organised during one of the annual technical meetings, which led to a request for more guidance on the design of PCR assays. Here, we describe the efforts and output from the initiative to meet these two most recently identified needs.

Comparative test guidelines

A group of eight ISHI members was formed in November 2021 to collectively develop technical guidelines to help with preparing and running comparative tests (CTs) and analysing the data gathered. The group is currently in the process of finalizing the technical guidelines, which will be published on the ISF website.
A CT is defined as an evaluation of a single assay or a complete method that involves running replicate samples in multiple laboratories within pre-determined conditions and within a determined timeframe to show the reproducibility of an assay or a method (*see*: ISHI glossary of terms, 2023). Reproducibility is defined as the degree of similarity in results when the method is performed across laboratories with replicate seed subsamples.
The steps involved in the preparation and execution of CTs have been identified and are presented in Figure. As a first step, project leaders are requested to draft a CT plan that will contain the essential elements involved in the CT organization. It is important for CT organizers to identify the participants that are preferably laboratory proficient in the type of assays used. The minimum number of participants has been set to three to allow for sufficient statistical power in data analysis.
The next step, more hands-on, involves the

Comparative test process flow



CT: Comparative Test;
MUA: Material User Agreement

identification and characterization of seed lots, both healthy and infected with the pathogen of interest, to determine their suitability for the CT. Homogeneity testing is one of the important assessments of the seed lots and aims at estimating the distribution of positive/negative subsamples in each seed lot.
It is important to note that whenever possible, CT organisers should use homogenous seed lots that are uniformly contaminated. Specific requirements in terms of the number of seed subsamples to be tested for the homogeneity test and the level of infection of the seed lots are also indicated in the technical guidelines.

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A robust 'toolbox' enhances the global seed health testing standards

On the website

In order to provide general guidance to laboratories developing and performing seed health tests, individual best practices for six assays used in routine seed health testing have been developed and published over the past years (https://worldseed.org/our-work/seed-health/ishi-best-practices/). Additionally, guidelines on seed health testing in the vegetable seed industry and on real-time PCR, and technical opinion papers on High Throughput Sequencing and the Tobamovirus indicator plant test are part of ISHI's 'toolbox' (https://worldseed.org/our-work/seed-health/ishi-technical-resources/).
The latest publications in the initiative's technical resources are the glossary of terms and abbreviation list (https://worldseed.org/document/ishi-glossary-of-terms), which were developed to provide more clarity on the language used by the initiative.

Following the homogeneity test, guidance for preparing the sample set according to the homogeneity test results, as well as the number of participants, is given, together with an indication for the preparation of the controls. A quality check, to exclude possible errors during the sample set preparation and packing, is the next step.
After sample testing by all participants, a stability test is performed by the CT organizer to evaluate the influence of shipment and storage on the infection status of the samples. This step is crucial to determine the fitness of the samples and helps to predict unexpected results. Finally, the CT guidelines give guidance on the data analysis, when to exclude results, and how to process data gathered using several tools.
Overall, the technical guidelines are aimed at being a tool to ensure uniformity in the execution of CTs and their successful outcome as part of the validation of assays and methods within ISHI, but also for the seed health community worldwide.

PCR assay development guidelines

Polymerase Chain Reaction (PCR) is a molecular biology technique to detect genetic material from specific organism(s) by the process of multiplication of small nucleic acid templates (*see*: ISHI glossary of terms, 2023S). In the case of seed health testing, the starting material is nucleic acid extracted from seed extracts, isolates or leaf material.

Development and use of PCR assays for seed health testing has been growing tremendously since its development in the 1980s, firstly for the identification of isolates isolated during dilution plating assays and then more recently, for a rapid detection of pathogens by Seed-Extract PCR (SE-PCR). Developing PCR assays for the reliable detection of pathogens can however be challenging. To assist in the development of PCR assays and their validation, a group of 10 scientists from the ISHI community was formed in November 2023 to draft technical guidelines for the development of PCR assays.
Just as for the CT guidelines, the PCR assay guidelines will be published on the ISF website once finalized.
The document aims to help scientists to design PCR assays for the specific detection of target pathogens and to evaluate the stringency of the assay developed through the assessment of specific performance characteristics.
The first step in the development of a PCR assay is the clear definition of the goal of the assay. Once this is defined, the target(s) (i.e. the gene detected), the type of material used, also called the matrix, and the required performance of the assay should be identified. A literature review on the biology of the pathogen, existing assays and available sequence data would be the first hands-on step.
Primer design is a very important part in PCR assay development. Primers are short synthetic single

stranded DNA fragments that are used to select a genetic region of interest. They are specifically designed to match the target of amplification, for which they determine the specificity of the PCR amplification. For designing primers, the guidelines introduce the determination of the melting temperature, and the identification of the genome location for the design of the primers. The main characteristics are recommended, such as primer length.
After the design part, it is crucial to determine the quality of the primers designed. As such, the guidelines present a number of actions, such as PCR optimization, to assess the performance of the PCR. Within ISHI, these PCR assay technical guidelines are expected to help the community in developing rigorous assays and will help track the quality performance assessment over time.

What is next?

The next collaborative work from the initiative will be the publication of an updated version of the method validation guidelines. Validation is a critical aspect of method development and is intrinsically embedded into each project in ISHI. To ensure its methods are fit for purpose, ISHI has identified six validation criteria, which are analytical specificity, analytical sensitivity, selectivity, repeatability, reproducibility and diagnostic performance, against which the performance of the method is measured. The method validation guidelines describe how these validation criteria should be measured and the updated version is expected to be available online towards the end of the year.
To summarize, ISHI has consistently demonstrated its commitment to advancing seed health through the development of a robust 'toolbox' aiming at enhancing global seed health testing standards. By using the collective expertise of its members, ISHI effectively responds to the evolving needs of the seed health community, developing and disseminating a broad range of technical resources including best practices, guidelines and technical opinion papers.
The initiative's focused efforts on developing technical guidelines for CTs and PCR assays underscore its dedication to improving the reproducibility, reliability and accuracy of seed health testing methods. These endeavours not only facilitate standardization across laboratories, but also contribute to the broader goal of ensuring seed health and agricultural sustainability worldwide. As ISHI moves forward, it remains ready to continue its vital work in developing, validating and updating seed health test protocols and supporting tools, thereby ensuring that its contributions are relevant and beneficial to scientists and practitioners in the field of seed health.

CropXR takes up the **challenges**

John van Ruiten

On 29th February 2024, a memorable moment was celebrated. After some years of preparation, the official and festive launch of CropXR took place in Utrecht, the Netherlands. The ambition of this initiative is to develop strategies, knowledge and 'smart-data' technologies to assist breeders in making future varieties more resilient, sustainable and climate adaptive.

Resilient crops should be able to cope with a wide variety of setbacks
(Illustration: Guido Hinfelaar, CropXR)

Throughout history, plant breeding has successfully resulted in crop varieties with ever increasing levels of yield and quality. Today's crops perform well under stable conditions. High yields and quality can only be achieved if plants are supported and protected against a wide array of biotic and abiotic stresses by control measures. Challenges like climate change, new limits on the use of agrochemicals and a growing world population put pressure on the current agricultural system worldwide. Therefore, growers need more resilient crops that must overcome increasingly common and intense heat waves, droughts, floods, nutrient shortages and higher salinity. Furthermore, resilient crops should be able to cope with diseases and pests, while the use of fertilizers and pesticides are being reduced. As the pace of climate change picks up, speeding up the development of resilient crops and resilient cropping systems is urgent.

Smart-data breeding

Current plant breeding techniques cannot effectively enhance highly complex traits like resilience. To breed a new generation of robust varieties, smart interventions are needed. A new generation of smarter technologies and breeding tools should be capable of improving complex plant characteristics. That is where the new initiative CropXR comes in. By combining plant biology, simulation modelling and artificial intelligence, CropXR aims to develop, optimize and utilize a revolutionary 'smart-data breeding' methodology. Thus, breeding for complex resilience traits in different growing systems for several crops can be speeded up. This enables breeders to develop 'extra-resilient' (XR), more sustainable crops.

The CropXR institute

CropXR is a 10-year Dutch initiative. It is a collaborative effort involving four universities (Utrecht University, Wageningen University and Research, University of Amsterdam and Technical University Delft), Plantum (the trade organization in the field of breeding and propagation of seeds and young plants) and a number of industrial partners. These include leading plant breeding companies in the vegetable, potato and ornamental sector, as well as processing companies and biotech companies. In addition to scientific research and data collection and sharing, human capital development and practical research projects in agriculture and plant breeding are important subjects. The institute works on these topics in close collaboration with Universities of Applied Sciences. CropXR is financially supported by the Dutch Research Council (NWO), the Dutch National Growth Fund and the Foundation for Food & Agricultural Research. (Learn more about CropXR at www.cropxr.org).

CropXR's mission

The sense of urgency to develop more resilient and climate adaptive crops is a crucial pillar of the CropXR endeavour. All partners work together to contribute to developing a sustainable agricultural eco-system. The need for increased food security fuels the positive energy of the CropXR coalition towards achieving its mission: '*In 2033, we will have resilient crops developed through data-driven design*'.

Ir. J.E.M. van Ruiten recently retired as director of Naktuinbouw, Roelofarendsveen, the Netherlands

Botanical Art

Painters drawn in by **eye-catching** flowers

John van Ruiten

Plants and flowers have always been a source of inspiration for artists throughout the ages. From the drawings of early botanists in the early 16th century, via the floral still lifes in the Dutch Golden Age and the famous sunflowers by Van Gogh in the 19th century, to the present day, painters have always been fascinated by flowers.

Ir. J.E.M. van Ruiten recently retired as director of Naktuinbouw, Roelofarendsveen, the Netherlands

What an important year in history 1492 was. That year marked the beginning of the exploration of the world by Europeans. The start of the Columbian Exchange: crops, previously only grown in specific continents of the world where they originated, now began to spread around the globe. The era of 'discoveries': Vasco da Gama and Magalhaes sailed the world sees. And the 15th century was also the period of emerging science in the western world: the scientific renaissance with Leonardo da Vinci, Copernicus and the invention of book printing in Europe by Gutenberg.

Novelties

All those new plant species inspired a new interest: botany became very popular. Huge amounts of money were spent collecting new seeds and plants, studying them and growing them. Botanical gardens started to appear. The first university botanic garden was founded in 1543 by naturalist, doctor and botanist Luca Ghini (1490-1556) in Pisa, Italy. Catalogues and detailed illustrations (made with wood blocks printing) were published. One of the most well-known books is Historia Stirpium by Leonard Fuchs, published in 1542.

Some artists specialized in painting all these new plants. Beautiful books were produced and magnificent coloured plates (copper plate engraving) were printed in large formats. Through these books, the knowledge about the existence of all these species became widespread. The number of documented species (with descriptions and drawings/paintings) grew from around 500 in 1550 to more than 7,000 in the year 1700.

The botanical album by Jacques Le Moyne de Morgues (published shortly after he died in 1588) is one of the earliest widespread books with coloured aquarelle paintings. It was mainly used by pharmacists and doctors as many plants were used to produce medicines. But besides the herbal, medicinal and kitchen gardens, also purely ornamental gardens and books became fashionable. Florilegia ('flower books') were made, especially in the 17th century. Some of the best examples are the Hortus Eystettenis (the garden of Eichstatt; 1613) with plates by Basilius Besler, the Florilegium Amplissimum et Selectissimum (1612) with paintings by Emanuel Sweert and the Hortus Floridus (1614) by Crispijn de Passe with flowers from four seasons.

For a 17th century person, this must have given the impression of excessive abundance. Flowers were precious; a garden contained only a few flowers amidst lots of greenery (*Jan Brueghel the Elder, 1602, collection Rijksmuseum, Amsterdam, the Netherlands*)

Famous botanical researchers can be regarded as true artists. Their work is absolutely worldclass and present in exhibitions all over the world. Just to mention some of them: Pierre Joseph le Redouté, Maria Sybilla Merian, and Franz and Ferdinand Bauer. Especially in the 19th century, the number of botanical paintings and books produced was huge.

Correct

Botanical artists always focused mainly on the detailed and scientifically correct visualisation of plants in all their stadia. They were able to highlight specific characteristics of the plant, distinguishing it from other plants. These botanical drawings are still used today for more scientific reasons. Photography is an excellent additional feature, but only in a drawing can all these specific details be shown in one plate.

In many countries, botanical artists are still very active. Associations and societies are founded and they all want to promote the appreciation of botanical art. And they are active in educating scholars and those who like to make drawings as a hobby. Many of them have in common that, with this form of art, the protection and conservation of plants and natural habitats can be supported. In the botanical garden in Leiden, artists like Anita Walsmit Sachs and Esmee Winkel (professional artists employed by Naturalis Biodiversity Centre in the Netherlands) organise many workshops and exhibitions of their work.

Golden Age

Another form of botanical art is the floral still lifes, especially popular in Flanders and the United Provinces of the Netherlands in the Golden Age period.

The Flemish painter Pierre-Joseph Redouté (1759 – 1840) was famous for his paintings of the roses in his garden in Malmaison

This bouquet shows more than ten types of flowers and is teeming with insects. The flowers have different flowering periods, so such a bouquet would be difficult to put together in real life (*Rachel Ruysch, 1716, collection Rijksmuseum, Amsterdam, the Netherlands*)

The metamorphosis of the emperor moth (Saturnia pavonia) (*studio of Maria Sibylla Merian, 1679, collection Rijksmuseum, Amsterdam, the Netherlands*)

Rich bouquets of flowers were depicted in paintings. The more, the better was the credo and sometimes more than thirty types of flowers featured in one painting. Lush and asymmetric. Painted with fantasy, because all the species did not flower at the same time of year. Sometimes also painted in combination with artefacts, such as symbols of love, hate, time or death. The meaning of various flowers and artefacts had a much deeper meaning, something we are not really aware of any more nowadays. The market for such paintings was great and diverse. Rich aristocrats, but also wealthy commoners, all over Europe bought these paintings

Jan van Brueghel the Elder is said to be one of the first painters to make a still life in 1605. Other famous painters: Ambrosius Bosschaert, Maria van Oosterwijck, Judith Leyster and Gerard van Spaendonk. Very well-known, and probably one the most productive painters in the Baroque period, was Rachel Ruysch. More than 100 paintings still exist and she probably painted more than 250 works (while being a mother and raising ten children). Her father was a famous anatomist and botanist and he was appointed as the director of Amsterdam Botanical Garden in 1685. Rachel painted elegant bouquets and dark forest flora with great attention to detail and delicacy of colour, and she continued to paint all her life until she passed away at the age of 83.

Present day

Especially at the end of the 17th century, the bouquets in those still lifes seemed to explode: even more flowers of all different colours, butterflies, insects, reptiles, small mammals, light effects and beautiful vases. The popularity of flower still lifes waned in the course of the 18th century. Flowers appeared in new forms of art (eg. classicism, romanticism, realism, impressionism, art nouveau) but in a very different way. But who does not enjoy sunflowers, irises or almond flowers by Vincent van Gogh, waterlilies by Claude Monet or dahlias by Pierre-Auguste Renoir? Even in contemporary art, flowers play an eye-catching role. For example, have a look at the work of Georgia O'Keeffe, with her close-ups of Calla flowers in a sensual (or even sexual) context. Or look at Erik Andriesse, who created beautiful large paintings of red poppies and Amaryllis in the 1980s.

Botanical art fascinates: historical or modern, scientific or artistic, pen drawings, aquarelles or oil paintings, it is always a pleasure for the eyes.

To an internationally accepted SNP **database**

International Harmonized Tomato SNP set Consortium

The use of DNA profiles is an effective and useful tool to manage reference collections for DUS-testing. A SNP database of tomato varieties with its enormous varietal diversity would therefore be a welcome tool to improve efficiency. The International Tomato SNP set Consortium has developed a harmonized and validated SNP set for this crop.

The International Harmonized Tomato SNP set Consortium, corresponding author Claire Lessa Alvim Kamei, Naktuinbouw, Roelofarendsveen, the Netherlands, c.kamei@naktuinbouw.nl, the contributing partners are summarized in the table.

Tomato is one of the most cultivated vegetable crops worldwide, grown for its edible fruits, with an annual production of approximately 180 million tonnes (FAO, 2022). From its first seeds brought from South America to Europe in the 16th century to now, a long history of crossing and selection has resulted in an enormous varietal diversity within the species. More than 10,000 tomato varieties are grown for various purposes, and have been selected for different fruit types, resistances and for optimum growth in several growing conditions.

In addition to this high number of varieties, every year new ones enter the market as a result of intensive breeding efforts. Many large-scale breeding companies operate on a worldwide basis and the introduction of their new varieties is not confined to certain regions or countries. In contrast, small scale companies often create new varieties for local niche markets and introduce their new varieties, where relevant under national listing systems, in just one or a few countries.

Given its economic importance, tomato has attracted great scientific interest and is extensively studied as model crop due to its autogamous diploidy (2n = 24) and relatively simple and small genome size (~950 Mb). In 2012, the genome of the cultivated tomato and its wild ancestor, *Solanum pimpinellifolium*, was decoded (the international Tomato Genome Consortium), providing a powerful tool and new possibilities in targeted breeding for specific traits.

DUS testing system

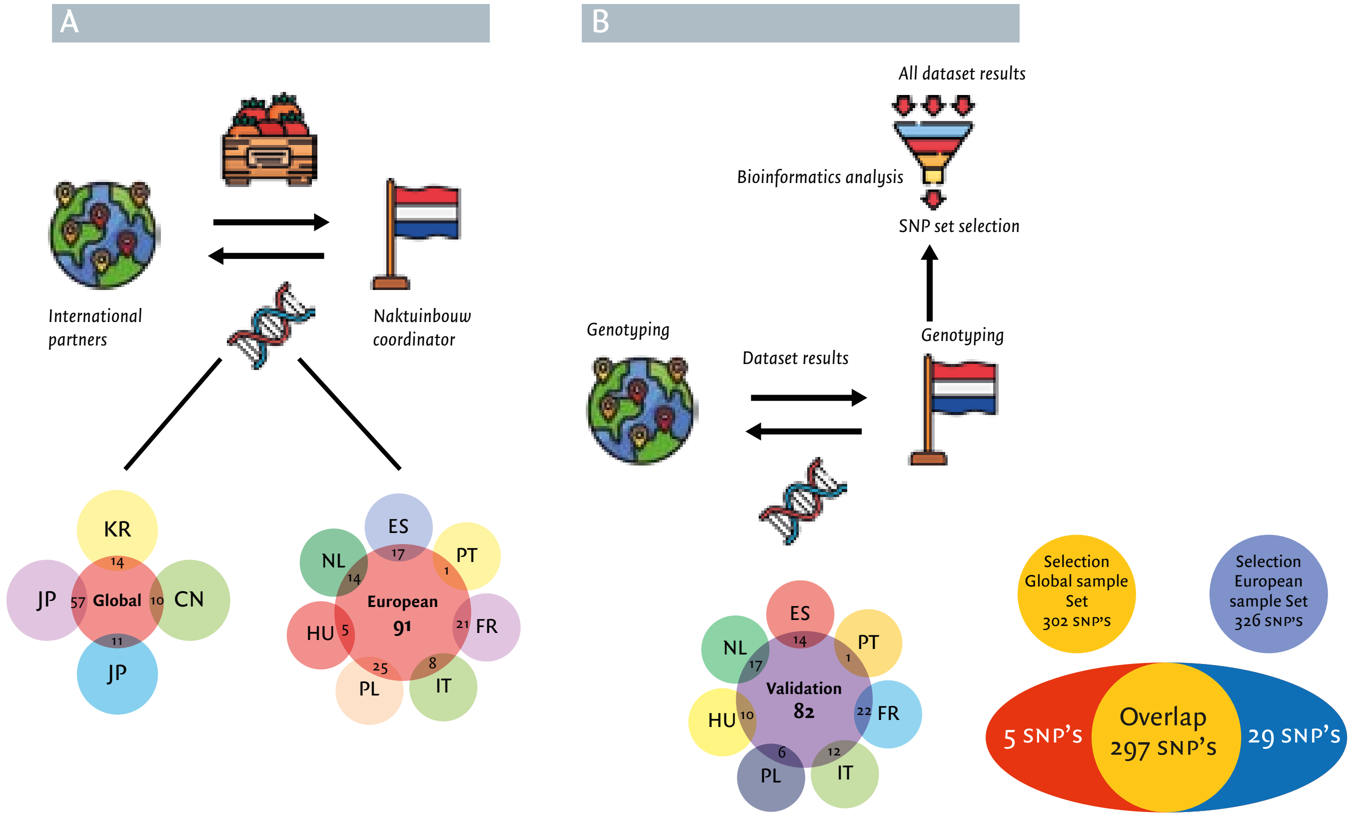
Before entering the market in most countries, all novel varieties need to fulfil three technical prerequisites: (1) be **distinct** from all other publicly known varieties, (2) be **uniform** in expressing their phenotypical characteristics, and (3) be **stable** over subsequent generations. Together with other factors linked to its agronomic performance (e.g., value for cultivation and use, sustainability), these three basic criteria (i.e. DUS requirements) need to be fulfilled for the variety to be registered on national lists and further commercialized. In the European Union (EU), national lists from all contributing member states are merged to form the Common Catalogue, whose varieties then have access to the entire common market. In parallel, DUS requirements must also be fulfilled for the protection of variety via Plant Breeders' Rights. In the EU, seven Examination Offices (EOs) are entrusted by the CPVO to perform DUS tests for tomato (ES, FR, PT, PL, NL, HU and IT), and they are all being challenged by the significant increase in the number of varieties as a result of all the breeding and research activities in tomato. That has a direct impact on the DUS work routine, creating a major challenge to ensure that new applications are clearly distinct from all the existing ones. Ideally, the design of the DUS trials should contain an acceptable and workable number of comparing reference varieties without missing any relevant variety of common knowledge.

Reference collections

A resourceful solution to help the DUS testing system of tomato relies on the rapid developments of high-throughput DNA sequencing and genotyping approaches. Varieties can be distinguished based on their unique DNA profile, and generating these profiles has become an efficient and cost-effective possibility. The germplasm of many important crops has been sequenced and revealed a substantial number of single nucleotide polymorphisms (SNPs) useful to distinguish varieties. SNPs are the most abundant genetic variation in plant genomes, defined as a single base change in a specific position in the DNA sequence, including insertions, deletions or substitutions, and are highly correlated to phenotypic variation. Different SNPs features (e.g. low mutation rate, stability and abundance throughout the genome) make them an ideal molecular marker for the generation of reliable DNA profiles.

The availability of DNA profiles in well-organized databases, with DNA data of varieties of common knowledge, can improve the efficiency and quality of DUS tests. For example, there is no restriction on the number of varieties within a database, also not on phytosanitary regulations (as DNA can be exchanged instead of whole plants/seeds). Additionally, they have a high discriminatory power, a high repeatability, are applicable to seed or early developmental stages (speeding up data production and analysis) and grant the possibility to screen over thousands of varieties in a faster and more efficient way.

Most importantly, by choosing SNPs as molecular markers to build a database, it is possible to generate



Visual overview of the workflow of this project. **(A)** As the main goal of this project was to work towards a harmonized SNP marker set, each partner had access to the exact same DNA samples. Seed samples were sent to the project coordinator in The Netherlands, and the defined Global and EU DNA sets were assembled and distributed afterwards to all partners for the first round of genotyping. The larger circle in the middle represents the entire plate, with the total number of varieties/samples included. The smaller circles surrounding the plates represent the number of varieties included per partner. **(B)** After the genotyping step, all dataset results were analysed together and SNP set selection done, yielding in 297 robust SNPs. This selection was used in a validation DNA set, according to the partners' selection and the coordinator assembly and distribution. After validation, a set of successfully harmonized and validated SNPs was identified.

globally harmonized and validated sets, and identify with precision varieties regardless of where (different EOs), when (in time) or how (using different genotyping technologies) their molecular data was produced.

International collaboration

A joint European effort was funded by the CPVO to promote the development of a tomato specific SNP set that is internationally accepted and validated to be fit for purpose. Outside the EU, three EOs from China, Japan and Korea, additionally contributed to this 4-year project. An overview per partner and their roles is provided in the table. The primary goal of the project was to establish a SNP set that could be used by all partners in their laboratories, regardless of their geographical location and genotyping platform. In the scope of the project, the diversity of workflows was deemed beneficial, so that the harmonization would not be restricted to a single technique and would find a broader harmonization and acceptance. A schematic representation summarizes all the steps followed until the final SNP set selection.
As starting point for this project, a tomato Axiom Array (Affimetrix: 51.214 markers, Catalogue Number 550497) was screened using a representative set of tomato varieties, carefully chosen to represent all types and all characteristics. Based on their discriminative power, robustness, performance and reproducibility, 500 high polymorphic SNPs were pre-selected. The next step was to select which varieties to be tested using these SNPs. For that purpose, the sets of varieties had to fulfil important criteria, such as (1) collectively represent a wide spectrum of genetic diversity, incorporating all types and characteristics; (2) include variety pairs possessing characteristics sufficiently different to be considered distinct, while morphologically highly similar; (3) being derived from different germplasms; and (4) include only cultivated varieties (*i.e.* no wild types).
Two training sets were devised - Global and EU. To ensure all partners would work on comparable DNA samples, seeds from all selected varieties were sent to Naktuinbouw for uniform DNA extraction. The two DNA sets were then divided in plates and distributed to the partners, together with the SNP flanking sequences information (see figure 1A).
The first round of genotyping experiments was performed by all partners and dataset results were sent to

Partners	Roles	Website
Europe		
France - GEVES	EO, LAB	https://www.geves.fr/en/
Italy - CREA	EO, LAB	https://www.crea.gov.it/en/home
The Netherlands - Naktuinbouw	EO, LAB	https://www.naktuinbouw.com/
Spain - INIA	EO, LAB	https://www.inia.es/en-en/Pages/Home.aspx
Hungary - NÉBIH	EO	https://portal.nebih.gov.hu/
Poland - COBORU	EO	https://www.coboru.gov.pl/en/about
Portugal - DGAV	EO	https://www.dgav.pt/
Euroseeds	OBS	https://euroseeds.eu/
CPVO	OBS	https://cpvo.europa.eu/en
Asia		
China – CAAS (IVF)	EO, LAB	http://www.ivfcaas.ac.cn/en/
Korea – KSVS	EO, LAB	https://www.seed.go.kr/sites/seed_eng/index..do
Japan – NARO (NCSS)	EO, LAB	https://www.naro.go.jp/english/

Overview of the different project partners and their roles.
EO (*Examination Office*) - all experienced EOs in the DUS testing of tomato; LAB (*Laboratory*) - all EOs with a laboratory facility that actively participate in the method validation and the evaluation of SNPs and methods between the different laboratories; OBS (*Observer*) – representatives of breeder organizations interested in this project, thus having an advisory role without an active contribution.

the Naktuinbouw project coordinator. The genotyping data was then analysed together and compared. After this phase, results were shared and, based on SNP performance, a set of markers were chosen to enter a validation phase. A DNA validation set was also designed among partners, focusing on varieties that, when compared morphologically, could not be distinguished. It included: (1) varieties coming from different seed lots; (2) samples of the same variety known and sold under different names; (3) biological replicates (*i.e.* a DNA extraction done separately from the same plant material); and (4) technical replicates (*i.e.* the same DNA extraction included in the analysis in duplicate).
Once the decision was finalized on the composition of the DNA validation set, the same steps were followed to guarantee the same quality material would be used by all partners, therefore the new set was assembled and shared by the coordinator (see figure 1B). The importance of this last phase was to certify the harmonized performance of selected SNPs and the capability of each laboratory of producing consistent and repeatable genotyping results.

Validated SNP set

Throughout this project, the participating laboratories have successfully genotyped 257 tomato varieties on 297 robust SNPs (see figure 1B). In the first round of genotyping, these SNPs yielded an average similarity of >95% and were able to be genotyped in at least 75% of the participating laboratories. After the validation step, 236 SNPs sustained the initial criteria of being reproducible for at least 95% in all the participating laboratories. Based on the data provided by all partners, an average similarity of 96,5% on 89 out 92 samples were achieved.
When focusing only on the 236 high quality SNPs, the average similarity of the genotypes increases, but consequently the discriminative power of the SNP set is slightly lowered, which is not expected to have major consequences on future applications. It is possible to incorporate the entire set of 297 SNPs, but it would require some changes in the current workflow adopted in this project. The optimal workflow, supported by all contributing partners, should be discussed in the period leading up to a follow-up project. The flanking sequence of the final SNP set will be publicly available and can be provided by the Naktuinbouw project coordinator, to be used by any authority responsible and/or entrusted for tomato DUS testing. Extra information on the project, such as validation results, are available at the CPVO website (https://cpvo.europa.eu/en/about-us/what-we-do/research-and-development).

Learning experience

Through this project, experience was gained on the set up of such international consortia of partners having different technical and administrative constraints, and is worth sharing with others interested to follow similar steps. Early in the project, it became evident that the complexity of the legal aspects had been underestimated. Non-EU countries abide by different legislations, and different scientific institutes follow distinct confidentiality policies, for example. For future collaborations, also the time required to secure the consent from breeders and establish the sample selection criteria, are advised to be taken into account.
The future steps, after the successful completion of this project, will focus on the database implementation and the dissemination of the results (in respect of CPVO's policy on confidentiality), and should start with the discussion of these three main steps (1) constructing and safe-hosting of a database; (2) generating genetic profiles of varieties of common knowledge; and (3) implementing a tool for similar variety identification usable in DUS trials.

Sjoukje Heimovaara, Wageningen University & Research

'Drive to make a **difference unites** students'

Monique Krinkels

With 220 professors, 13,564 students, 2,463 PhD-candidates and 59,367 alumni, Wageningen University & Research is not a large institute, but its global impact is not to be underestimated. In the 105 years of its history, its fame has spread worldwide. According to the QS World University Rankings, WUR is the best agricultural university in the world for the seventh time in a row, with the University of California at Davis, USA, and the Swedish University of Agricultural Sciences in Upsala, Sweden, in second and third place.

"The basis of our strength lies around the beginning of the last century, when the Netherlands decided to focus on education, research and information to modernize agriculture and horticulture," says Sjoukje Heimovaara, President of the Executive Board of Wageningen University & Research (WUR). "It was based on a long-term vision." The roots were laid in 1876, when the state took over the local agricultural school in the small town of Wageningen. At the time, there was no Ministry of Agriculture – the first Minister of Agriculture of the Netherlands was Jacob Dirk Veegens in 1905 – so the inspector of secondary education was responsible for supervising the college. By 1918, the status of Wageningen as an academic institute was legally ratified, and it became the National Agricultural College. Only in 1986 was the word college changed to university.

Global leader

Together with the agricultural sector, the University has since developed into a global leader. "Agricultural policy, the agricultural sector and agricultural education have worked together for decades," explains Sjoukje Heimovaara. "At the end of the twentieth century, the Agricultural Research Services were transferred to Wageningen University and we became Wageningen University & Research. That turned out to be a masterstroke: stagnant student numbers grew again and the symbiosis between fundamental research (at the university) and more practice-oriented, applied research (at the research institutes) led to the leading institute that WUR is today."

Wageningen is a small provincial town with only 35,000 inhabitants. Thanks to WUR, there are more nationalities (115) among its citizens than in many a metropolis. Approximately a third of the students at WUR come from abroad. The campus is a true melting pot, with students from Africa, Asia, North and South America and of course Europe. The largest groups come from Germany, Italy and China. It is reflected in the curriculum. Seven bachelors courses and almost all masters courses are taught in English.

Broader view

Earlier this year, the Dutch government proclaimed that Dutch universities should stem the influx of foreign students and limit the use of the English language. WUR, however, has chosen to focus on the international market. "We certainly do," answers Sjoukje Heimovaara. "Particularly in the themes that WUR is working on, such as climate change and biodiversity loss and the necessary changes in global food systems, it is extremely important that international students acquire and implement knowledge in their own countries. And that we learn from other countries. When our advisors sit down with the agriculture minister of Nigeria, for example, it is not surprising that the minister himself, or two or three of his/her policy advisors, are our alumni. So, international students are essential, for us and for the world."

She believes it is very important that the students of WUR get to know students from all over the world and thus gain a broader view than just the Dutch one. "Moreover, the metropolitan problem of student housing (which politically fuelled the problem of foreign students in the Netherlands) is not, or is hardly, an issue in Wageningen. At the same time, we understand that society has questions about the influx of international students and we therefore think, along with the other Dutch Universities, about how we can deal with this in a good way. For that reason, we have decided, for example, to offer a Dutch variant for a number of BSc courses."

Clear profile

There are 21 different BSc courses, of which 7 are in English, and 45 MSc courses. The fields of study are very diverse for an agricultural university, from molecular sciences and economics to communications and tourism. "We are not exclusively an agricultural university, but we do have a very clear profile regarding agrifood and our green living environment. We are into agriculture, but also into healthy food, green economy and biodiversity; that is our domain.

"Our motto is: to explore the potential of nature, to improve the quality of life. This means that we want to work in a world that functions within the carrying capacity of the planet. We want to understand how that world works from the molecular level to global food systems. We want to understand the impact of tourism on coastal areas and how this can be realised more sustainably. We want to investigate the impact

'It may sound a bit trite, but our ranking is mainly thanks to all our colleagues. If you have been the most highly rated university in the Netherlands for 19 years in a row and have scored high in international lists for years, then that is not due to administrators. They come and go. You simply have very good teachers, researchers and staff,' explains Sjoukje Heimovaara

(Photo: Duncan de Fey)

of policy on the agricultural economic system. Not only in the Netherlands, but also in the Global South, i.e. China, India, Indonesia, Brazil and Pakistan."

Challenges

WUR has been the most sustainable university in the world for seven years now. This is stated in the GreenMetric ranking. This list examines worldwide how scientific institutions deal with energy, climate, waste, transport, water, biodiversity and infrastructure. Sustainability in education and research is also measured. Last year, WUR joined the Nature-Positive Universities Alliance - a global network of more than 500 higher education institutions with the aim of, among other things, promoting nature on all campuses. This means, for example, that damage to nature as a result of WUR activities must be prevented or repaired. The campus is ecological and green, with sustainable buildings and facilities. There are natural gardens with rare plants and all kinds of insects, birds and bats.

WUR is an important institute for development cooperation, for limiting climate change, for reducing the environmental consequences of agricultural and horticultural production. "WUR knowledge and skills play a role in all those policy areas at regional, national and international level. But more importantly: what do the decision-makers do with that knowledge and expertise? By 2050, we must be able to feed 10 billion mouths worldwide within the limits of what our planet can support, i.e. sustainably. The science on this is crystal clear: we are facing unprecedented challenges in the areas of climate, biodiversity and water quality. These challenges are already having an impact on agriculture and horticulture worldwide, especially in the Global South.

"WUR can continue to produce knowledge and skills for evermore, and we will certainly continue to do so, but ultimately, we also need brave leaders. Leaders in business and politics who take that knowledge to heart and sometimes dare to make unpopular decisions that help us move towards a sustainable future."

'We' feeling

WUR alumni have a strong 'we' feeling, which you see much less at other universities. This is reflected, for example, in supporting each other's careers. How does WUR stimulate this? "We have an active alumni policy, which organizes return days, local meetings for the many alumni in the country, but also for our alumni who work all over the world. We publish 'Wageningen World', a magazine especially for our alumni, but the most important thing is that our alumni are and remain proud of what WUR does and means in the Netherlands and worldwide! That drive to make a difference really unites us," concludes Sjoukje Heimovaara.

The Best Summer Reads

Books you should not forget to pack

Chaïma Chammakhi

Plant breeding literature abounds: Bernardo, Fehr, Acquaah, Falconer, Allard, BD Singh... Hard choice for the holiday's reading. The people at Doriane software company compiled a list of the most useful plant breeding books to ignite the understanding of this topic. Which one would you read? One of the latest works in modern breeding? A reference work in the field? Or a less serious one?

No need to present ***Introduction to Quantitative Genetics*** by Falconer, classic of its kind, but about animal breeding and difficult to apprehend... In this article, I will highlight contributions of the most famous plant breeding authors and detail the practical applications of their work. By sharing those sources, I wish to contribute to plant enthusiasts and breeders.

The four classics

Breeding For Quantitative Traits In Plants by Rex Bernardo (Stemma Press, 2020, ISBN 978-0972072434)
The author, who has been a scientist in a seed company and a professor, wanted to help students and plant breeders with three main objectives:
- Understand the basics of plant breeding and population genetics.
- Learn how we can use quantitative genetics and modern tools for our breeding programmes.
- Get a grip on the theory, experiments and evidence behind these breeding concepts.

In later editions, the author details molecular marker applications all over the book, making it even more helpful. He has kept it updated and removed outdated breeding methods, such as microarrays and random mating designs. To get the most out of the book, the reader should have some knowledge of plant breeding and stats, but the author explains matrix algebra briefly for those who might be rusty. If someone wants to level up their plant breeding game, this might just be the perfect book

Principles of cultivar development by Walter Fehr (Macmillan Pub., 1993, ISBN 978-0070203457)
In this book, the author takes the reader on a journey, guiding him step-by-step through the exciting process of developing cultivars for different crop species. And guess what? He didn't hold back. He discusses all the alternative strategies available at each stage of the plant breeding process and spilt the tea on the ones that work like magic. He covers all the major types of cultivars grown commercially. From asexually propagated cultivars to pure-line cultivars, and hybrids, he covers it all in one or more chapters. The author has gathered all the basic methods used by plant breeders for cultivar development. As he mentions: "The purpose of the book is to provide some assistance in the decision-making process that every plant breeder encounters."

For more:
Introduction to Quantitative Genetics by Douglas Falconer and Trudy Mackay (Addison Wesley, 1996, ISBN 978-0582243026)
Principles of plant breeding by Robert Allard (John Wiley & Sons, 1999, ISBN 978-0471023098)

Modern books

Principles of Plant Genetics and Breeding by George Acquaah (Wiley Blackwell, 2020, ISBN 978-0470664759)
This book is a perfect blend of insights into fundamental principles and cutting-edge techniques of modern plant breeding. The author brought together classical and molecular tools to give a complete picture of how new crop varieties and plants are created. He has given the molecular genetics and breeding sections a major makeover, diving into all the latest plant breeding techniques like zinc finger nuclease, reverse breeding, genome editing and more. George Acquaah also has this neat description that lets us compare a whole bunch of molecular markers like RFLPs, RAPD, ISSR and SNPs. The updates don't stop there! The new 'Industry Highlights' sections give us real-world examples of how these breeding methods are being practically applied on varied species of plants. To make things even better, there are plenty of illustrations and self-assessment questions at the end of each chapter and relevant websites. It's like the author wanted us to have all the tools we need to succeed.

Chaïma Chammakhi is an agricultural engineer specializing in biotechnology and plant breeding at Doriane, Nice, France
www.doriane.com/ressources/blog

The 'Indiana Jones of Seeds' takes you to a worldwide journey

For more:
Linear Selection Indices in Modern Plant Breeding by Jesus Céron-Rojas and José Crossa (Springer Cham, 2018, ISBN 978-3319912233)
Seed Science and Technology by Malavika Dadlani and Devendra Yadava (Springer Singapore, 2023, ISBN 978-9811958908)

Less serious

Alice in the Land of Plants: Biology of Plants and Their Importance for Planet Earth by Yiannis Manetas (Springer Berlin, 2012, ISBN 978-3642432323)
Get ready to have your mind blown with this book! The author takes on some mind-boggling questions about plants that challenge our perception of them. We often wonder why plants don't move like animals. But guess what, they've got some clever ways to do things without moving! They can have sex and defend themselves, even though they're non-mobile. Plants also communicate with each other, like a hidden world of whispers and signals. The author brilliantly highlights that plants are far from simple creatures. They've got specific behaviours and intelligence which we might have overlooked. It's like taking a trip down the rabbit hole with Alice, discovering a whole new world of plant wonders. And the best part? The author explains all this fascinating biology in a way that even your grandma could understand.
The Murder of Nikolai Vavilov by Peter Pringle (Simon & Schuster, 2011, ISBN 978-1451656497)
Embark on a thrilling journey through the life of Nikolai Vavilov. This extraordinary scientist had a big dream – to conquer world hunger using the power of genetics to create super plants that could grow anywhere. Supported by none other than Lenin himself, Vavilov set up the worlıd's first seed bank, a magnificent living museum of plant diversity that amazed scientists all over the world. But, when Stalin came into the picture, things took a dark turn. Vavilov's vision clashed with political forces. He faced persecution and false accusations. A real-life drama, filled with love, revolution and war.
The Seed Detective by Adam Alexander (Chelsea Green Publishing, 2022, ISBN 978-1915294081)
Good read for people who studied plant breeding mostly at university, where local traditional breeding is not always highlighted. Travel book like no other, this autobiography by the 'Indiana Jones of Seeds' takes you to a worldwide journey in the quest of ancient varieties. Discover local traditional plant breeding methods and follow the guide to unveil the breeding targets of farmers across the centuries: sell or eat their produce. Traits like taste and yield are very high on the priority list.
Garlic from Oman, peppers from Morocco, blue maize from Arizona… as the subtitle puts it, you are about to *uncover the secret histories of remarkable vegetables*. An example? In Europe, we are used to flavouring gherkin jars and other pickles with tiny onions. These are called Pearl Onions (*Allium ampeloprasum)* but, actually, it's not an onion but a close relative of leeks. Oh, and did you know asparagus has been a delicacy for thousands of years? Appreciated for its medicinal properties (diuretic and supposedly aphrodisiac), it's been gathered for pharaohs in Egypt, ancient Greeks, in Mesopotamia and even in India. Asparagus plant breeding started in the Roman Empire. They were so keen on it that they conveyed carts of it up the Alps to keep them frozen and savour some any time of the year.
Seeds "are a visceral connection that I have with my most distant ancestors. It takes me back way beyond civilization," says Alexander.
For more:
The Selfish Gene by Richard Dawkins (Oxford University Press, 2006, ISBN 978-0199291151)
Crops and Man: People, Plants and Their Domestication by Thomas Stalker, Marilyn Warburton and Jack Harlan (ACSESS, 2021, ISBN 978-0891186335)

Europe's journey with agricultural **innovation**

Inge Corino and Ben Excell

The 1970s and 80s marked the inception of genetic engineering with an explosion of research breakthroughs, from the development of restriction enzyme tools and the creation of the first recombinant DNA molecules to the first genetically modified organisms (GMOs). Since then, Europe's journey with genetic engineering has been marked by optimism, concerns, and ongoing debate.

Between 1996 and 1999, 1.8 million cans of Flavr Savr tomato paste were sold by the supermarket chains Sainsbury's and Safeway in the UK

Throughout the course of agriculture's multi-millennia-long history, humans have actively shaped the genetic composition of the crops they grew. Through the practice of domestication, prehistoric farmers were responsible for the creation of the crops we know today, such as maize, wheat, and brassica varieties. This, somewhat rudimentary, selective breeding practice evolved with the emergence of genetic science in the 20th century. While the continent has witnessed significant achievements in genetic engineering, it continues to grapple with complex questions about risk assessment, public engagement, and regulatory frameworks.

Initial optimism

When genetically modified (GM) crops were introduced to the market in the 1990s, there was widespread optimism among scientists and policymakers about their potential to address agricultural challenges, improve food production, and enhance nutritional quality. Many viewed genetic modification as a groundbreaking technological advancement with the potential to liberate us from the constraints of a crop's genome. One of the first successes for GM crops, albeit a commercial failure, was the introduction of the Flavr Savr tomato to the consumer market. Modifications enhanced the shelf life and flavour of the tomatoes by inhibiting the softening of the fruit as it ripens. Developed by Calgene, a biotechnology company, it was approved for sale in the United States (US) in 1994 and from 1996-1999 it was available in the United Kingdom (UK) in the form of tomato paste.

After the Flavr Savr tomato, several more GM crops were developed for commercial cultivation in the late 1990s. Most of these modifications focused on resistance against pests and tolerance against herbicides, such as Bt maize and Roundup Ready Soybeans.

In the European Union (EU), only Bt maize was authorized for cultivation. This was in 1998. Shortly thereafter, the EU enacted a de facto moratorium on new approvals of GM crops pending new regulatory laws in 2001 (cultivation) and 2003 (import and consumption). To this day, Bt maize remains the only commercial GM crop approved for cultivation in the EU.

As GM crops began to be commercially cultivated, some activists and consumer advocacy groups became increasingly more vocal about their fears of long-term health and environmental impacts of GM crops, and the dominance of agrochemical companies in the agricultural sector. The introduction of Roundup Ready crops especially, led to fiery debates about the environmental consequences of increased pesticide use, the spread of transgenes to wild relatives, and risk of herbicide-resistant weeds.

These growing concerns led to a wave of violent protests by activists, who focused their attention on GM field trials. In 1997 France, a coalition of radical farmers' union and environmental activists strategically destroyed an experimental rapeseed trial owned by Monsanto. This movement then spread across Europe, with Germany alone witnessing over 100 acts of vandalism. By the end of the 1990s, vandalism of field trials had become widespread, with significant consequences. The threat of destruction, combined with political pressure and challenging market conditions, discouraged many companies and public institutions from pursuing further GM crop projects in Europe. For instance, in France, which once hosted the highest number of field trials in Europe (totalling 590), no requests have been submitted by academic laboratories or private companies since 2008. Trials that continued incurred exorbitant security costs. As a result, field trials became unfeasible in many European countries, dealing a severe blow to Europe's research standing globally.

Regulation & bans

Despite efforts by proponents of GM crops to address safety and regulatory concerns amidst mounting public concerns, opposition to genetic engineering persisted in various forms, including legal battles, grassroots activism, and political lobbying.

In the 2000s, the resistance to GM crops led the European Union to implement possibly the most stringent regulations on GM crops in the world, including mandatory labelling, complex approval processes for cultivation and import, and guidelines concerning the coexistence of GM and non-GM crops.

So far, the EU has only authorized the import and

> 'Field trials became unfeasible in many European countries'

At demonstration maize field plots in Fairmont, USA, farmers can compare which variety has better growth and yield

consumption of specific GM varieties of cotton, maize, oilseed rape, soybean, and sugar beet, the majority of which were for use in animal feed. In 2018 the EU imported more than 45 million metric tons (MT) of soybean, maize, and rapeseed products. The share of GM products of the total import is estimated at 90-95% for soybean.

In March 2010, a potato called Amflora joined BT maize as the second GM crop approved for commercial cultivation in the EU. Amflora was withdrawn from the EU market in 2012, and in 2013 its approval was annulled by an EU court.

Several European countries, such as France and Germany, imposed national bans or moratoriums on GMO cultivation on their territory - since 2010, cultivation of Bt maize has been banned in 18 EU member states. Spain has been the most accepting country to GM crops and has produced over 95% of GM maize in Europe since 2014.

Debate & polarization

While conventional GM technology failed to gain widespread public acceptance, New Genomic Technologies (NGT) incorporating breakthrough genome editing technology such as CRISPR emerged in the 2010s as a promising alternative. NGTs enable directed editing of the genetic code, and can therefore be used to precisely control the expression of a plant's genes without the need to add any genetic material from outside the genome. A new term was coined - genome editing (GE).

The legislative distinction between GE and GM technologies has proven difficult. In a significant ruling in 2018, the EU's highest court determined that GE crops should be subject to existing GM regulations. However, in light of growing concerns over climate change and market competition, the European Commission initiated a review in 2021, deeming the GM legislation from the early 2000s "not fit for purpose". Subsequently, in February 2024, the European Commission accepted a proposal for the deregulation of GE crops, signalling a shift in EU regulation.

Some European nations outside of the EU demonstrated earlier steps in embracing GE. In Norway, revisions have been recommended to ease regulations on GE crops in 2022. That same year, Switzerland voted to exempt crops edited without foreign DNA from their GM regulations. Following Brexit, the UK has made the largest strides in legalizing and supporting the use of GE in crop development.

Nevertheless, the debate over genetic engineering in Europe persists, with entrenched polarization. Gene-edited crops, such as CRISPR-edited varieties, have reignited debates about regulation, labelling, and the ethical boundaries of genetic engineering in agriculture.

Future perspective

As Europe navigates the complexities of regulating genetic modification and editing, the continent remains at the forefront of global discussions about the intersecting futures of agriculture and biotechnology. The EU's decision to further the proposal on deregulation of GE crops reflects an acknowledgment of the necessity to balance regulation and technological advancement. Many see it as an opportunity for Europe to once again take centre stage in agricultural innovation. However, the proposal still needs to be approved by the EU member states and this is not likely to occur until after the EU elections in June, by which time new opinions might have formed.

An ongoing discussion also remains on the practical impact of NGTs and whether they can realize their promised benefits. Few GE products have so far been introduced to the worldwide consumer market as companies remain wary of the potential reputation such crops will have amongst consumers.

Europe's genetic engineering journey reflects the complex interplay of scientific advancement, public opinion, and regulatory policy. The ongoing dialogue between these elements will determine the course of Europe's agricultural future.

Tulips from ~~Türkiye~~ Amsterdam

First **trade catalogue** stimulated bubble

John van Ruiten

Besides cheese, is there anything more Dutch than tulips? Maybe windmills or clogs. But it has not always been that way. As almost everybody knows, tulips originate from the Türkiye and Turkmenistan region and the first bulbs came to Europe (or more precisely to Vienna) in the middle of the 16th century. But since tulipmania, the flower has been inextricably linked to the Netherlands.

It was Carolus Clusius, appointed as the first prefect of the newly established botanical garden in Leiden University in 1590, who brought some bulbs with him from Antwerp, Belgium, and planted them in his garden. To his surprise the bulbs grew very well in the cold and wet climate of the Low Countries. The popularity of the new flower was great. Its shape was so different from other known flowers. And the colour was intense. Very soon, painters started to make illustrations of this new species.

Tulipmania

One of the most famous illustrations was made by a nurseryman and painter called Emanuel Sweerts. In his beautiful book 'Florilegium Amplissimum et Selectissimum' (the most extensive and the most selective collection of flowers), produced in 1612, he presented a selection of tulips that he had available for sale from his nursery. This book, in fact a catalogue, received a lot of attention and probably supported the popularity of the new crop. A number of editions appeared in the period until 1647. Undoubtedly, the book contributed to what has become known as 'tulipmania'.

Emanuel Sweerts composed the first trade catalogue of tulips, Florilegium Amplissimum et Selectissimum, in 1612 (Source: Emanuel Sweerts, Wellcome Collection)

In the years 1634-1637, the value of the recently introduced flower bulbs reached extremely high levels. At the height of the market, at the beginning of 1637, contract prices for individual tulip bulbs were about 4,000 Dutch guilders. That was more than ten times the annual wage of craftsmen. You could buy a huge house in Amsterdam with that amount of money. The dramatic collapse of the market for bulbs in that year is well known as the first case of speculation in goods coming to an end.

To this day, it is still not precisely known what caused the sudden fall in prices in the first week of February of that year. Obviously, new financial legislation in the United Provinces to prevent speculation played a role, but it was perhaps also related to the fact that growing and propagating flower bulbs was successful, and that the available quantities for sale grew rapidly. Exclusivity was gone. In 1639, the Dutch court also decided to cancel all existing contracts that had been previously made.

Trader

Initially, Emanuel Sweerts (1552-1612) was in fact more of a bulb trader than a bulb grower. He was born in a well-to-do family of merchants in Zevenbergen. He moved to Amsterdam and his main products for trading were 'rarities', peculiar goods that came on ships to the Netherlands, mainly from so-called colonies, countries that were 'discovered' by Europeans. Many new plant species arrived and some of the merchants planted them in their gardens and presented them in catalogues.

Sweerts was one of the leading sellers of seeds, bulbs and planting stock at the time and his garden grew. Around 1610, Sweerts was also connected to the gardens of Emperor Rudolf II in Vienna, Austria. At that time, he produced his book, also using many plates and examples from others who cultivated plants around Europe (copyright was not yet known). He passed away in Amsterdam in 1612, very shortly after the publication of the first edition of his famous book.

The name of Emanuel Sweerts is not well known. But it is nice to know that the Dutch bulb traders' organization, Royal Anthos, used his name to create an award for outstanding people that have professionally contributed greatly to the interests of the flower bulb sector in the Netherlands. Since its introduction in 1990, it has only been awarded to seven people or organizations.

Ir. J.E.M. van Ruiten recently retired as director of Naktuinbouw, Roelofarendsveen, the Netherlands

Increasing quality of **hybrid rice**

Wladimir Tameling, Wilco Ligterink, Dwarkesh Parihar and Paresh Verma

Multiplex gene editing as a separate validation tool to identify desirable combinations of genetic variants in combination with effective random mutagenesis breeding, promises to be a valuable approach for developing better crop varieties, which are exempted from complex GM-legislation.

Wladimir Tameling is scientist and Wilco Ligterink is team leader Innovation for crops at KeyGene, Wageningen, the Netherlands, Dwarkesh Parihar is head biotechnology and Paresh Verma is director research at Shriram Bioseed Research, Hyderabad, India, contact: wladimir.tameling@keygene.com

Rice (*Oryza sativa*) is one of the world's most important staple crops and a primary food source for more than half of the global human population. Originating in Asia over thousands of years ago, rice cultivation has spread across continents, adapting to a wide range of climates and agricultural practices. Rice is a cereal grain that plays a crucial role in food security and the economy of many countries, particularly in Asia, Latin America and parts of Africa. Its yield, determined by the quantity of grains produced per unit area, is a critical factor in ensuring food security. Advances in rice breeding and genetics have led to improved varieties with enhanced yield potential, resistance to pests, diseases and environmental stresses, contributing to increased yields and sustainability.

Despite these advancements, rice cultivation faces challenges such as climate change, water scarcity and the need for sustainable farming practices to ensure that this vital crop continues to nourish the growing human population well into the future. Additionally, an increase in yield potential is needed because of the increasing world-population and decreasing area of arable land. This requires the development of high yielding rice varieties. Hybrid rice can have much higher yields, but in India the difference with non-hybrid rice was not yet significant enough. Moreover, the grain quality is often lower, compared to traditional inbred varieties. To improve hybrid rice in India, the yield and quality characteristics need a boost.

Improved rice hybrids

With the aim of bringing novel and improved rice hybrids to market, the Indian seed company Shriram Bioseed and research company KeyGene, in the Netherlands, started a multi-year strategic co-development research programme in 2015 for the development of improved rice hybrids with higher yield, increased tolerance to abiotic stresses and better grain quality for consumers in India and South East Asia.

This programme synergistically bundles Shriram Bioseed's proprietary germplasm, breeding, product development and commercialization expertise with KeyGene's innovative crop improvement technologies and know-how. This enables the improvement of hybrid rice with increased precision and efficiency.

In rice, improving grain yield is the most important breeding goal. In the second half of the last century, rice grain yield has more than doubled in most parts of the world in a process known as the 'Green Revolution'. This was possible due to two major genetic improvements: improved harvest index and plant architecture through the use of semidwarf genes and generation of productive hybrids based on heterosis. Rice grain yield is a complex agronomic trait that can be divided into four major subcomponents: 'number of plants per unit area', 'panicle number per plant', 'grain number per panicle' and 'grain weight'. The branching characteristics of shoots and panicles have been recognized as significant traits for improving grain yield. However, apart from panicle length, less focus has been put on the genetic control of the entire panicle architecture, such as the number and length of its primary and secondary branches.

To increase yield, it is important to reveal and understand the genetics behind its subcomponent traits. Shriram Bioseed and KeyGene targeted the 'panicle number per plant', the 'grain number per panicle', 'grain size' and 'grain weight' to increase grain yield and the trait 'rate of chalky grains' to improve grain quality.

Candidate genes, which have the potential to improve these individual traits when mutated (conversion to beneficial allele), were selected based on public research data. These data were based on phenotypes of plants carrying a beneficial allele, obtained either from existing germplasm, random mutagenesis, gene overexpression/silencing or gene editing. The subsequent induction (through random mutagenesis) and detection of mutations is performed with the KeyPoint® Breeding technology* and the mutants are phenotyped for the different traits (reverse genetics approach, see below).

Drought resilience

Amongst cereals, rice as a paddy field crop is particularly susceptible to water stress during water deficit and it is estimated that 50% of the world rice production area is affected by drought. Of the different developmental stages, the reproductive stage is most sensitive to drought stress and therefore highly conducive to large yield losses. Therefore, this developmental process is intensively studied to identify

Experimental field with KeyPoint® Breeding plants in Telangana, India

Increasing yield, drought resilience and grain quality

stress-responsive genes that may provide tolerance and thereby yield protection under drought.
A large number of abiotic stress responsive genes has been reported in a variety of plants, including rice and *Arabidopsis*. Efforts to identify and characterize these stress-responsive genes have uncovered several abiotic stress regulatory networks in rice. With the aim of improving resilience to pre-flowering drought stress, several candidate genes were selected as additional targets in this collaboration.

Genetic variation

To go from a set of candidate genes with the potential to increase grain yield and quality, and drought resilience (yield protection), to rice germplasm that harbours these trait improvements, a so-called reverse genetics approach is a powerful technique. There are several reverse genetics methods, but to be able to develop germplasm that is exempted from GM-risk assessment, a random mutagenesis approach is the most suitable for inducing genetic variation. In order to allow efficiency in the subsequent breeding process, the required rice mutant population is generated with an elite hybrid parental line that already harbours multiple desired characteristics. Reverse genetics approaches typically rely on the effectiveness of the detection of sequence alterations in target genes to identify allelic variants within the mutant population. Efficient detection is possible with the KeyPoint® technology, a high-throughput mutation/polymorphism discovery technique based on massive parallel sequencing of target genes, amplified from thousands of mutants in the population. It combines multi-dimensional pooling of large numbers of individual DNA samples and the use of sample identification tags ('sample barcoding') with next-generation sequencing technology.
After detection of mutant plants carrying mutations in the candidate genes, the effect of these mutations on the functioning of the genes and on related yield and drought resilience characteristics is determined.

Phenotyping

For subsequent analysis of the rice mutants, 'precision' phenotyping protocols are needed, which enable the identification and quantification of the causal relationships between mutant alleles and the target traits (yield subcomponents, grain quality and drought tolerance). Depending on the trait, these protocols involve growing rice plants under controlled conditions in the field, greenhouse or growth chamber, and rely on morphological phenotyping in a

Discovering bold horizons

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Panicles from wild type elite line (left) and a derived KeyPoint® Breeding plant with increased grain number per panicle

classical or digital manner. For each trait, statistically appropriate protocols have been defined, developed and validated. Mutants that show a reliable relationship between the mutant allele and a significant improvement in the target trait are both used for backcrossing with its own wild-type background, and for introgression into additional elite parental lines. The back-crossing process is to remove the undesired background mutations elsewhere in the genome.

Rapid phenotypic validation

Although yield can already be enhanced by introgression of a single beneficial allele that improves a single subcomponent yield trait, the ultimate goal is to stack all the beneficial alleles to improve all the above mentioned (subcomponent) traits in hybrid rice. Such a hybrid will result in an even larger increase in grain yield and quality.
Using random mutagenesis and cross breeding to generate the many possible allele stack combinations and to phenotype such plants, in which the beneficial alleles are all present in a homozygous state, would take a lot of effort and time and a high number of crossing and selection steps.
Multiplex gene editing (GE) can be used as a validation pipeline to allow for early phenotyping of gene stacks without the necessity to make crosses. This will generate insight into which beneficial allele combinations work synergistically for improving grain yield and quality. Drawing on these insights, similar or identical alleles of these genes within the aforementioned non-GE mutant population can then be selected for stacking using traditional breeding methods. This approach would enhance efficiency and lower expenses.

Outlook

With this collaboration, Shriram Bioseed and KeyGene are well under way to bringing newly developed, high-performing and high-quality hybrid rice seeds to market, thereby contributing to future food security in India and South East Asia and to enhanced sustainable agricultural practices. These new hybrids hold the promise of being beneficial for both farmers and consumers; they will enable farmers to obtain higher yields, especially those farming in harsh climate conditions, while also meeting the grain quality demands of rice consumers. ❦

*The KeyPoint® Breeding is protected by patents and/or patent applications owned by KeyGene N.V.

ABZ Seeds

Only the **signatures** were missing

Monique Krinkels

Friday 12 April 2024: for the last time as director of ABZ Seeds, Gé Bentvelsen closes the door behind him of the striking Cape Dutch style house. From tomorrow on, he will be a pensioner, as on his 67th birthday he is entitled to a state pension in the Netherlands. But whereas most people celebrate this moment in their lives, for Gé Bentvelsen it means an uncertain future as there is no successor.

It is not lack of preparation for this moment in time. "We started planning the transfer to a new owner years ago, as I was sure I would like to enjoy the freedom of being a pensioner," he explains. "There is more to life than work alone. On the other hand, ABZ Seeds is my life's work, so I care very much about the company's future. The last few weeks, I have tried to prepare our staff for the new future. The breeding activities are being phased out for the time being, as I will not be here to examine the offspring. And I am no longer 'in house' every day. I had to reassure my colleagues that they can manage just fine without me. I will continue to come in twice a week and I am only a phone call away if need be. But from now on, I am a pensioner."

Crazy idea

Gé Bentvelsen started the strawberry breeding company ABZ Seeds in 1993. Already back in 1976, one of the breeders at Sluis & Groot (nowadays part of Syngenta) wanted to create F1 hybrid strawberries. "Willem Sterk strongly believed it would be possible to breed parent lines of *Fragaria* x *ananassa Duch*, an octoploid." Most colleagues – and statisticians for that matter – thought it an impossibility to put it mildly, but in the end he proved it right.

"After I joined Zaadunie (S&G) as an ornamental breeder in 1984, the experiments of Willem Sterk piqued my interest. Soon after, the director of breeding asked me to execute a feasibility study on breeding strawberry F1 hybrids for commercial fruit production. I set up two separate breeding programmes, one in the Netherlands and the other in Spain."

In 1991-1992, Zaadunie went through a difficult period and they decided to discontinue the strawberry breeding project. I was asked to contact interested parties for a take-over of the breeding programme. But this did not bring us the right partner. In the summer of 1992, Jasper Veldhuyzen van Zanten, the former R&D director of Zaadunie, invited me for a meeting at our Sarrians breeding station in Provence. He asked me the historical question if I had ever considered starting my own breeding company? I answered him that I thought about it almost every day, but that he might tell me how! Then he answered: in that case, I will help you to find out!

Together we decided to continue the breeding programme under the company name ABZ Aardbeien uit Zaad BV. The endeavour – or crazy idea, as some might call it – met with success. Especially as an edible ornamental, the strawberry plants soon found their way to garden centres and consumers. Several series with, for instance, extra large flowers, semi-double flowers and upstanding plant architecture, flower colours ranging from white, several shades of pink to red, saw the light of day. And ABZ Seeds won many industry awards, such as the Fleuroselect Award with F1 '*Toscana*', All America Selections Award with F1 '*Delizz*'® and IPM Innovation Award with F1 '*Summer Breeze Snow*'.

Game changer

It took a while longer to convince professional strawberry growers. For many people, strawberry seems to be a relatively minor crop, but it is a high-value and popular summer fruit. Not only in Europe and Northern America, but even more so in China and Japan. The global fresh strawberry market was worth 17.8 billion euro in 2023.

"We have developed F1 hybrids for every production system, every market and every season," states Gé Bentvelsen. "Moreover, our varieties are everbearing, day-neutral types, guarantying a harvest of up to 2 kilos of fruits per plant in a season. And we focussed from the start on the quality of the strawberries. As F1 hybrids, the plants are healthy, vigorous and can be grown in a sustainable way. To please not only the growers, but also retailers and consumers, our varieties have a firm structure, an attractive colour and a gourmet taste."

Traditionally, strawberries are propagated by runners. Despite the many disadvantages, like disease susceptibility, it took over 25 years before other strawberry breeders tried to copy ABZ Seeds' successes. Last year Bayer, Rijk Zwaan and Sakata announced their activity in hybrid strawberry breeding programmes. "Of course, the Japanese company Miyoshi has been involved in F1 hybrid strawberries for years," says Gé Bentvelsen, "although they focus on short-day, low-chill varieties for winter production in tunnels. Most Japanese F1 hybrid strawberry varieties come from the government's breeding programmes, initiated by the ABZ variety 'Elan', introduced in that country at

In the middle of the meadows surrounding Andijk, the Netherlands, the head office of ABZ Seeds catches the eye. The architecture is inspired by the traditional Dutch houses in the Stellenbosch wine district of South Africa

the end of the nineties. They were quick to recognize the advantages.” At the International Soft Fruit Conference last January, the development of hybrid strawberries was one of the main topics. It was called a game-changer in breeding. The Limgroup, a Dutch breeding company specialized in asparagus and runner propagated strawberries, announced their portfolio addition with strawberries from seed with much fanfare as a ‘*Tesla transition in strawberry breeding*’.

Responsibility

“When we began to explore the possibilities for a future takeover, there were over twenty companies that showed interest. During the process, the most promising companies were chosen until there was only one left. To ensure continuity, we selected a new director and a new breeder to replace me. Both are eager to start but have to wait until the final decision has been made.”

For ABZ Seeds, life has come to a standstill. Gé Bentvelsen cannot wait to start his new life, but feels responsible for the company he founded. “What I want to do is spend more time at our forest gardening project, ‘*De Haling*’, initiated by the Institute for Nature Education IVN. Agroforestry is booming in the Netherlands. It offers a great variety of food products, vegetables, as well as fruits, and people may harvest them for their own use for free.”

In 2020, a group of enthusiastic volunteers obtained 1.2 hectares of grassland and started creating Food Forest ‘De Haling’. It consists of different growth layers with all kinds of trees, shrubs and herbs, with as many edible items as possible. These can be nuts, berries, flowers, leaves or roots and, of course, many strawberries! The forest is constructed in such a way that maintenance is minimal as everything has to be done by volunteers.

The biodiversity in a food forest is enormous. “For instance, we introduced ‘haskap’, or blue honeysuckle berries, a rare *Lonicera* species that is virtually unknown in the Netherlands.” A QR code at the entrance explains when which crops are flowering and when they are ready to be harvested. The goal is of course education: teaching people where their daily meals come from. “Besides the food forest, I have been a nature guide since my student days, a passionate bird watcher, an enthusiastic tour cyclist and, since last year, the proud owner of an e-boat. No way will I get bored.”

But what if there is no successor in the short term? “I might continue as owner of the company,” he says reluctantly. “We have already found a director and a breeder to take over the daily tasks. However, I am still hopeful that white smoke will be visible from the chimney of Holland Strawberry House before 3rd May, the day of my farewell party.”


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agricultural and
horticultural crops
• Description of varieties
• Identity Investigation
Education
• Regular training courses
• In-company training
courses
• Plant Breeders' Rights
for Food Security and
Economic Development

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: a seed fiddle.

Spotlight on

A seed fiddle

Monique Krinkels

In the early 1800s, portable, hand-operated broadcast sowing machines were introduced in the U.S.A. These were mainly used for sowing grass and clover seeds. The most popular was the seed fiddle, which took its name from the fiddle-like action required to distribute the seed. It was a direct improvement on hand sowing. The first seed fiddle was exported to Western Europe around 1850.
The fiddle was carried over the shoulder by a strap. It consisted of a canvas seed bag housed in a small rectangular box frame, with a horizontally mounted finned disc. The disc was rotated in alternating revolutions by a leather thronged bow which was moved from side to side to broadcast the seeds in a wide arc from the tray. The sower could adjust the rate of seed flow onto the distributor to match the length of his stride, with up to ten different settings. A person could sow two acres an hour using a seed fiddle.
In the UK, a company named DLK of Kilmarnock introduced its own seed fiddle in the 1950s under the brand name ‘Aero’. It was typically used on smallholder farms where seed drills and tractors were not cost efficient. At the time, they sold for 27 shillings and sixpence plus a shilling for carriage, the equivalent of 1.61 euro.

ISF Pea Pest List

Key findings of **assessment**

Bénédicte Lebas, Bertrand Monsimier, Emilie Froussart, Harmen Hummelen, Samer Habash and Rose Souza Richards

The Regulated Pest List Initiative (RPLI) of the International Seed Federation has conducted an assessment of 87 pests that are regulated on pea seed for international trade, at the time of the project in 2022. The scientific information related to the regulated pests was verified to see whether pea seed can be a source of introduction and spread of these pests.

The production of pea seed can be impacted due to a number of pests that affect pea plants in the field. Types of pests affecting pea plants include bacteria, fungi, nematodes, insects and viruses. A number of these pests may be associated with seed, as surface contaminants (such as some fungi and some insects) or as seed-borne (such as specific bacteria and viruses).

Pea (*Pisum sativum*) is a herbaceous annual plant in the family *Fabaceae*. Several varieties of pea are commonly cultivated, for example, garden pea [var. *hortense*], sugar pea [var. *saccharatum*] and field pea [subsp. *arvense*]. The worldwide production of green pea and dry pea in 2022 was estimated at 20.9 and 14.1 million metric tonnes, respectively (FAO stat, 2022, https://www.fao.org/statistics/en/).

Seed is a pathway

The assessment concluded that seed is a pathway for the introduction and spread of the pest for only 20.7% (18/87) of the pests regulated on pea seed (*see* table). Insects are the most represented with 10 out of 18. This is because part of the life cycle of these insects takes place in pea seeds during storage with larvae feeding inside the seed. Several beetles of *Bruchus* have been detected in seeds of pea by visual inspection (of external damage to seeds observed by naked eye or with a microscope) and/or by X-ray. Other insects found on pea seed are the moths *Cydia nigricana* (pea moth) and *Spodoptera praefica* (western yellow striped armyworm). The larvae of *Cydia nigricana* attack the young pods and feed on the developing seeds until pupation. An inspection of pea seeds was able to visualize *Spodoptera praefica* by using a floating method. The only nematode regulated on pea seed, for which seed is a pathway, is the stem and bulb nematode, *Ditylenchus dipsaci*. This nematode can parasitize and multiply on any plant parts, including seeds. Pea seed is also a pathway for the bacteria *Erwinia rhapontici*, *Pseudomonas syringae* pv. *pisi* and *Pseudomonas syringae* pv. *syringae*, the fungi, *Didymella pinodella* and *Didymella pinodes* and the viruses, *Pea early-browning virus* and *Pea seed-borne mosaic virus*. These pests were detected from naturally infected pea seed and transmitted to seedlings grown from these seeds. These pests are important pathogens of pea and cause important yield losses.

Not a pathway

Pea seed is however not a pathway for more than half (45/87) of the pests regulated. For 25.3% (22/87) pea is not known to be a natural host. No scientific references indicate that pea is a host for 12 pests, nor that pea seed is a pathway (one bacterium, two fungus, two viruses, five beetle species, a moth, and a mealybug). In the case of *Bean golden mosaic virus* and *Strawberry latent ringspot virus*, these viruses are regulated on pea seed although pea is not listed as a host on any of the database searched (for example, APS diseases of pea; EPPO Global database), nor in the scientific literature. For the 10 other pests, pea has been used as an experimental host but there is no scientific evidence of pea being a natural host. For example, pea has been used as an experimental host for mechanical and nematode transmission studies of viruses (such as *Red clover mottle virus*, *Tobacco ringspot virus* and *Tomato black ring virus*). Pea plants have also been used as an experimental host for the fungus *Ascochyta medicaginicola*, the

Categorization of pests regulated on pea seeds, based on an assessment of the scientific literature

Pest	Seed is a pathway	Seed is not a pathway	Pea is not a host	Seed as a pathway is uncertain	Not applicable*
Bacterium	3	4	3	1	0
Fungus	2	3	3	3	4
Insect	10	4	7	4	7
Nematode	1	1	0	0	1
Virus	2	11	9	4	0
Total (number)	18	23	22	12	12
Total (percentage)	20.7%	26.4%	25.3%	13.8%	13.8%

* for pest regulated at genus or family level

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The assessment of pests regulated on pea seeds has revealed that over half of these pests do not use seeds as a transmission pathway

bacteria *Pseudomonas savastanoi* pv. *phaseolicola* and *Pseudomonas syringae* pv. *tabaci*.

For 26.4% (23/87) of the regulated pests on pea seed, pea is a host, but pea seed is not a pathway for the introduction and spread of the pest. Viruses are the most represented with 11 out of 23. Some of the pests have been reported to be seed-borne (for example, *Phomopsis longicolla*, *Pseudomonas viridiflava*, *Rhodococcus fascians*, *Tomato spotted wilt virus*), of which some are known to be transmitted by seed in some crops other than pea (such as *Alfalfa mosaic virus*, *Broad bean true mosaic virus*, *Broad bean wilt virus*, *Cucumber green mottle mosaic virus*, *Peanut mottle virus*, *Peanut stunt virus* and *Xanthomonas axonopodis* pv. *phaseoli*). However, there is no evidence of transmission by seed of these pests in pea.

As an example, *Alfalfa mosaic virus* (AMV) has been reported to be seed transmitted in several crops, such as alfalfa (*Medicago sativa*), chickpea (*Cicer arietinum*) and lentil (*Lens culinaris*). No study has yet shown that the virus is seed transmitted in pea. Furthermore, it was shown that AMV was not detected in any of the 30 commercial pea seed stocks tested. Aphids are deemed responsible for the transmission of AMV from infected plants to healthy plants in the field. Other aphid transmitted viruses, namely *Bean leafroll virus* and *Soybean dwarf virus*, are phloem-limited viruses that are not known to be transmitted by seed.

As for *Tomato spotted wilt virus* (TSWV), it is seed-borne on pea; TSWV has been detected in seed of pea, but it was not transmitted from seed to seedlings.

Limited evidence

Seed as a pathway was concluded to be uncertain for 13.8% (12/87) of the pests regulated on pea seed. This is because the scientific evidence is limited. Weevil eggs of *Callosobruchus analis*, *Callosobruchus chinensis* and *Callosobruchus maculatus* could reach the adult stage when feeding on peas under experimental conditions. However, the experiment has not been repeated under commercial storage conditions. No other references on weevil feeding on pea seeds are currently available. Similarly, the pod borer, *Etiella zinckenella*, was recovered from seeds in field cages and laboratory studies. However, there are no references indicating seeds are an entry of the pest in pea in natural conditions.

The fungus *Cladosporium cladosporioides* is a widespread mould that occurs on a wide range of outdoor and indoor surfaces and materials. It was isolated by blotter and agar methods from non-disinfected seeds, as well as from surface disinfected seeds harvested from field pea (*Pisum sativum* subsp. *arvense*) cultivars of commercial fields. The fungus was detected in very few cases of young field pea seedlings under experimental conditions. However, because of the presence of other fungi, such as *Ascochyta pinodes*, the impact of

Peas are grown worldwide for their edible seeds as dry or green and also green pods

C. cladosporioides on the seedlings is unclear. Scientific information on whether seed is a pathway was limited for a number of viruses that are regulated on pea seed. This is the case for *Cucumber mosaic virus* (CMV) and *Bean yellow mosaic virus* (BYMV). CMV and BYMV were detected by serological assay on 1 and 3 seedlings, respectively, of 30 commercial pea seed stock samples. However, the pest management strategies put in place to prevent the inadvertent infiltration of aphids, which can efficiently transmit these viruses, is not clear from the paper.
Another example is *Broad bean mottle virus* (BBMV), which is also transmitted by aphids. Only one publication reports on the possible transmission of BBMV by pea seed. BBMV was transmitted in pea seed at a rate of 1%, with seeds harvested from mechanically inoculated plants. However, it is not clear if insect vector management strategies were put in place to prevent the inadvertent infiltration of aphids in the greenhouse. Furthermore, the experiment was not repeated with naturally infected seeds. No other references were found indicating BBMV is seed transmitted in pea. In the case of *Broad bean stain virus* (BBSV), for which there is no known insect vector, the situation is similar in terms of the absence of confirmation of seed transmission using naturally infected seeds.

Genus/family level

Some pests are regulated at the genus or family level on pea seed, encompassing 13.8% (12/87) of the regulated pests. However, as not all species within a genus (or family) share identical transmission characteristics and have the same host range, an assessment of genus (or family) level is not possible. This is the case for the insect family *Bruchidae* and several genera of fungi, insects and nematodes. For example, the regulated species of the insect genus *Bruchidius* were concluded to be either not a host of pea (for *B. atrolineatus* and *B. quinqueguttatus*) or pea seed is a pathway (for *B. incarnatus*), based on the current scientific literature. This is why it is recommended in ISPM 38 – International movement of seed (http://www.fao.org/3/i7219en/i7219en.pdf) to assess pests at the species level.

Conclusion

The assessment of pests regulated on pea seeds has revealed that over half of these pests do not use seeds as a transmission pathway. Furthermore, pea is not a natural host for about a quarter of these pests, and for another quarter, while pea is a natural host, seeds do not serve as a pathway for pest transmission. ISF underlines the importance of robust scientific experiments to provide the necessary answers to justify the regulation of a pest in relation to the seed pathway. This approach, supported by evidence from original scientific papers, can help in accurately determining the pests that genuinely require regulation, thereby avoiding unnecessary measures for those not naturally associated with the crop. The ISF regulated pest list database is an essential resource of scientifically verified information and knowledge of pests regulated on seed.

More information: see the ISF regulated pest list database for details and references, https://isfpestlist.worldseed.org/)

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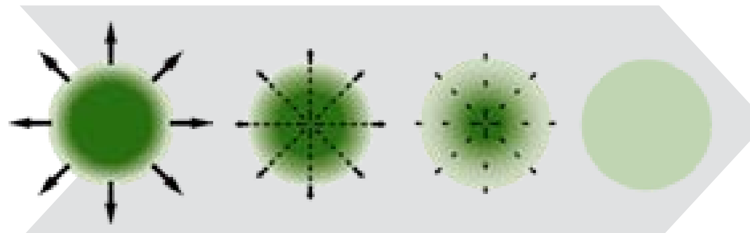

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The ABC Processor enables variable temprature and airflow which lowers 65% of the energy cost compared to a fixed air flow and heating system. The tables indicates the decrease in kWe.

% control	kWe	m3/h	Delta-T	kWe
100	22	30000	5	48
80	11,3	24000	14	100
60	4,8	18000	20	115
40	1,4	12000	20	77
20	0,2	6000	4	8
Total	35,7			348

Variable Air Flow & Heating

% control	kWe	m3/h	Delta-T	kWe
100	22	30000	20	192
80	22	30000	20	192
60	22	30000	20	192
40	22	30000	20	192
20	22	30000	20	192
Total	110,0			960

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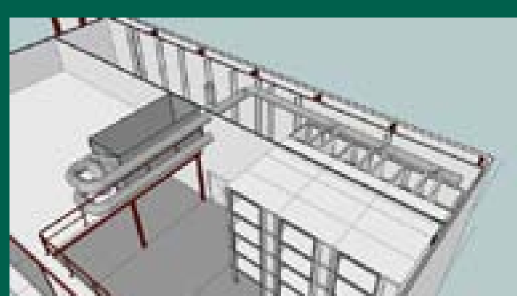
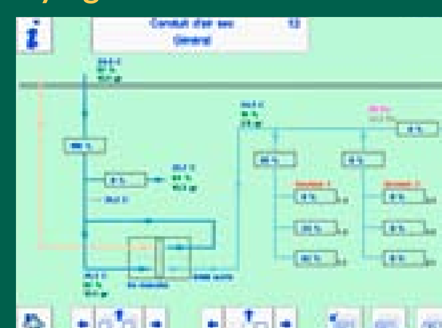


The hybrid air dryer distributes the process air to different drying sections



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  - An increase of the drying capacity of your installation
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