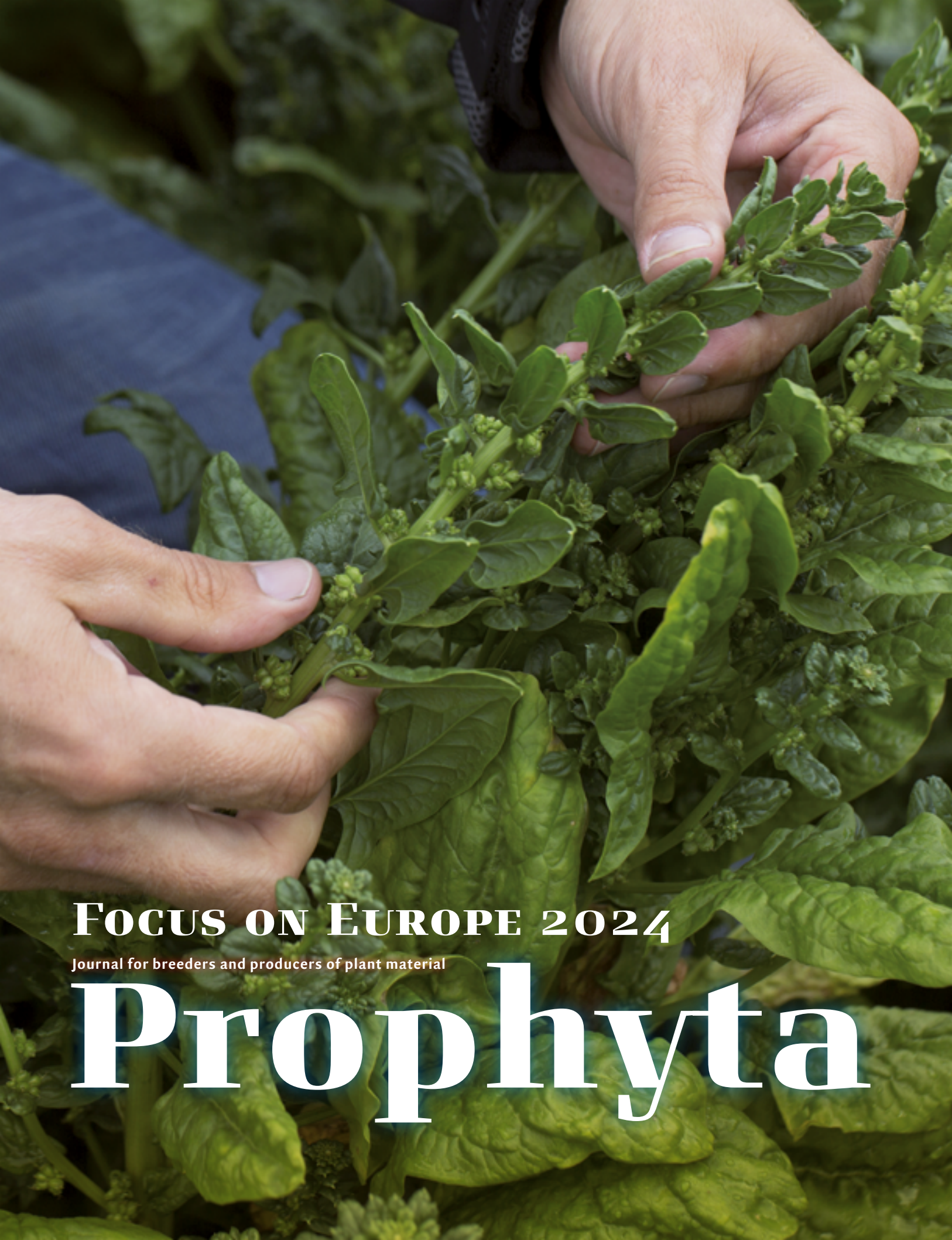

Focus on Europe 2024

Journal for breeders and producers of plant material

Prophyta

Prophyta Focus on Europe 2024
A publication of the Prophyta Foundation in co-operation with Blue Bird Publishers

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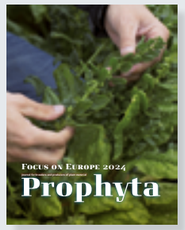

On the cover: While Denmark is the world's largest producer of spinach seeds, most breeding of new varieties takes place in the Netherlands. Disease resistance is an important theme for this crop and wild species from gene banks are an important source for the required genes

Focus on Europe 2024

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Prophyta

Rijk Zwaan celebrates centenary

After 100 years, the company still carries its original name: Rijk Zwaan Zaadteelt en Zaadhandel (seed cultivation and seed trade)

From a simple seed shop in the city of Rotterdam, the Netherlands, in 1924, to a renowned internationally operating seed company in 2024, Rijk Zwaan has proven that focus on quality and an innovative attitude is a fruitful combination. That is underlined by the award of the predicate 'Koninklijk' (Royal) the company received at its centenary on 1 July 2024. It symbolizes the King's respect, appreciation and trust towards the company.

When Mr. Rijk Zwaan opened his seed shop, he could not foresee that the company bearing his name would be so successful. Today, Rijk Zwaan employs 4,000 people and is represented in over a hundred countries through more than thirty subsidiaries, spread across the world. As a descendant from a family of seed producers and traders, he immediately envisaged the possibilities improving seeds offered. Within five years after the opening of his shop, he purchased a piece of land and started selecting superior plants. In the 1920s, only a few people in Dutch horticulture were working on the insights of scientists Darwin and Mendel. Rijk belonged to that select group of pioneers. As one of the first, he used pedigree selection as his main breeding method. Another novelty: he personally visited growers to provide them with cultivation advice.

In the first forty years of its existence, the emphasis was on the Dutch horticultural market, with some exports to Germany, Belgium and France. In 1964, the first subsidiary was opened in Germany. Nowadays, plant breeding of tropical fruits and vegetables is part of its activities. In Tanzania and Vietnam, the company produces vegetable varieties that are adapted to local climates, cultivation methods and consumer preferences. The latest expansion is a breeding location in Brazil, where fruit and vegetable varieties are selected that do well in the warm and humid climate with occasional heavy rain showers.

Rijk Zwaan is still one of the few family-owned companies. There was a three-year interruption when the family Zwaan sold their shares in 1986 to BP Nutrition as there was no successor. However, the chemical company quickly lost interest. The then management - Ben Tax, Maarten Zwaan and Anton van Doornmalen - repurchased the shares and Rijk Zwaan became an independent family business once again, run by the three families. They formulated an exceptional objective for the company: to offer employees a pleasant and sustainable job with attractive employment conditions. It still remains a focal point for the company, as are quality and innovation.

Export ban to Belarus

The EU Council has banned the export of ornamental planting material to Belarus. These additional measures on Belarusian's trade operations are in response to the involvement of Belarus "in the unjustified and unprovoked Russian military aggression against Ukraine that has been going on since the end of February 2022." In summary, it concerns starting material for ornamental horticulture (flower bulbs, perennials, nursery stock products, cuttings, but also potted plants and ornamental branches) and wood.

In addition, the transit of these materials through the territory of Belarus is also prohibited. The close integration of the Russian and Belarusian economies has substantially facilitated the circumvention of existing sanctions against Russia. Furthermore, the export restrictions are meant to prevent these products from strengthening Belarus' industrial capacities. Before the war, Belarus served as a transit hub for flowers from the Netherlands, Colombia, Ecuador and Kenya, most of which were for the Russian market and other post-Soviet states. In 2019, imports reached a value of almost US$367 million. At the time, the main problem the Belarusian cut flower producers faced was the lack of domestic planting material.

The sanctions are laid down in Regulation (EU) 2024/1865.

Salt tolerance in tomato discovered

Solanum pimpinellifolium, a close wild relative of cultivated tomato, has proved to be tolerant to salt stress, according to a recent study at the Boyce Thompson Institute, Ithaca, NY, USA. The edible, cherry-sized fruits, commonly known as currant tomato or pimp, owes this property partly to its overall vigour – its ability to grow quickly and robustly. The findings can support breeding efforts for salinity tolerance in tomatoes and other crops.

The researchers found that traits, such as transpiration rate, shoot mass and ion accumulation (the build-up of ions, such as sodium and potassium, within plant tissues), showed significant correlations with plant performance under salt stress. But one of the most exciting findings was the identification of candidate genes not previously associated with salt stress tolerance. "These specific genotypes can be used as allele donors for further improving crop performance and developing more sustainable agriculture," says assistant Professor Magdalena Julkowska, lead author of the article published recently in The Plant Journal.

S. pimpinellifolium is a wild relative of the domesticated *S. lycopersicum*. It is native to Ecuador and Peru, but is commonly grown in gardens as heirloom tomato and can be hybridized with common tomatoes. The species has been used in the past for the introduction of disease resistance traits in tomato varieties.


The so-called 'pimp' is commonly grown as an heirloom tomato, but the species has far more to offer

Hanging by a thread

To our great sadness, if nothing happens, this might well be the last edition of Prophyta that you will read. In this edition of our magazine, you can find two 'farewell' articles. One from our present editor, Monique Krinkels, in which she looks back over 33 years of service to make this magazine a success. And one from myself, board member of the Prophyta Foundation, in which I inform the readers that the continuation and existence of Prophyta is hanging by a thread. We sincerely hope that we will be able to find someone ready to take over the challenging but beautiful task of producing this magazine twice a year. To coordinate the content, to write articles, to find and maintain contacts with advertisers and to take care of having the magazine printed and distributed.

Over the years, Prophyta has given the readers background information and personal stories about plant breeding in vegetables, ornamentals, field crops and fruit plants. Informative articles on seed production, seed trade, plant propagation, company profiles, specific crops, new upcoming legislation, biodiversity issues, human health, new breeding techniques, tissue culture, test techniques, quality systems, organizational information, interviews with industry leaders and scientists and much more! Sometimes, even surprising topics that you normally will not find in seed magazines. A magazine with a Dutch background, written mainly by Dutchmen, but aiming to connect to global topics and an international audience. I dare say that we have been successful in achieving this goal.

A magazine in which a platform was created for young researchers, for breeders, for government employees and organizations to tell their own story. To present their work. To call for action or to present an opinion.

The Prophyta magazine has always been delivered to you all free of charge. Keeping the costs low, working with a great number of volunteer writers and, throughout the years, supported by loyal generous advertisers. So yes, a big challenge ahead to give it a last try. Our deadline is 31 December 2024. And yes... miracles can happen!

But in any event: the Board of Prophyta Foundation, on behalf of all its readers, would like to thank Monique from the bottom of our hearts for having given us so many enjoyable articles to read, so many inspiring thoughts and so many beautiful colourful magazines all these years.

John van Ruiten, Prophyta Foundation

Ukraine struggles with potatoes

Only 19 certified seed potato growing farms are still functional in Ukraine. Potato cultivation by households and industrial enterprises in Ukraine in the first year of the war decreased by 36% compared to pre-war figures and the situation continues to worsen. According to the director of the Institute of Potato Growing, Mykola Furdyha, they would grow 38,147 tons of seed potatoes in 2024, which is not enough to meet the needs of the market. Annually, Ukraine produces 20 million tons of potatoes. The potato yield per hectare is increasing in the country as a whole; in households it is 16.5 tons per hectare, in industrial enterprises some 25.8 tons per hectare. The Netherlands has been supporting the potato industry in Ukraine for many years - from improving growing technology, storage, institutional capacity building to realizing the export potential. Currently, the question of drafting a strategy for the development of the potato industry is relevant, taking into account the challenges caused by the war, the loss of infrastructure and the complications of logistics.

Gene-edited wheat and barley in trials

The first gene-edited wheat and barley crop trials in Europe will be held on conventional farms, and will soon be underway in up to 25 farms in the United Kingdom. The aim is to gain valuable information about the viability of gene-edited traits in a variety of field conditions. The trials, called PROBITY (Platform to Rate Organisms Bred for Improved Traits and Yield), are being organized by the British On-Farm Innovation Network (BOFIN) along with partner organizations including Rothamsted Research, the John Innes Centre, the University of Nottingham and Aberystwyth University. Two gene-edited crops developed at Rothamsted are included in the farm-based field trials. One is a line of barley that has been edited to produce a higher content of lipids in the leaves. Lipids have been linked with reducing the methane when fed to cattle. The other crop is a wheat variety that has been gene-edited to lower the levels of amino acid aspargine in the grain when cooked. This is a probable carcinogen and food manufacturers are keen to have varieties that produce lower levels, so that wheat products will comply with pending European Union regulations.
It could, however, take several years before foods derived from gene-edited crops grown in the UK become generally available, not least because the secondary legislation to implement the Precision Breeding Act is still being finalized for introduction to the British parliament later this year.

Rabobank presents vegetable seed trends

"The past few years have been anything but dull for the global vegetable sector," says Lambert van Horen, sector manager at RaboResearch Food & Agri, in a trends report of the bank. "The COVID-19 pandemic, extreme weather, rapidly rising production costs and logistical challenges are just a few of the many challenges that have affected global vegetable consumption, production and trade."
Global vegetable trade was remarkably high in 2021 and consumer prices for vegetables rose sharply. However, most developments in the vegetable sector are long-term changes. For example, Turkey and Poland are emerging in the trade of both fresh and processed vegetables. A number of things have not changed in recent years. Mexico, Spain and the Netherlands are still the world's largest export countries of fresh vegetables.
The Netherlands is the number one exporter of vegetable seeds in the world, followed at a distance by the USA and France. According to UN Comtrade, the export of vegetable seeds reached a value of over US$ 2 billion in 2022, while the USA and France sold slightly over 500 million US$ worth. The Netherlands is a leader especially when it comes to high-quality vegetable seeds.
The import of vegetable seeds by Russia has increased year upon year since 2015 and this shows how important this valuable input is to Russian farmers. The import of fresh vegetables from the EU has been banned since 2014, while the import of seeds from the same EU is permitted by the Russian authorities.
A country like Chile is almost invisible in statistics on the end product, but specifically for the production and export of vegetable seeds, this country has a strong position due to its unique location in the southern hemisphere. The US is both an important import and export country for vegetable seeds. When they are exported to Mexico, they often return to the American market as vegetables.

Farewell Prophyta

Time to say **goodbye**

Monique Krinkels

‘Nothing lasts forever but the earth and sky’, one of my favourite bands sang years ago. So, even being the editor of Prophyta should come to an end. After 33 years and nearing my 70th birthday, it is high time for me to leave the ‘plant breeding universe’. Hopefully the Prophyta Foundation will find a capable successor.

When, in spring 1991, the publisher of the horticulture division at Reed Business Information entered my office, I had no idea he had a life-changing surprise for me. “We have a new journal in our portfolio,” he told me, “and you are going to be the editor. It is about seeds and it is named Prophyta.” Having worked for him as an editor for several years, I knew that saying ‘no’ was not a viable option, but I could not hide my surprise, as my knowledge about seeds at the time was next to nothing. “It will suit you fine,” he continued. “It is an international operating industry, with deep roots in science, has interesting judicial concerns and kindles lively discussions about new developments such as genetic engineering.”
At the time, I could not fathom how right he would prove to be. From the start, in June 1991, until this October edition, I have encountered wonderful people, learned about interesting topics, seen countless developments and travelled to many countries to attend the annual congresses. Never a dull moment in the world of plant breeding.

Memory lane

So much has happened in the past three decades. Companies expanded, were taken over, while innovative startups developed products for niche markets. Genetic engineering was embraced, discarded and replaced by new breeding techniques. The concept of essentially derived varieties was introduced, leading to never-ending discussions on its scope. In 1991, at the Earth Summit in Rio de Janeiro, 150 government leaders signed the Convention on Biological Diversity, resulting in endless debates on how to implement this agreement. The plant passport was introduced in the nineties to address the problem of diseases entering Europe. Unfortunately, it did not stop diseases from crossing the borders. The EU regulations regarding plant reproductive material have been revised several times in the last thirty years. This, combined with the effects of climate change and a world population that has grown by more than three billion people since 1991, has urged plant breeders to come up with new varieties that are more resilient to abiotic and biotic stress factors and, at the same time, are more productive, healthy, tasty and environmentally friendly.
In short, there have been more stories to tell than there were pages to fill. As a bonus, I visited the international congresses, travelling to countries all over the world (often adding a vacation to learn more about the local circumstances).

A great thank you

When in 2005, Reed Business Information decided Prophyta no longer belonged to their core business, the Prophyta Foundation endorsed the initiative to continue the publication with me as publisher-editor. It was not always comfortable, as I am by nature a journalist, not an advertisement acquirer. It is much easier for me to ask inquisitive, candid questions than to sell a page in a journal. Luckily, there was often no need for serious sales pitches, as the companies valued the existence of the journal.
It has been an honour to take care of a journal that has its roots in the post-war years. In 1948, several organisations took the initiative to start a publication together, first under the name ‘Zaadbelangen’. Later, as the international aspect became more important, the journal was renamed ‘Prophyta’. I am indebted to the companies that have financially supported the publication of Prophyta all these years. And, of course, I am grateful to the many people who contributed articles, shared their opinions in interviews and explained new developments. Last but not least, I would like to thank all the readers. Without you there would not have been a reason to write. You have given me a very satisfactory working life. Wishing you all the best!

Monique Krinkels presented and promoted the magazine during the congresses

Farewell to Prophyta magazine?

John van Ruiten

For over 33 years Monique Krinkels has been the chief editor of our Prophyta magazine. An era that will now come to an end. Twice a year, a colourful and interesting magazine has been issued under her responsibility, one on the occasion of the Annual ISF congress and one at the Euroseeds congress. The magazine was always available to all participants at the congress and it was distributed by regular mail to around 3,000 readers (breeders, propagators and organisations) worldwide without any cost. Readers appreciated the articles and the personal touch and ‘flavour’! All the magazines from the last 18 years can be found on the website: www.prophyta.org

Foundation

The independent Prophyta Foundation has been the organization that gave the right to Monique Krinkels to use the name and to produce these magazines. She herself took care of both the content of the magazine (supported by an editorial board), as well as finding advertisers to make it possible again and again to realise the printing and distribution of both the Annual and the Europe edition. And she presented and promoted the magazine during the congresses. Monique carried out all those activities non-commercially and gave her time without being paid for all those hours of work. Prophyta, as the readers know, combines articles on breeding and propagation techniques, regulatory issues, companies, crops, people in the news and scientific developments.
A clear focus on seeds and plant material in the international horticultural and agricultural sector.
A broad field to be covered and contributors from mainly WUR, Plantum, ISF, Naktuinbouw and many others have always been prepared to write articles for the magazine.

Successor

Over the last year, the board of the Foundation has tried to find a successor to take over the responsibility for producing the magazine from Monique. As yet, we have not been able to find a successor. In the coming months, our search will continue and still we are hopeful to find a new host and editor for this wonderful magazine. If we do succeed, we hope to produce a new Annual in 2025. But if not... then this Prophyta – Focus on Europe 2024 might be the last one to read.
If readers have any suggestions, or if they are able to support the continuation of our magazine in one way or another, then please contact us through johnvanruiten@ziggo.nl

Focus on exporting **high quality** seeds

John van Ruiten

Being a relatively small country in the EU, Denmark nevertheless plays an important role in the production and marketing of agricultural goods. Around 75% of the total produce is exported; for certain commodities even reaching 95-99%. Around 1.5% of the Gross National Value comes from trade of agricultural products.

Particularly the daylength and a cool maritime climate makes Denmark very suitable for spinach seed production (Photo: Rijk Zwaan)

Of the total surface area of Denmark, over 60% is used for agriculture. 90% is arable land and 10% grassland. A big portion of grassland and arable land is used to produce feed for cattle, as the most important commodities in value are pigmeat (7% of the EU production comes from Denmark) and dairy production (4% of EU milk).

Cooperatives

As in all EU countries, the number of farms is gradually decreasing (by 2-3 % a year) to now altogether 35,000, mainly small and medium sized family-owned companies, with an average size of 75 hectares. Around 186,000 people (3% of the Danish population of 6 million) are employed in the agri-food business, which is good for marketing products with a value of 25 billion euro, of which 75% is exported. Agriculture here relies on export. The most important export markets are Sweden, Germany, the Netherlands, UK, Norway and USA.
Agri-food business and marketing in Denmark was traditionally done through farmer-owned cooperative structures and organizations. Although this is changing gradually, the majority of produce is still sold cooperatively.

Denmark leads the EU production of mink and fox furs. Although this production system is viewed critically, the farms still manage to stay in business. Fishing and fisheries in Danish and Atlantic waters make the country the largest EU exporter of fish and shellfish.
The country is home to - and strong in - certain horticultural seeds: breeding and production of grass and clover seeds, spinach and cabbage seeds and also strong in niche markets for herbs and floricultural seeds. And as is the case with other products, the focus is fully on export of these seeds. Denmark used to be an important supplier of glasshouse produced pot plants in the EU. But this position can no longer be held. High fuel costs, high labour costs and changing marketing systems are the reason for a gradual decline of this business.

Sustainability

Another remarkable aspect in Denmark is the commitment to improving the sustainability of production systems and farm management. Due to early and proactive implementation of integrated pest management (IPM), Denmark became one of the EU countries with a relatively low-level use of pesticides. Earlier than in some other countries, Denmark producers moved towards increasing organic production. Nowadays, 12% of the agricultural land is in certified organic production. Over 30% of the milk produced is organic.
Denmark manages to use the trademark 'Produced in Denmark' (strongly supported and controlled by certification systems) as a recognized high-quality label. It is needed to be able to compete on the world market and to hold its strong position.

Spinach seeds in the lead

Monique Krinkels

Denmark is renowned for its agricultural and horticultural products. While in agriculture the grass seed industry plays a leading role in Europe, in the ornamentals the pot plant breeding is prominent, and in vegetables it is the spinach seed production that catches the eye. Worldwide, over 75% of the hybrid spinach seeds have their birthplace in this small country.

The main stem of bolted spinach elongates and forms clusters of flower buds
(Photo: Centre for Genetic Resources, the Netherlands)

"Particularly the daylength and a cool maritime climate makes Denmark very suitable for spinach seed production," says Rob van Treuren, senior scientist at Wageningen University & Research. Located between 55th and 57th north latitude, the plants profit from 17 hours of daylight during the summer. The coastal climate ensures stable temperatures during the growing season. Furthermore, the fairly isolated production areas experience minimal diseases pressure. "In the past, most production took place in the Netherlands and the USA, but it has shifted to Denmark for good reason. In 2000, the Scandinavian country produced between 7,000 and 8,000 tonnes of hybrid spinach seeds, to be exported all over the world."

Healthy

"Spinach (*Spinacia oleracea* L.) is a healthy, nutrient-dense vegetable, rich in minerals and vitamins, including substantial levels of the carotenoids vitamin A, lutein and zeaxanthin and other molecules with high antioxidant properties such as vitamin C, vitamin E and phenolic compounds including flavonoids." The health-related effects have been studied by Joseph Roberts and Régis Moreau. They concluded that the biological activities of spinach contribute to the anti-cancer, anti-obesity, anti-inflammatory, hypoglycaemic and hypolipidemic properties of this vegetable.
But they also observed that, despite these valuable attributes, spinach consumption remains low in comparison to other leafy green vegetables, such as lettuce, endives and chicory. The global consumption of spinach reached over 32 million tonnes in 2020. Approximately 91.5% of this global spinach consumption is accounted for by China alone, followed (at a distance) by Belgium, Turkey, Japan and the USA.

Short history

Compared to other foods, spinach is relatively new to the human diet. Around 12,000-10,000 years ago, people in the 'Fertile Crescent', a region where Iraq, Syria and Israel are today, took wild plants from nature to grow them for their own use. Among the first vegetables were onions and cabbages. However, it took until the current era before spinach was discovered. The crop is thought to have been domesticated in former Persia (today Iran). "But recent discoveries suggest that domestication took place further east in Afghanistan or Pakistan," says Rob van Treuren.
The closest wild relatives of cultivated spinach are *Spinacia tetrandra* and *Spinacia turkestanica*, which both are native to areas surrounding the Caspian Sea. *S. tetrandra* is indigenous to the Transcaucasia and Kurdistan region, and *S. turkestanica* to Central and Southern Asia. *S. turkestanica* is the most likely ancestor of cultivated spinach. "It is presumed that the crop has spread late in history, as no references to spinach from the Greek and Roman cultures have been found and because the oldest written records in which spinach is mentioned are from the fourth century AD in Mesopotamia," explains Rob van Treuren.
"Distribution of the crop to the West possibly occurred through expansion in Muslim territories. Current evidence suggests that spinach was introduced in Europe by the Moors through the Iberian Peninsula. The first written evidence in Europe mentions spinach cultivation in Moorish Spain since the 11th century and the first archaeobotanical evidence is from the Pyrenees mountain range dating back to the late 12th or early 13th century. The introduction of spinach in Northern Europe took a few more centuries."
The journey to the east is even more obscure. "The oldest written records report that spinach was introduced into China via Nepal in the 7th century. It remains unclear, however, how spinach was introduced in Nepal. Additional collecting of spinach landraces could allow a more precise reconstruction of the crop migration routes."

Adaptation

During the migration route, spinach had to be adapted to the local taste and requirements. *Spinacia oleracea* L. that has followed the Eastern route is clearly distinguishable from the varieties that came to Europe. The Asian-type and Western-type spinach have their own morphological characteristics and differ in aspects such as leaf shape, petiole, leaf colour and bolting tendency. The Asian varieties are, for instance, dark green with large, hastate-formed leaves. In Europe, the smooth, oval-shaped leaved type and the Savoy type with its thicker leaves and crinkled, textured surface are popular. The 'wild spinach'

In 2023, Roel Hoekstra and Wouter Groenink of the Centre for Genetic Resources undertook an expedition to Uzbekistan to find wild relatives of spinach
(Photo: Centre for Genetic Resources, the Netherlands)

found in supermarkets is not a *S. turkestanica* as its name suggests, but rather a smooth type *S. oleracea* L. that has matured longer.
Traditionally, in Northwestern Europe, spinach is served as a cooked vegetable with a strict warning not to reheat it for a 'second day serving'. It was a common belief that reheating would cause the nitrates to convert into (carcinogenic) nitrosamines. That is outdated advice as it is the bacteria that cause the conversion and that can be prevented by quickly cooling the vegetable. Nowadays, stir-frying spinach, adding it into a salad or using it in a smoothy has become more popular than simply cooking.

Wild varieties

"Spinach seed is one of the most often requested crops at the Centre for Genetic Resources, the Netherlands," says Rob van Treuren. "A few years ago, the number of available wild spinach populations in our gene bank was increased, mainly due to two collecting expeditions. Currently, a total of 39 *S. tetrandra* accessions from Armenia, Azerbaijan and Georgia and 75 *S. turkestanica* accessions from Tajikistan, Turkmenistan and Uzbekistan have been added to the gene bank. The collection now includes 541 accessions (427 culture, 114 wild). In addition, 7 culture numbers and 27 numbers are awaiting inclusion."
Through domestication and modern breeding, spinach varieties have been greatly improved in response to grower and consumer needs. The slightly bitter taste has gone, leaves are no longer prickly, seeds are round and smooth and germination has improved. But the most important progress is disease resistance. "By far the most destructive disease in spinach on a global scale is downy mildew (*Peronospora farinosa*)," says Rob van Treuren. "Resistances are regularly broken down by this oomycete due to the rapid evolution of the pathogen causing new races to appear. Breeders are therefore continuously looking for new resistances, especially in the wild species."
In collaboration with spinach breeding companies, the CGN material is periodically screened for new resistances. "Breeding for abiotic resistance and quality traits has received little attention in spinach research and breeding. This is expected to change considering the potential effects of climate change on these traits."

Breeding

Resistances against downy mildew is by far the most important breeding goal for companies. "There are currently 20 named physios," says Beatrice Lindhout, breeding manager Terra at Rijk Zwaan. "PE: 20 was denominated last May. The International Working Group on Peronospora in spinach (IWGP) is responsible for the process of establishing the official physios. This takes place based on a number of criteria: how often does the physio occur, in which geographical areas and how often does it happen. The economic relevance is also a criterium. In addition to the official physios, there are many isolates in the world that are ultimately not named because, for example, they have only been found once. The time it takes for a breakthrough is very diverse and the process underlying this is still not fully understood."
Other perilous pathogens in the breeding programme at Rijk Zwaan are stemphylium, fusarium and white rust. "Disease resistance is an important theme for spinach. Besides, abiotic stress is or will become a more important theme for many crops. This is based on two things. On the one hand, we are globally dealing with climate change and on the other hand, we see that chemical applications are increasingly subject to laws and regulations that also differ depending on the location. This means that there is certainly a challenge for all vegetable breeding companies to create varieties that are resilient and can withstand all kinds of stress factors."

High Quality Trees

Merry Xmas from Denmark

John van Ruiten

It is not the first product that you think of when you talk about Danish horticulture: Christmas trees. But they are an important product with an annual value of over 250 million euros. The Danish climate, growers' experience, automation and proper trade channels makes Denmark the most important country in the EU for exporting Christmas trees.

Most families celebrate Christmas with a house decorated with greens and a Christmas tree. Only few realise that the trees have their birthplace in Denmark. Annually, over 10 million Christmas trees find their way to consumers all over Western Europe. An even bigger amount of 2-3-year-old trees (25-35 cm high) are supplied for further cultivation to growers in Germany, Austria, Belgium, France and the Netherlands.

Tradition

The tradition of using Christmas trees and green branches in wintertime is very old. Before this era, Romans, as well as Germans, celebrated the winter solstice by decorating their houses with greens.
On the shortest day of the year, a big green tree was erected in German villages.
In the early 16th century, decorated trees were placed in churches in countries like Latvia, Poland and Germany. In the 17th century, well-to-do individual households in Germany and England also started to bring a tree into the house and decorate it with apples.
The Roman Catholic church for a long time opposed the use of Christmas trees. Especially in the 19th century, the church warned against this 'pagan ritual'. It took until 1982 before the first Christmas trees were used in the Vatican!

Species used

Nowadays, by far the most popular species used for Christmas trees in Europa is *Abies nordmanniana*, the silver fir or Nordmann tree. Its dark green colour, its shiny and softer needles, but especially the characteristic that the needles do not easily fall off ensures that the market share of these trees is still growing. It is estimated that more than 50% of the trees marketed in western Europa are Nordmann trees. The share of the traditional *Picea abies* (the Norway spruce or regular fir tree) is decreasing, despite its nice fragrance. But, in the heated living rooms of modern houses, they quickly start to drop their needles. Other tree species used are *Abies koreana* (Korea fir), *Picea omorika* (Serbian fir), *Picea pungens* (blue fir) and *Picea glauca Conica* (Canadian fir). In the USA and Canada, the most important species is the Fraser fir *Abies fraseri* (which is now also grown more and more in Europe), but Nordmanns are becoming more popular there too.
Scotch pines (or 'Tannenbaum' in German; *Pinus sylvestris*) were sometimes used in the past and still in the UK as Christmas trees, but have now been almost completed replaced by firs.

Von Nordmann

The Finnish naturalist (botanist, biologist and zoologist) Alexander von Nordmann (1803-1866, born in Ruotsinsalmi/Kotka) 'discovered' the species *Abies nordmannia* in 1836. Growing in the Caucasian region (southern Russia, Georgia, north eastern Turkey), trees of this species can reach a height of 50-75 metres, can reach an age of several hundreds of years and they are very winter hardy. Von Nordmann, being the director of the botanical garden in Odessa from 1834 until 1848, participated in several expeditions and collection activities. He investigated flora and fauna in the Balkan and Caucasian region and described many plants and birds. He was also the founder of a horticultural high school. In 1838, he took material from this Abies with him and introduced this species in other parts of Europe.
A colleague and friend, the Finnish/Russian botanist Christian von Steven, gave this species its name: *Abies nordmanniana (Steven) Spach*. Also in the USA, the new species gained (ornamental) attention: after introduction of some seeds in 1859, it spread rapidly amongst ornamental growers in Oregon

Growing Nordmanns

Growing Christmas trees is not regarded as forestry, but as a horticultural ornamental activity. Also, EU legislation on forestry reproductive material is not relevant. There are no specific obligations to use genetic material originating from defined origins (as is the case with forestry oaks, pines, firs, etc). But *Abies nordmanniana* is also grown in certain areas for forestry reasons, mainly wood production (construction timber), although seed regulations for this species are not yet relevant at this time.
Most seeds used for growing Nordmann trees come from Georgia (the area of Ambrolauri or Borjomi) and are collected 'in nature' and not in specific seed stands. The collection of seeds is hard work and it is said that the working conditions are not very good.

Nordmann trees grow twice as slow if compared to the traditional Christmas fir *Picea abies*

The vast majority of seeds are marketed to Danish and German growers. Each kilogram contains around 10,000-15,000 seeds, of which on average 5,000 seeds will grow out to usable seedlings. They are relatively easy to germinate (short dormancy).
After two years, the young plants are still very small, circa 10 cm. They are then replanted and grow to plants of 30-40 cm in another two years. These are also the young plants that are supplied from specialist young plant growers to Christmas tree growers in Europe. These 3-4-year-old plants are planted on the location/fields where they can grow (in 5-10 years) into marketable trees. Often in those fields, the harvest will be done over a number of years, allowing plants that remain in the field to grow into bigger trees. For those trees, fields with a heavy (clay) soil are optimal.
Nordmann trees grow relatively slowly. Twice as slow if compared to the traditional Norway spruce and Christmas fir *Picea abies*. That is the most important reason for the higher cost price of the product. Tree cultivation also requires a lot of attention. It is not just planting and waiting a couple of years... Protecting the fields/plants from damage by deer and birds. Keeping the field relatively free from weeds, but especially regularly pruning the plants is labour intensive. Mechanisation is a clear goal for growers to stay in business. And also more sustainable cultivation is an important issue for them so they can sell the trees with an environmentally-friendly trademark.
Despite their resilience, growers still have to be aware of a number of pests and diseases that can infest the crop, such as woolly adelgids, woolly aphids, Scolytus beetles and neonectria canker.
The number of tree growers in Denmark is going down. Over 10 years, the number of Christmas tree growers (registered with the Danish Christmas Tree Growers' Association CTGA) declined from 3,500 to 2,300. Also, the area of cultivation decreased in that period from 25,000 to 19,000 hectares.

Breeding and selection

Breeding of *Abies nordmanniana* is still a very long-term activity (1 generation over 15 years) and not done specifically for Christmas trees. Some breeding activities are done more for forestry purposes. Provenance research (selecting proper origins) has been done in Denmark since the 1960s. Recent work has focussed on producing/multiplying seeds on a commercial scale in new seed orchards. Attention has to be paid to avoiding cross pollination with other Abies species (such as *Abies alba*). A breeding programme started in 1992 in order to find less susceptibility against neonectria and to improve production capacity, among other things.
More work has been done in the past to select a multitude of other types (dwarfing, needle colour, tree shape) within the species *Abies nordmanniana* and thus develop varieties. These are 'clones' and propagated vegetatively. They are mainly grown as ornamental plants for gardening and not for Christmas tree uses. Golden Spreader is a variety found as a yellow foliage type in the Netherlands in 1961. Pendula as a weeping fir with good vigour was already found in 1874 in a British nursery. Some other varieties have been propagated with compact pyramidal forms, more silver / white needles or mat-forming /flat growth.
Clonal propagation is too expensive for Christmas tree production.

Market

An estimated 60-70 million true Christmas trees are marketed in the EU every year, of which around 35 million are Nordmann trees. By far the biggest market for Christmas trees is Germany. Annually over 30 million trees are sold there and approximately 20 million trees are produced in the country itself on an area of 16,000 hectares. The UK 8 million (of which 50% is produced in Britain), France 7 million, Belgium 5 million (3 million plants own production) and the Netherlands 3 million are important markets. In Denmark itself, around 2 million trees are sold. Most of the 10 million exported Danish trees go to Germany, Belgium, Netherlands and UK.
The market of trees is very competitive. Garden centres want to offer their customers trees for affordable prices. A regular sized Nordmann tree is relatively expensive and will cost the customer on average (dependant on the size) between 25-60 euros. The biggest competition in the market is however with artificial trees, mainly from China. Their market share in Europe is around 50%.

Plantum Director Niels Louwaars

‘Forever **enthusiastic** about seeds'

Monique Krinkels

After 13 years as director of Plantum, Niels Louwaars will retire this autumn. The Euroseeds Congress in Copenhagen, Denmark, will be the last one he will attend. His enthusiasm about the sector is unwavering. “Our members have an enormously positive attitude,” he says. “Plant breeding is a knowledge-intensive field, with visionary people who dare to think at least ten years ahead.”

When, in September 2011, Niels Louwaars became director of the seed organisation Plantum, his knowledge of the Dutch seed companies, ornamental breeders and producers of young plants was limited, to say the least. “It was a jump into the deep end,” he acknowledges. It was not the most comfortable transition. Aad van Elsen was taken ill that spring, so his predecessor could not introduce him to the members, the national and international organisations and the seed universe. “And several aspects of the job were new to me. I came from the academic setting at Wageningen University & Research, without any lobby or even management experience.”

New responsibilities

“At the yearly General Membership Meeting, I was formally presented to the representatives of Dutch seed companies and young plants producers. It was only then that I discovered that the job came with several other obligations, such as joining the boards of the inspection services, the Horticultural Council, and more.” It seemed a complete turnaround from the tasks he had at Wageningen University & Research. “Well, not completely,” he says. “At the Centre for Genetic Resources at WUR, I was involved in policy matters, such as plant breeders’ rights, and I advised developing countries and institutions, such as the World Bank and FAO.”

> ‘If farmers know which spots on the leaves relate to seed-transmitted diseases, major problems could be reduced’

It was in 1991, during a meeting with Ms. Victoria Sekitoleko, the Minister of Agriculture in Entebbe, Uganda, where he worked in a seed production programme at the time, that his interest in policy matters was triggered. “We could not supply (dry-)bean seed in a cost-covering way, but beans are important in the diet – a poor man’s meat. I suggested that seed quality could also be increased without centralised seed production, using the extension service. ‘If farmers know which spots on the leaves relate to seed-transmitted diseases, major problems could be reduced,’ I told her. It sounded so logical to me.

“The Minister reacted that the seed law prescribes that all seed has to be certified and that the Government could not be seen to be supporting a principally illegal action, i.e. the use of farm-saved seed. Since less than 5% of the bean seeds used in the country were officially certified, I wondered why the seed law was so removed from reality. It was the case that British seed law had been taken as the example, while the seed situation in Uganda was, of course, very different. I started to become interested in policies and laws that affect seed systems.”

Beside seed regulation, it was especially intellectual property and national sovereign rights on genetic resources which caught his attention upon his return to the Netherlands, where he became course leader, programme manager, consultant and researcher in Wageningen, eventually at the Centre for Genetic Resources. In 2011, he traded academic freedom for private sector realities when he joined Plantum as Director/Secretary General.

A large team

Plantum has one of the largest secretariats of the national seed associations in the world. “Our team consists of over twenty-one people. This is mainly due to the fact that the sector for seeds and planting materials is large, diverse and operates globally.” Plantum thus realizes that it has responsibilities beyond the Dutch borders. “We contribute to ISF, Euroseeds and were instrumental in the establishment of EUPlant, the organisation of young plant growers.”

He added three functions to the team: Public Affairs and additional staff for Communications and Phytosanitary Affairs. “We have to inform government, members of parliament and civil servants in the Netherlands, as well as in Europe, about the consequences of their decisions, and communicate with value chain partners and societal organisations about the important roles of the sector. That is vital to the companies we represent. Furthermore, people need to know more about the source of their foods, their flowers and bio-based products. We must enlighten them with objective information and counter disinformation.”

“For instance, we introduced the ‘Fascination of Plants Day’, a two-yearly event, where politicians are challenged in creative means and people can learn more about the importance of seeds for their daily meals and their gardens. The ‘Take a Seed’ food and flower chair, also on display at ISF-Rotterdam, is just one example.” Also, the PlantumGate debates in the Parliament Building, where representatives of government, press, knowledge institutes and NGOs meet and exchange ideas, put the sector, and Plantum, in the limelight.

‘Moving in the political arena has brought me great pleasure,’ says Niels Louwaars, former director of Plantum, the Netherlands

Plantum is quite successful when compared to many other sector organisations, but Niels adds that patience - next to perseverance - is a virtue for him and his staff. “Take, for instance, the regulations concerning new breeding techniques. It takes forever before everyone is convinced of the usefulness and safety, and before decisions are made.” When asked about what has not been successful, Niels says: “We decided to put more energy into the dialogue with NGOs. That has worked out well with some development organisations and some in the organic sector, but not enough for my taste.”

Change

Niels Louwaars is known in the sector as a flamboyant, even Burgundian, person. Although serious when necessary, he is always up for some fun.

The new director, Michiel Klompenhouwer, was formerly director of Food & Agri Mid-Netherlands at the Rabobank, so he knows the agricultural and horticultural businesses in the Netherlands well. But seeds are predominately international, even though the Netherlands plays a leading role. Niels explains: “At the Euroseeds Congress, I will introduce him to the colleagues in Europe, and two weeks later in Geneva to the global ones; that network is vital, and I will have the chance to play a role in his ‘onboarding’ later.”

Of course, it will mean a change for the secretariat. “When I started in 2011, I caused a bit of a culture shock. My way of managing professionals, derived from the academic world, was a change.” That expressed itself even in the dress code. “Wearing casual clothing, the usual outfit at a university, was unheard of at Plantum – suit and tie, or conventional skirts, were the norm, even if that would create an unnecessary distance. It was something Niels quickly changed. “I am conscious of the effect of your presentation. I always check my schedule in the morning and adapt my clothing. Even my orange-red jacket at large conferences had a function. One of the first things I did was to invite all colleagues at Plantum to think about this too.”

No commitment

Niels Louwaars has made only a few plans for the future. An example of his ‘what will be, will be’ attitude. “I expect to be in Denmark more often, the home country of my wife Solveig, as we have a summer house close to Copenhagen. And I plan to continue to write, maybe even about seeds,” he says with a smile. “But beyond that, I will see what my new life as a pensioner will bring. A luxurious situation, I agree, to be able to choose only things that I will find both relevant and fun; I have not made any commitments as yet.”

Power of **faba beans**

Anker Sørensen

Plants provide a very interesting protein source for human nutrition, as do animals. The balance between the two in our current diet is skewed toward a high proportion of animal proteins. A more balanced consumption - resulting in a significantly higher proportion of plant-based proteins in our diet - would be beneficial from a nutritional point of view, and would also favour a more sustainable food production system. The footprint of production of plant-based proteins is (much) smaller than for production of animal-based proteins.

Plant-based proteins are produced by all plants, but especially the legume family of plants stand out as a powerhouse of low-cost protein production. Legumes benefit from their ability to establish a symbiotic relationship with soil-borne nitrogen-fixing bacteria (Rhizobia). In this relationship, the Rhizobia provides the plant with its required nitrogen, which makes a nitrogen fertilizer application redundant. Even in the consecutive season, the next crop can profit from the nitrogen captured in the legume crop. Nowadays, European crop-rotation schemes contain around 5% legume crops, far less than optimal for a lower input of synthetic fertilizers.

> 'The amount of knowledge, data and sequence information of crops is currently very large'

Faba bean is a well-known and ancient crop but has lost its position in European crop rotation systems, because of the possibility of importing soybean at low cost from the Americas. Besides, cash crops - e.g. potato, sugar beet, onion - provide farmers with a better income. We believe that faba bean should be reintroduced in European crop rotations and that the use of faba bean protein in food applications will be a valuable driver for that.
Therefore, we have started the FabaFood initiative which, in essence, is an effort to breed novel Faba-Food varieties that are attractive as sourcing material for food grade plant-based proteins and also economically attractive for farmers to grow.

Advanced molecular breeding

So what can make a bean more attractive for food applications? To find out more about this, the genetics scientists at KeyGene conducted a number of interview sessions with various active players in the whole value chain; from sowing seeds to plant-based food products. When focusing on the quality aspects of the bean, a number of common attributes clearly emerged. Taste, colour and anti-nutritional factors (ANFs) are essential quality attributes to be improved in order to develop a high-value bean for food applications.
With those quality attributes, or 'traits', in mind, the challenge for the genetics scientists has been to translate these traits into knowledge about genetic factors (genes) responsible for the expression of these traits in faba beans. This process, that we call lead-discovery, makes use of the state-of-the-art knowledge of gene function in any plant that has been studied, in order to infer a genetic factor in the faba bean genome that could have a similar function (= the lead). Computational methods and models are essential in this lead discovery process, since the amount of knowledge, data and sequence information of crops is currently very large. Biological expert knowledge and computational methods have to work in synergy in order to arrive at interesting lead-genes - in this case in the faba bean genome.

Table 1. Targeted trait of the FabaFood initiative and its related anti-nutritional factors (ANFs)

A: traits	B: ANFs detail
Anti-Nutritional Factors (ANF)	Vicine & convicine (favism)
Colour (white)	Phytic acid (bioavailability)
Taste (neutral)	Tannins (bioavailability)
Seed protein content	Protease inhibitors (bioavailablity)
Protein amino acid composition improved	Raffinose (flatulence & IBS)
Seed size	Saponins (bitter and astringent taste)
Lodging resistance	Lectins (food intolerance)

Anker P. Sørensen, Vice President New Business, KeyGene, Wageningen, the Netherland

Taste, colour and anti-nutritional factors (ANFs) have to be improved in order to develop a high-value bean for food applications

The traits mentioned in table 1 have served as input for the discovery process and resulted in a list of approximately 30 leads in the faba bean genome (list is still growing).
For each of the lead genes, variation in the DNA sequence has been studied. A different variant of the DNA sequence will often result in a different enzyme being produced, or a different amount of the enzyme being produced. This will result in a different expression of the trait we are studying, or even the complete absence of the trait (i.e. absence of an anti-nutritional factor, ANF). For some of the lead genes, DNA variation has been discovered in existing faba bean germplasm.
In addition, we have developed a population of faba bean genotypes where additional DNA variation has been induced through chemical treatment of seeds. In the FabaFood research, the induced variation method has been used to discover novel variants in many of the lead-genes (table 2). Each of these new variants potentially results in a change of expression of the quality traits that we are looking for.

Chain collaboration

Next step in the FabaFood initiative is to validate the functionality of all the generated novel variants, in relation to the desired quality traits. Thereafter, the best performing variants will be combined into a novel food grade faba bean variety.
The best way to validate the functionality and quality of novel food grade faba beans is to evaluate the new variants by chain partners that are currently active in the production of faba-proteins and faba-based food products. The FabaFood initiative has therefore established a chain-collaboration of active partners that will screen all novel variants in their internal processes and report to the collaboration partners about the pros and cons of the novel faba bean variation.
By integrating the evaluation process throughout the chain, we have established an innovation model that actively funnels innovations from the genetic side into value for faba-protein based food products. Figure 1 depicts the chain partners and their respective role in the FabaFood initiative. The Dutch provinces Gelderland and Overijssel, united in EFRO Oost, are financially supporting this chain collaboration, which will be instrumental in realizing the potential of modern faba bean breeding efforts towards food grade faba beans.

Power of Partners

The FabaFood initiative includes multiple chain

ME-AT the alternative developed and produces plant-protein based Faba burgers

Table 2

Novel variants discovered in faba bean grown in the KeyGene greenhouse for seed multiplication

Trait target	number of novel variants
Bitterness	4
Protease inhibitors	1
Phytic acid	1
Vicine	3
Enzymatic browning	9
Off flavours 1	7
Off flavours 2	3
Raffinose	2
Protein content	8
Protein quality	4
Seed size	1
Total	43

partners. Agrifirm, as the agronomy specialist of the consortium, is very much looking forward to observing and evaluating the improved value of the food grade faba bean crop. That higher value will make the crop economically more attractive for farmers, whilst making the crop production more sustainable. Both Upfield and ME-AT are active players in the consumer markets for plant-protein based food products. By participating in this consortium, both companies will be able to very quickly test the improved consumer value offered by the new FabaFood varieties. Ebro Ingredients, being an intermediate between farmers and food industry, is looking for faster and less resources-consuming extraction processes of the high-quality proteins fraction, when using the innovative FabaFood varieties.

Future

Taste, appearance, quality and nutritional value are essential for broad adoption of food products, such as novel plant-protein based products. The FabaFood initiative is actively pursuing the goal of increasing the adoption of those products and thereby increasing the proportion of plant-based protein products in our daily diets. In addition to the contribution to a more balanced diet, the broad adoption of plant-based protein food products derived from FabaFood varieties will increase the legume production in Europe, and the proportion of legumes in crop rotations. Legumes will play a very important role in the increasing sustainability of agro-ecological systems of the future. By including all value chain partners in the innovation process, strong partnerships, like this FabaFood initiative, will not only lay the foundation for a more value-driven approach to innovation in food-production, but also immediately pave the way to direct use, growth and market introductions.

Disclosing the **secret life** of seeds

Theanne Boer

No seeds, no agriculture – it's a universal truth. However, it took Professor Leónie Bentsink five years to convince her colleagues and the industry of the importance of seed research. Now, Seeds for the Future is flourishing, with an increasing number of companies participating.

Seed research is on the rise. More and more companies in the seed sector are embracing the collaborative project Seeds for the Future, an initiative by Professor Leónie Bentsink. Moreover, Wageningen University & Research has recently appointed a seed technology researcher to meet the growing demand for seed research. The sector has a significant need for various forms of applied research.

Countless questions

It makes perfect sense, according to Bentsink: "We are dealing with climate change and the fact that many crop protection products are no longer permitted. The seed is your starting material; without good quality seeds, there is simply no agriculture. The Netherlands is excellent at producing vegetable seeds, with many originally family-owned businesses performing well in the international market. The sector is worth 2 billion euros annually, yet oddly enough, very little is invested in the related science. While there are countless questions that need answering. Think about improving seed germination, breeding climate-resilient varieties, researching seed storage or developing a method to determine seed quality. These are all valuable research topics that the industry can directly benefit from."
It was a close call and Bentsink could have been the last person to turn off the lights at Wageningen Seed Science Centre. Where 87 people once worked – when it was still called the 'Rijks Proefstation voor Zaadcontrole' (National Experimental Station for Seed Control) – she was the only one left after Dr. Steven Groot retired last year. How did that happen?
"Unfortunately, no policy was put in place," Bentsink explains, "and that's a problem throughout Europe; there is less and less attention and funding for seed research. Which is quite strange. Farmers and seed companies ultimately have only one wish: seed that is of such high quality that it germinates and grows into a healthy plant regardless of conditions. I do fundamental research myself, but we also need people who can apply the knowledge. Now that more and more companies are joining Seeds for the Future, I have hope that seed research at Wageningen University & Research will grow again. Yes, I think that is important. If we want to be a knowledge society and Wageningen is the hotspot for plant research in the Netherlands, then I feel the responsibility to keep highlighting such an important topic as seed quality."

Optimal protection

"We regularly have companies contacting us wanting to participate in Seeds for the Future," says Monique van Vegchel, policy specialist at Plantum. The trade association for breeding companies and young plant growers was pleased that Leónie Bentsink reached out to discuss collaboration: "It's great that Wageningen University & Research has appointed a full-time seed technology researcher again. Now that more and more crop protection products are being banned, you can look for other means, but you can also focus on the seed. If you can treat it in such a way that the grower in the field (or the greenhouse) needs to intervene as little as possible, by giving the seed optimal protection from the earliest stage, you already gain a lot. "Plants are expected to do more and more, because we are increasingly eating plant-based foods, but also because plants are increasingly exposed to extremes due to climate change. It is precisely those extremes that need to be addressed because we want the seed and the young plant to ensure as predictable a harvest as possible."

Shocking

"We store 23,500 accessions here," says Theo van Hintum from CGN, the Centre for Genetic Resources, the Netherlands. "We store about ten packets of seed for each accession in the freezer, so do the maths. Moreover, we are now also creating backup collections of related species found in the wild in the Netherlands. Occasionally, we take a sample and determine if it still germinates in a petri dish. That's how we check if the seed is still good, if it still works. There has actually been little research done as to why we do it the way we do. Should the freezer be at minus 20 degrees Celsius? Or would minus 15 also suffice? No idea. And why do we store the seeds in a vacuum bag? And what should the conditions be in the drying room? That has never really been researched, which is strange.
"Considering the worldwide expenditure on seed storage for gene banks and the basis of the knowledge upon which we operate, I find it shocking. It's going well now, though; we have seed that is forty years old and still germinates very well. But we could potentially save a lot on energy costs or determine germination viability in a non-destructive way if we knew more. That's why we are so pleased with the strengthening of seed research at WUR. I hope something will come out of it that we can use, because it is really needed. Not just for CGN, but for all those seed banks worldwide, which all operate under the same protocols, but actually don't know why."

Research trajectory

"With Seeds for the Future, we aim to create a research trajectory," says Leónie Bentsink. "A combination of fundamental research, applied research and product development that companies can work with. I find it very rewarding to see that three business units of Wageningen University & Research are now involved and that companies are joining. And then there is another world to be gained: we also consume a lot of seeds. Seeds have nutritional value, and for that role of seeds, it is also important to know how plant growth occurs, how seeds are harvested, how the nutritional value of seeds arises and perhaps can be influenced. There is still a lot to be discovered, so as far as I am concerned, this is just the beginning!"

Researcher in seed technology

Dr. Patricija Gran joined Wageningen University & Research last June as a researcher in seed technology. In this position, she aims to spearhead projects that bridge academic research with industry needs, addressing critical challenges in the agri-food sector. Her focus will be on enhancing seed quality through advanced breeding techniques, innovative treatments and seed testing methods, and improving overall seed health. Gran's research will contribute significantly to the Seeds for the Future initiative, tackling seed quality related issues posed by climate change and ensuring food security. Her efforts will strengthen the seed sector in the Netherlands and beyond, supporting one of the world's most important industries

Gaining knowledge about seeds to bridge the gap between, on the one hand, fundamental as well as applied research, and education on the other, is vital as there are countless questions that need answering

Collaborating Parties

The Seeds for the Future Initiative is supported by **Wageningen University & Research** and eight Collaborating Parties:
- **Plantum**
- **ASP - Quality Support**
- **Bayer Crop Science Monsanto Holland**
- **Bejo Zaden**
- **Germains Seed Technology**
- **Rijk Zwaan Breeding**
- **Enza Zaden**
- **Vilmorin & Cie**

Richard Visser

‘I am not sure what my **footprint** will be'

John van Ruiten

On 29th August 2024, Professor Richard Visser, after being in this position for over 25 years, stepped down as chair and head of the Department of Plant Breeding at Wageningen University & Research. In his long-lasting career, he has educated hundreds of students and coached and supported over 150 PhD candidates who are now active in global plant breeding research and business.

Professor Richard Visser was a member of the Academic Board and Dean of Research of Wageningen University & Research. He also played an important role in various societal discussions on genetic engineering and the use of advanced plant breeding techniques. Furthermore, Richard Visser was a member and vice chair of the Board for Plant Varieties in the Netherlands for almost 20 years and a member and president of EUCARPIA. He was elected a Member of Koninklijke Hollandse Maatschappij der Wetenschappen (Royal Holland Society of Sciences and Humanities) in 2015. Prophyta interviewed him.

When and where did you develop an interest in plant sciences?
“I grew up among pot plants and flowers as my father and older brother were selling pot plants at different open markets in Limburg. From the age of 12, I was already busy helping to load and unload trucks, watering plants and preparing them to be sold. From the age of 15, I was responsible for sales at one of the markets (Saturday market in Geleen) where I was ‘dropped off’ with the plants and then had to set up the stand and sell whatever I could.
I often accompanied my father to the auction in Aalsmeer and to growers in the Netherlands and Belgium to buy pot plants (azaleas, cyclamen, begonias and green plants). Around that age, I saw a short film about orchid growing and multiplication and it triggered that making plants from just a small piece of tissue, that was magic, and I wanted to do that as well.”

Where did you study?
“I wanted to study in Wageningen, but when I saw the first year’s programme, I did not really like the look of it, so I decided to study biology in Groningen, also because my then girlfriend, and still current partner, Anneke was studying there. I tried to attend as many classes and courses as possible which were plant and microbial oriented and, until my Masters, I was wavering between microbiology and plant genetics. I did my thesis work on potato (cell fusion, making amino acid analogue mutant cell lines) under the guidance of Evert Jacobsen in Professor Feenstra’s group and on the difference between aerobically and anaerobically grown E. coli in Professor Konings’ group.
“I went for an internship to the University of Warwick to study molecular aspects of photosynthetic bacteria. It was a good experience to be exposed to working in a lab outside the Netherlands. I do remember that I was really amazed about the differences. I was working opposite a sink where radioactive waste was thrown down the sink, while used bacterial cultures first had to be killed with soap and then had to be autoclaved. I remember that a janitor was coming to repair the sink and that I said he had to wait, and when I measured the radioactivity level, I told him he should come back after a week and then I put a note on the sink saying there should not be anything (especially radioactive waste) thrown in the sink again.
“I had a very nice supervisor who gave me all the freedom I wanted, partly because he was at the golf course almost every afternoon. So I learnt a lot and realized that I could also do this kind of work and get paid for it. I applied for a number of job applications in the Netherlands and started my paid working career.”

What was your first job and how did that influence your later career?
“My first job in this field was the PhD position in Groningen. I was offered a position by Professor Feenstra on cell biology of potato, but I wanted to go for molecular work (which at that time was really new). This was on starch metabolism in potato, together with the starch company AVEBE. I really liked doing research on something which could be useful right away, if successful, and this meant that I stayed in academia and did not go to work for a company.
“But I enjoyed working with companies and did so a lot. However, it is very important to have your own research agenda and direction, because if companies are involved and they pay, then they rightfully also want to (co-)decide on where the research is going. In order to avoid only researching what companies want, you need to be clear what you want to achieve in the research. If you also ensure that sufficient money is earned, you can afford to set up your own research (not company steered or bound) and in that way keep sufficient room for innovations.”

What is the footprint that you will leave behind?
“I had already set up a molecular lab in Groningen and brought that knowledge to Wageningen. So we set up not only a molecular lab, but also a tissue culture lab and a biochemical lab in Plant Breeding. These were great times, and I was lucky enough to be in Professor Jacobsen’s group who had just obtained a follow-up project on the starch biosynthesis in potato. I had a flying start with being responsible for the daily supervision of a PhD student and two technicians (a luxury).
“What my footprint will be in Wageningen, I am not too sure. I have been able to show (together with all the employees from Plant Breeding) that working in a combined group with a large enough critical mass makes a lot of things possible. Plant Breeding at WUR has an excellent name as one of the strongest research groups in plant breeding in the world and we are leading in several fields, like polyploid genetics and genomics, effectoromics, potato genetics, S-genes and so on. Of course, there is always room for improvement and new initiatives, which I leave to the group and my successor.”

‘I am pleasantly surprised to see that nowadays many students are enthusiastic and want to improve the world and the living conditions for everyone,’ concludes Richard Visser

What about the number of Plant Science students in Wageningen?
“During the last few years, we have seen an increase in the number of students in plant sciences and also in plant breeding. We now seem to have reached a plateau in the number of MSc students, while BSc students is decreasing slightly. Each year, we have around 100 MSc students, which is our maximum because of available lab space, but also because of available supervision and examining power. If I compare the 75-80 BSc students to the only three BSc students we had in 2005, then we have made a great jump, but we need to keep attracting new students.
“I am also pleasantly surprised to see that a lot of the students now are enthusiastic and want to improve the world and living conditions. Contrary to 10 or 15 years ago, where many students thought they could improve the world by becoming a medical doctor, they now see and believe that making the world a better place can also happen when you ensure that people have enough to eat in a healthy and sustainable environment. I would say the idealistic student is back!”

Plant breeding nowadays is the subject of societal discussions. Could you share your thoughts on these developments?
“I believe that plant breeding has always been a

‘I would say the idealistic student is back!’

subject in societal discussions and was, and is, really embedded in society. As a plant breeder, you need to know what society needs and wants. So keeping the wishes and desires and demands of consumers in mind is an almost natural thing for commercial plant breeders, but also for researchers. Ever since the green revolution, there has always been an ambivalent position towards plant breeding, which every so often surfaces, like with the GMO discussions, plant breeders’ rights and patents, and now with gene editing.

“What we have seen is diminishing numbers of companies active in crop breeding, down to a few very big ones. In my view, this is partly due to the technification of the field and the subsequent large investments which are needed. This is a trend which you also see in the production of cars, electronic machines or even microchips. Whether this trend is good or bad in itself, I do not know, but it is clear with all the current social discussions and global unrest that the production of food and the possibility of governments ensuring that their population gets sufficient food of good and safe quality is of the utmost importance.

“Hence more efforts are placed and should be further placed by ensuring that food production and thus having access to good seeds of different crops is safeguarded. What the maize crisis from a few years back in the USA and Mexico and the current crisis in Ukraine has shown us is that, if you do not produce your own food, you are depending on the world market. But if there is nothing to sell, or if no one wants to sell it, then you have a big problem as a government.

“I am pleasantly surprised to see that new breeding efforts have appeared, for instance, in tomato breeding. Some growers are so big now that they can make an easy calculation that making their own seed (and varieties) can be cheaper than buying it. Whether they will last is another question. On the matter of how society and politicians look in Europe at aspects, such as patents on natural biological processes and gene editing, depends to a large degree also on what will happen in the countries and continents around us. We do not live on an island, although with certain legislation, we have acted as if this is the case.

“With many countries approving exemptions and/or more relaxed rules with regards to gene editing, we have to wait before all these new products (and I have no idea how many there will be) are at the borders of Europe. How are we going to deal with that? And with international trade laws? Interesting times lie ahead of us.”

Which future developments do you envisage as relevant for plant breeders?

“I firmly believe that breeding should become much more efficient and effective. We cannot afford to make lots of crosses almost blindly and then hope to be able to select one potential variety from hundreds of thousands of seeds. The traits for the future are the difficult ones and thus it is important to develop methods and tools on how to deal with quantitative traits (for yield, climate change resilience, drought resistance, etc.). Also, more research and breeding for alternative cropping systems, such as vertical farming, strip cropping, intercropping, food forests, and also breeding for how plants respond to bio stimulants and biologicals. Furthermore, many diseases which are not a problem yet in certain areas will also become a problem there because of the transfer of material.”

In your opinion, how can plant breeding support the transition to more sustainable food, feed and flower production?

“A more sustainable production of food, feed and flowers requires less dependence on chemicals, water, fertilizer, etc. while still achieving high yields of high-quality products. Plant breeding can play an important role. Varieties need a good and durable resistance against biotic and abiotic stresses. Whole plant use or multipurpose use of all plant products will become important and, therefore, we also have to set up new production chains.”

Who is going to take over the WUR tasks that you carried out and who will lead the chair?

“Good question and, frankly, I have no idea. Five years ago, I started to prepare both myself and the organization for my retirement and, at that time, one of the first questions I asked the rector, and the then director of the Plant Sciences group, was whether Plant Breeding would remain a merged group (of WU and WR) or not. Luckily the answer was yes and, thus, I prepared further and, almost two years ago, I offered to step aside as chair and head to make way for a replacement. An interim chair has now been appointed for half a year (Professor Yuling Bai from within plant breeding) but, at this time, the advertisement still has to be placed.”

‘Working in a combined group from Wageningen University and Wageningen Research with a large enough critical mass makes a lot of things possible,’ says Richard Visser

You are not the kind of person to leave the world of genetics. What’s next in life for you?

“Although I retire as chair and head of Plant Breeding, I will remain active for two days a week as professor of Plant Breeding, specifically on two projects with regard to breeding for vertical farming in Singapore and China. I will be advising a number of companies and research institutes on a large fundamental project on breeding two brassica crops for vertical farming. And, of course, I will help the PhD candidates still under my guidance to complete their PhD theses successfully.”

And besides the scientific world, where do your other interests lie?

“I am very fond of history and will start to read more about it and maybe some other (research) work. Besides this, I have a large garden, and I have already been busy for five years making a hedgerow. I also like to read. And then, finally, I will spend more time with the assistance dog we are training. So I guess walking more with the dog will hopefully result in better fitness because sitting behind a desk the whole day is definitely not good.”

And to finish: is there any recommendation or some food for thought that you can give the readers of this magazine?

“Realize in what kind of privileged and important position you are and what kind of responsibility this brings! To quote a well-known Marvel character: ‘with great power comes great responsibility’. Try to do your best, not only for your publication list or company, but more specifically for mankind. Having access to good, healthy and safe food is something which should be true for every single inhabitant of this planet. Plant breeding can make a difference here!”

A Sea Change for Growers

Strawberry runners soon **outdated**

Monique Krinkels

Producers of strawberry runners and growers of this fruit find themselves on the eve of a sea change. Since some major vegetable plant breeders have been focusing on hybrid strawberry varieties, a stormy growth can be expected. In the future, strawberries grown from seed will be the norm. It will uplift the industry to a more sustainable and future-proof level, is the expectation.

"The transition from runners to seeds will probably not go as quickly as the Lim Group foresees," believes Gé Bentvelsen, the first breeder who developed hybrid strawberry varieties. "According to Sjoerd Gipmans, strawberry specialist of that company, strawberry from seeds will be the standard production method within five years. I expect it will probably take a little longer."

New players

The interest in breeding hybrid strawberry varieties is growing. Even renowned vegetable seed companies are entering this market. Last year, Rijk Zwaan announced the start of a breeding team for soft fruits. For that purpose, a new greenhouse was opened this summer. Besides hybrid strawberries, the company also wants to develop hybrid raspberries and blackberries. "The latter two are easier, as they are already diploids," says Gé Bentvelsen. Bayer is another new player in this field. Last year, the company took over NIAB's commercial strawberry breeding programme. Companies that traditionally breed strawberries are also exploring the possibilities hybrids offer, with the Lim Group as forerunner.
ABZ Seeds introduced its first seed strawberry varieties in the 90s. "As an ornamental, the product was immediately embraced by consumers. But it proved difficult to convince professional growers for the fresh market to make the change from runners to seeds. Despite the many advantages of seeds, even today, they still prefer runners from the ancient 'Elsanta'. That variety was bred in the 1970s by L.M. Wassenaar of the Institute for Horticultural Plant Breeding (IVT) at Wageningen University & Research and introduced on the market in 1981. "Worldwide, it is the fruit equivalent of Bintje, the potato that dominated the market from 1910 to present. But strawberry growers are by nature conservative."

Flexibility

An obvious advantage of seeds as starting point is that the product is clean. Seedborne diseases are rare and easy to prevent. That means the cultivation requires less plant protection chemicals and hence is more sustainable. Besides, resistances are more easily introduced. Tolerance against *Podosphaera aphanis*, powdery mildew, is important. "At ABZ Seeds, we use marker assisted selection techniques for research purposes. As a project, we study which genes are involved in resistance against *Phytophthora cactorum*." The technique is also applied to establish varietal trueness and purity. "We have marker sets for all our varieties," Gé Bentvelsen adds.
The plants are logically more uniform than clones. But it also presents flexibility for growers, because of the short period between ordering and delivering of the plants. With runners, it takes at least a year, while when seeds are used, the flowering plant is ready for production within three months. Furthermore, indoor strawberry seeds can be planted at any time of the year. "Adding to the flexibility for the grower is that our strawberries are day-neutral, ever-bearing varieties, which makes it even more easy to respond to the demands of the market."

One of the great advantages of growing strawberries from seeds is that the young plants are uniform

Good business

Gé Bentvelsen sees another market segment expanding. "Strawberries from seeds are also very suitable for vertical farming. These companies require absolute hygiene as an outbreak of a disease would be disastrous. The compact growth habit of our varieties fits in seamlessly with that cultivation method."
The fact that growing strawberries is profitable from a business point of view, has attracted the attention of tomato growers, who are used to plants grown from seeds. An important reason is the virus pressure in tomato cultivation, especially by the Tomato Brown Rugose Fruit Virus (ToBRFV). Economic factors also play a role. The energy costs to grow strawberries, which is at the moment an expensive input, is only one third compared to tomatoes. Strawberries are popular and remain well-appreciated in the market. Therefore, it did not take long for some to make the switch.
"Strawberries from seeds is not a development that is limited to the Netherlands," Gé Bentvelsen explains. "We export strawberry varieties to over 35 countries worldwide. While most are for use as an ornamental, the share of plants for the fresh market is steadily increasing. And the interest is rising. To illustrate this, the Austrian strawberry growers invited me to explain the changes that are awaiting them at their December meeting in Graz."
The transition from the use of clones to seeds is easier than you would think. Of course, it requires changes along the chain. The producer of the young plants needs a sowing machine and plug trays and needs to adapt to a new production system. But they benefit from 100% clean starting material and a production cycle that is shortened drastically. "For the grower, hardly anything changes, although he might need another producer of young plants," grins Gé Bentvelsen. "He receives flowering plants that produce fruits within a month and can quickly adjust his plans to the demands of the market."

Obstacles

Besides the conservative attitude of strawberry growers, one of the obstacles the producers of hybrid strawberries encounter are the European regulations that are lagging behind the facts. These regulations stem from 2014 and are hopelessly outdated. It is assumed that all fruits are vegetatively multiplied. So far, attempts to convince the legislator that hybrid strawberries should be treated the same way as vegetables have failed miserably. At the moment, however, Brussels is working on new regulations, where the rules for vegetables and fruits are harmonised. There is hope for a sea change in strawberry growing.

Sow to Grow

Sow to Grow is a so-called 'plant science experience centre', where people can learn more about plant breeding and its crucial importance for human health and wellbeing, as well as the environment. 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

Spotlight on

The spiral trieur

Monique Krinkels

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 spiral trieur.

"Many people who have visited the museum will have seen it at some point. The blue spiral, also called the spiral trieur or spiral separator, at the top of the museum. A simple-looking piece of ingenuity for separating round and angular seeds. Especially because the object itself, in most cases, has no rotating parts, it is also not taken too seriously as a groundbreaking invention, because this object seems so simple," explains Ramon Papa, author of 'The History of Seed Cleaning' (freely available at thehistoryofseedcleaning@gmail.com).

"Where in some countries the operation of the devisees is explained as a so-called apparent force, this device is equally way more complicated and works on the bases of centrifugal and centripetal forces. This high-quality piece of physical engineering is of a class that surpasses all other cleaning machines.

"It was 1907 when Edward Tompson first came up with the idea of using this technique. He invented a manually driven rotating scale machine consisting of multiple layers. However, it was Frank Pardee who, from 1924 to 1937, really developed the spiral trieur into the simple-looking design it has today. He did it based on piles of calculations: theoretical physics.

"Frank first started by making a spiral consisting of separate plates, but then quickly moved on to a rolled plate in one piece nailed to a wooden centre pole. Patent after patent followed and he soon realized that not every round seed rolls down in the same way - round and less round parts all move in their own way: centrifugal force (round outwards) and centripetal force (angular, less round parts inwards).

"It is a beautiful piece of physics because, together with the gravitational pull of the earth, the interaction between the three forces separates the seed. For 13 years he had been searching for the ideal length of the spiral, the right number of revolutions, the perfect radius, but also the correct angle of inclination for different types of seed."

A rapidly developing **seed world**

Niels Louwaars, Henk Bonthuis and ArndJan van Wijk

The concept of a variety list that did not only formally establish the identity of a named variety, but that also served as an independent source of information for farmers, has survived since 1924, but its implementation has gone through several significant changes. Today, a century later, it is again under discussion at EU level.

The first descriptive list of classified varieties in the Netherlands was published as a 3-page article in the stencilled 1924 edition of the 'Veldbode' (Field Messenger) weekly magazine. The cover of that edition, featuring prize-winning pigs, did not indicate that the editor realised the importance of this edition. Since then, the list of classified (i.e. recommended) varieties has continued, with interruptions only in 1933 and 1945.

A century ago

The first list in 1924 had a history connected with the development of professional plant breeding. A list of variety names had been started ten years earlier, responding to a widely felt concern about varietal identity. Professional plant breeding, which developed in the late 19th century, had given rise to a range of seed producers, selling their seed under the names of popular varieties and landraces, or selling seed of popular varieties under their own brand name. Both these strategies were to promote their business, while creating a rather chaotic situation for farmers. However, varietal identity was a prerequisite for field and seed inspections that were developed by provincial farmers' associations in the early 20th century.
The association in Zeeland developed guidelines and their colleagues in Holland published a first list of variety names in 1914. That same year, a regulation was published that allowed Dutch breeders to have their new varieties tested by the newly (1912) established Institute for Plant Breeding at Wageningen. From that moment on, a list of variety names was published annually, however, without any agronomic characterisation. As of 1920, the Central Committee (of provincial associations) started to provide brief variety descriptions.
The new professor of plant breeding, Broekema, took the initiative to bring together all trials performed by the provincial agricultural specialists and extension agents, and developed a protocol for interprovincial variety trials. The product, presented in 1924, was meant to serve the variety choice by farmers and was given formal government recognition that year. The list contained varieties of cereals, legumes, potato, fodder beet and industrial crops in the classes A: generally recommended; B: limited recommended or 'trial-worthy; and N: newly recommended. Information was given for a total of 70 varieties. In 1930, grasses were added after complex discussions about the variety concept for these crops. Already in 1925, a separate 38 page-brochure was published, which was distributed free of charge. English (1934), French (1935) and German (1939) summaries were included, as well as information about listing of the same varieties in these countries in 1936.

Continuous progress

The descriptive list for field crops expanded over time, notably through the inclusion of more and more traits that farmers became increasingly interested in. Continuous progress in mechanization, agronomic practices, disease control and industrial quality required continuous adaptations in the Value for Cultivation and Use (VCU) trial system. The dwindling opportunities for chemical crop protection led to the increasing demands by both farmers and breeders to include disease resistance testing in the trials from the 1980s onwards.
Despite the competition among breeders, they considered the official multilocational trials as an excellent last selection round. Intermediate trial results were an important tool in the prediction of seed demands once the final decision on release (and ranking) in the list became known, and consequently in seed production planning.

Potatoes and vegetables

For potato, the support for the official VCU testing diminished significantly over the years. Special research programmes on control of wart disease, nematodes and viruses made separate VCU testing redundant. Prediction of consumer preferences and even testing of late blight susceptibility became ever more challenging. Moreover, many potato varieties are bred for cultivation in other countries, only to be grown as seed potatoes in The Netherlands. Breeders' recommendations were taken up in the self-organising potato value chain which, in the end, resulted in minimizing the VCU programme (although still in compliance with EU rules). In the late 1990s, the Dutch testing authorities realized that, in many aspects, potatoes are more comparable with vegetables being released based on DUS only.
In 1943, a descriptive list of vegetable varieties was

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The first Netherlands Lists of Recommended Varieties contained information on 70 varieties of cereals, legumes, potato, fodder beet and industrial crops in total

first published based on trials performed in farmers' premises and collected by either the extension service or the Wageningen institutions. This list was discontinued in 1994 – interest was waning as cultivation technologies developed at a rapid pace and, similar to potato, quality (and diversity) aspects and disease resistances, rather than yield data, became increasingly important. Within the crop value chain, growers were happy to rely on the information given by the few(er) breeding companies and breeders were happy to reduce costs of variety introduction.

Institutional responsibilities

The initiative of the variety list was taken by the Wageningen Institute for Plant Breeding, which took responsibility until 1943. The promulgation of the 'Breeders' Decree' of 1941, which among other things introduced the plant breeder's rights, had led to the establishment of a separate 'Institute for Variety Research of Field Crops' (IVRO), which would organise variety testing of field crops for both registration and plant breeder's rights, as well as VCU testing as a basis for recommendation. The breeders' decree of 1941 was consolidated in the first Seed and Plant Materials Act of 1967.
In 1977, the IVRO took up the responsibilities for the variety testing of vegetable crops as well and was renamed RIVRO (with the first R standing for 'State'). The Variety List Committees, responsible for the trials and decisions, were extended with officials and private sector specialists.
Meanwhile, the directive of the Council of the European Economic Community in 1970 created a Common Catalogue of Agricultural varieties of the European Union. However, national autonomy in VCU testing remained. Only seeds of registered varieties (in the EEC member states) were allowed to be grown in the common market.
In 1990, the government decided to reorganise (and privatise) the agricultural research institutes at Wageningen. RIVRO was split into two parts: an executive unit charged with VCU testing and a supervisory unit controlling VCU test results and charged with statutory tasks (registration and listing). The executive unit was located at the centres of applied research, initially 50% funded by the government and 50% by the private sector (breeders, farmers and industry).
In 1992, in anticipation of further privatisation, the Variety List Committee introduced the so-called National List, which later on (in the new Seed and Plant Materials Act of 2006) became the National Register of released varieties.
In 1997, the government funding was withdrawn, leaving full responsibility of VCU testing to the private sector, comprising two years of mandatory VCU for National Listing (based on minimum criteria in compliance with EU regulations) and one more year of voluntary testing for the Recommended List (sometimes based on additional criteria and indexes).
In 1997, the amenity grasses, being excluded from mandatory VCU by the EU Regulations, were removed from the Recommended List. As of that moment, the testing of such grasses was done under the responsibility of the National Olympic Committee/National Sports Federation, which publishes its results separately in the 'Grasgids' (Grass Guide).
Two years later, the publication of the Recommended List for potatoes was discontinued. In 2001, when the agricultural research institutes at Wageningen were privatised, the coordination of variety testing was transferred to the Centre for Genetic Resources, being part of a group of institutes within Wageningen University and Research (UR) charged with statu-

tory tasks. The responsibilities for VCU testing were tendered. Most crops are still tested at the centres for applied research under Wageningen UR. However, VCU-testing of potato (although at minimum level) is done by the seed inspection service (NAK), sugar beet by the Institute for Rational Sugar Production (IRS) and some smaller crops by the (in the meantime also privatised) Extension Service. VCU testing of flax was discontinued in 2006 due to lack of funding.

Current situation

Since 2006, at the start of the new Seed and Plant Materials Act, varieties of all crops have been registered in the National Variety Register under the full responsibility of the Plant Variety Board, an Autonomous Public Authority (APA). The recommendation of varieties is left to private parties, as this is not required by (Dutch and EU) law.
The association for seeds and young plants, Plantum, together with farmers' organisation LTO, took the initiative to continue the Recommended List based on (in most cases) third year trials following the two years' registration research. They established the 'Committee for the Composition of the Recommended list of Varieties' (CSAR) in 2010 consisting of these two stakeholders under independent chairmanship, which publishes the results.
Plantum is responsible for the testing contracts (based on protocols supervised by VCU experts on behalf of the Plant Variety Board). Until 2015, farmers' and breeders jointly funded the tests (for registration and recommendation); the testing of fodder crops (maize and grasses) was fully funded by the applicant breeders. In 2015, breeders started to pay for all testing because the system for collective farmers' funds for research had stopped.
The characteristics that determine the ranking of the varieties are summarised in indexes suggested by crop committees consisting of breeders and farmers. This has resulted in the assessment of not just yielding capacity, calculated over locations and years, but also in an extending range of disease resistances, agronomic traits and characteristics, such as baking or brewing qualities.

Future

It is a moment to celebrate the progress made by VCU-testing of the most important field crops and the effective extension of the data to farmers, who base their variety choice to a significant extent on such recommendation. However, it is also important to see how the system has evolved, including increasing ranges of tolerances and disease resistances where necessary, reducing the extent of such tests where appropriate and changing responsibilities between public and private sectors.
Currently, the EU regulation on 'Plant Reproductive Material' (PRM) is under debate. A more level playing field in Europe, in terms of variety registration and seed quality controls, may indeed be useful, but growing conditions and ideal-type variety characteristics greatly differ within and among EU member states. The rules were established to protect farmers from fraudulent seed, ascertaining identity and quality. Calls to exempt large numbers of seed suppliers, notably in the organic sector, due to absent or lower quality and identity standards, may significantly reduce such protection by law. Furthermore, including agricultural performance requirements for registration of vegetable varieties, will almost certainly delay release processes in this very dynamic subsector, with devastating consequences for resistance management, notably in spinach and lettuce, and reducing the diversity of choice for the increasingly professional vegetable farmers.
The legislator has to carefully balance different policy objectives and their effect on a wide diversity of farmers, crops and cultivation techniques throughout Europe and, of course, limit undue administrative burden in a very dynamic world of breeding and seed supply.

100 years history of Dutch recommended lists of varieties (currently operating in an effective public-private cooperation) is a good moment to think about the future.

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