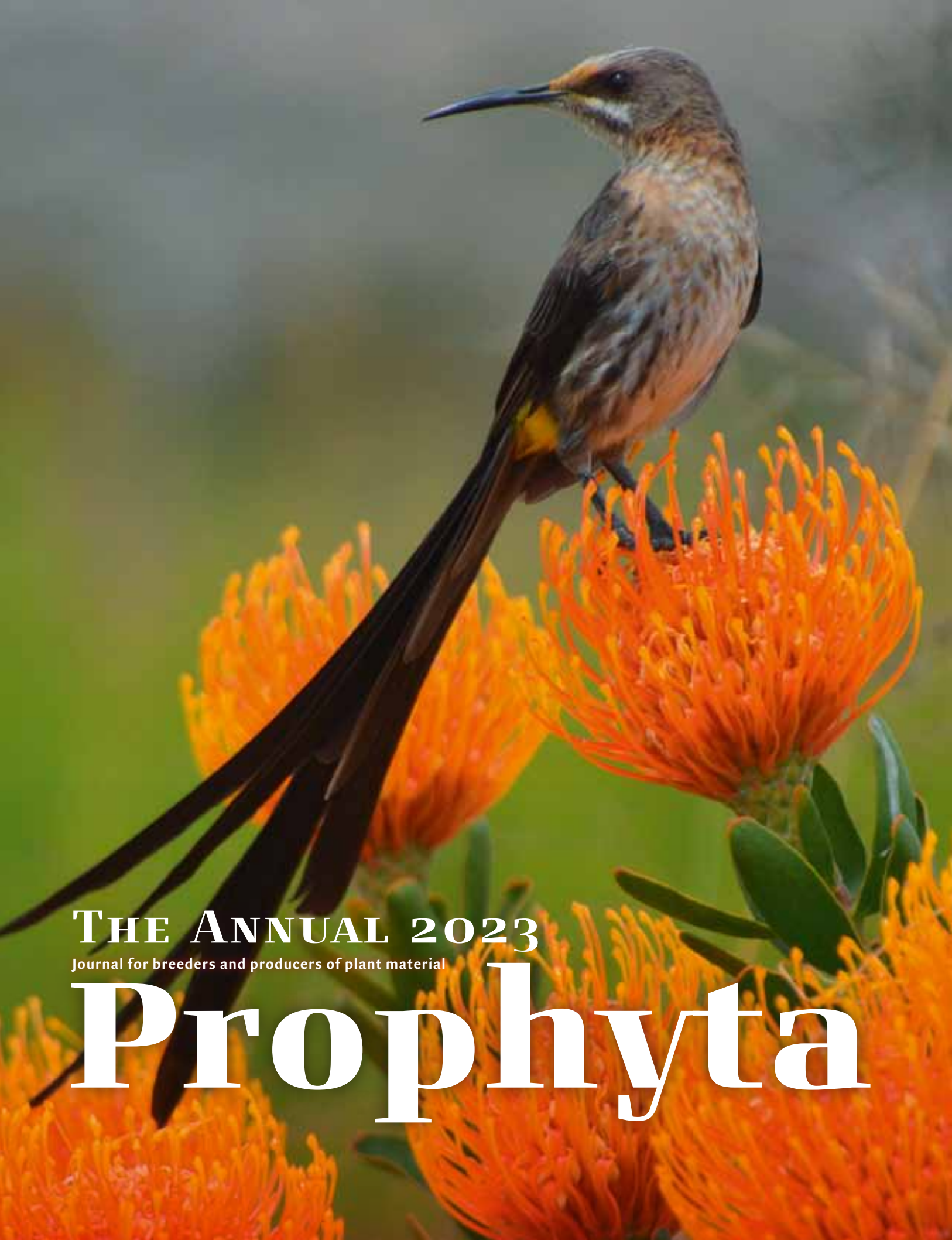

The Annual 2023

Journal for breeders and producers of plant material

Prophyta

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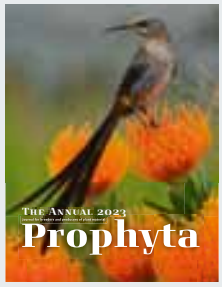

On the cover: The sugarbird (Promerops cafer) with its distinctive long tail is one of the iconic birds of the fynbos in South Africa. Feeding on the nectar, it pollinates a suikerbossie or sugar bush (Protea) in Kirstenbosch National Botanical Garden

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Fleuroselect presents Gold Medal winners

Earlier this year, Fleuroselect presented its 2024 Gold Medal winners. All three are breeding breakthroughs, with an outstanding score for innovation, beauty and garden performance.

Gazania rigens F1 *'Zany Sunny-Side Up'*, bred by Benary, has an extraordinary colour combination, with golden orange petals blending into light yellow tips. The plants of this new variety are incredibly consistent in growth and produce numerous large, colour-stable flowers that even open earlier and longer on cloudy days. 'Zany Sunny-Side Up' reaches sales maturity in the same short flowering window as the other varieties in the Zany series, and is just as suitable for cultivation in pots and packs. For growers, this means the option of a space-saving production cycle with uniform cultivation processes and coordinated sales of each variety.

Helianthus annuus *'Desire Red'*, bred by Burpee, is a sensational dwarf Helianthus variety which dazzles consumers with its innovative, unique russet flowers. The deep, rich red colour makes it just perfect for the late summer range. This high performer is an early, profusely flowering variety - new blooms form continuously on its multiple branches, well into autumn, and blend wonderfully with its dark green foliage. 'Desire Red' can be marketed as an attractive seed packet product, as plug or flowering pot and container plant. Its long sales season from May to August make it an ideal product for impulse purchases in garden centres and retail outlets. An added value: pollinators just love the deep dark centre of this sunflower.

Lycopersicon esculentum *'Tiny Temptations F1 Orange'*, bred by Prudac, stands out not only for its bright orange fruits but also for its wonderful flavour. The ultra-sweet cherry tomato fruits of this variety are a real breeding breakthrough in trailing tomatoes. The Fleuroselect jury praised the delicious taste and excellent plant habit with multiple branches bearing a constant supply of new fruits. The bushy plants with their small, sturdy green leaves are highly tolerant to Phytophthora, not susceptible to mildew and therefore easy to grow. In addition, the abundant flowers are a magnet for bees.

Cry for help from Ukraine

The director of the botanical garden of Dnipro University, Anatoly Kabar, sent out a message early this year asking for help to maintain the garden. Because of the war, there are only 22 employees, mostly women and pensioners. The area of the garden is 27.5 hectares, with four greenhouses. The botanical garden's collection of plants includes more than 3,500 species and varieties. In the exposition greenhouse of the department of tropical and subtropical plants there is a collection of heat-loving species from Africa, South Asia and Australia. There is also a unique collection of palm trees, some of which are over 90 years old.

The situation has become more complicated due to regular power outages: workers of the botanical garden are forced to take turns, to heat the pots in order to somehow maintain the temperature regime, at least in the greenhouses. If the temperature drops in the greenhouse, for example, more than 1,500 taxa of plants, including 900 species of closed soil, will die.

The unique herbarium of the Kherson State University has been preserved. It consists of 32,000 specimens collected over the past 50 years. In the first days of the Russian occupation, about 200 of the most valuable specimens – reference or typical specimens – were hidden in the basement of the university. The occupying authorities did not know about the valuable 24 boxes. As soon as the city was liberated in November last year, the first thing scientists did was take typical samples. Volunteers who brought relief supplies agreed to take the herbarium in the already emptied van when returning home. So, on 2 December, the first batch of the herbarium was taken to a safe place. On 5 January 2023, the last fully loaded truck with the remaining specimens went to Vasyl Stefanyk Prykarpattia National University in Ivano-Frankivsk, West Ukraine.

A total of 32,000 herbarium specimens in more than 1,000 boxes were transported. Of these, 16,000 are lichens and fungi, 15,000 are vascular plants and about 1,000 are mosses. Only two days after the herbarium was taken away, a shelling occurred near the university, right next to the place where herbarium specimens were stored for trans-shipment.

Second chance

Later this month, the European Commission will reconsider the admissibility of new breeding techniques, such as CRISPR/cas9. In 2018, the EU ruled that new plant varieties obtained by these techniques should be treated as GMOs, despite the advice of Advocate General, Michal Bobek. That meant that the varieties would not be considered in a similar way to conventional mutants, but be subjected to the same stringent regulations that govern genetically modified plants. The fate of this new technique not only harms European breeders but, for instance, also the South African breeders, where the same discussions are taking place.

During the last five years, it has become obvious that plants need to adapt to new circumstances quicker than ever. Climate change is here to stay, so plants should be able to withstand droughts, floods and other, thus far unusual, weather conditions. The war between Russia and Ukraine underlines the importance of self-sufficiency when it comes to fundamental supplies, such as energy and food. It came as a shock to learn that, according to the UN HungerMap, at least 670 million people still go hungry in this modern world.

At the same time, the interest in biobased products is growing fast. The changing attitude towards meat-free food, whether because of animal welfare, human health aspects or climate fear, has caused a plant-based food revolution. The market is demanding improved vegetal suppliers of proteins and omega-3 oils. Biobased products can also fill a gap as energy supplier, as ingredients in medicines, but can also change so-called marginal lands into commercially fruitful fields.

Several studies reveal the usefulness of new breeding techniques. To obtain a desired mutant in the traditional way can take decades, while with CRISPR/cas it can be fixed in a relatively short timeframe. That means that in an instant, crops such as root chicory can be a new source of cancer-fighting medicines and a weed such as Camelina can become a supplier of energy.

Let us hope that the EU-politicians will review their earlier error and will allow the use of new breeding techniques to the benefit of all.

Monique Krinkels

Microplastics on their way out

In January 2019, the European Chemicals Agency (ECHA) proposed a wide-ranging restriction on microplastics in products in the EU/EEA. Last year, a draft regulation for the use of microplastics was published and this year the new regulation is expected to be adopted by the European Union. After a transition period of five years, intentionally added polymers will be forbidden in the EU, but some countries, such as France, might well adjust its legislation sooner. The proposal is expected to prevent the release of 500,000 tonnes of microplastics over 20 years.

Many seed coatings rely on petroleum-derived binders – so-called polymers – to attach useful additives onto seeds. While seed coatings are not a major contributor to the microplastic waste (that 'honour' goes to the wear and tear of car tyres and synthetic textiles), the binders should be free of polymers in the near future. As Incotec stated in their white paper 'A microplastic-free future for seed treatments', microplastics are on their way out. Seed companies and coating companies need to prepare themselves. The company, and their colleagues in the Croda Group, started to replace all synthetic polymers in their seed treatments four years ago. Incotec calls on all interested parties to share expertise and start discussions. The white paper can be downloaded at: mpf-whitepaper-2.pdf (incotec.com)

Wageningen number 1 in rankings

The Dutch university Wageningen University & Research is one of the top-ranked universities in the world. According to influential university rankings, the university ranks as the world's best in the field of Agriculture and Forestry in 2022. For the 18th time in a row, students claim it is also the best university in the Netherlands.

According to the National Taiwan Ranking, which compares over 300 universities, Wageningen is the number 1 agricultural university. In the Shanghai Ranking, Wageningen also holds first place in agricultural sciences. In the US News ranking, WUR is number 1 in environment/ecology, number 1 in agriculture and among the 80 best universities worldwide. And lastly, in the GreenMetric ranking, Wageningen University & Research is once more the most sustainable university in the world.

Dogs can help stop the spread of Xylella fastidiosa at critical strategic locations, such as greenhouses and ports

Super-sniffers can detect Xylella

Italian olive tree producers have turned to a squad of supper-sniffer dogs in the ongoing battle to prevent Xylella fastidiosa from spreading. The disease was first recognized in 2013 in the olive orchards of the Salento Peninsula in the region of Apulia, one of the main olive-growing area in southern Italy. According to the local farmers, the unusual desiccation symptoms of 'sindrome del declino rapido dell'olivo' ('quick decline of olive syndrome') in olive canopies started to appear on a few scattered trees between 2008 and 2010. Today, the disease threatens over 600 plant species all over the world and there is no cure. In the southern Italian region of Puglia alone, the bacterium has killed 21 million olive trees.

To prevent the disease from spreading, early detection is a major prerequisite. Dogs can be trained to discover drugs, banknotes and even human diseases, so the idea of training them to recognize Xylella fastidiosa is not farfetched. A dog's nose has features that make the animal a super-smeller. The front part of the nose serves to humidify the incoming air, which aids olfaction. The air is then pumped in part into an olfactory chamber, packed with receptors to catch odorants. Dogs have 20 times more olfactory receptors than humans. Furthermore, dogs can sniff in a continuous cycle, catching large volumes of air and odorants. According to Serena Donnini, dog trainer and coordinator of the Xylella Detection Dogs experimental programme, a well-trained dog can pursue a scent for hours. When they discover Xylella they just sit in front of the affected plant and wait for their reward.

Victory against Phytophthora

A PhD student at Wageningen University & Research has succeeded in creating a potato variety that is resistant to Phytophthora infestans. Using Crispr-Cas, Daniel Moñino-López changed non-functional resistance genes of varieties susceptible to Phytophthora into gene variants occurring in wild potatoes that are resistant to the disease. This water mould is able to quickly adapt to resistance genes, which makes obtaining resistance using traditional breeding techniques almost impossible. Daniel Moñino-López received his doctorate last April.

Potato production is threatened by this devastating potato disease which is responsible for 3-10 billion euros in yield losses and extra costs in growing potatoes worldwide every year.

EASAC cautions against loopholes

The Scientific Advisory Board of the European Academies (EASAC) warns against emergency authorisation of neonicotinoids and the development of neuro-active substitutes that are worse than the original insecticide. That is the conclusion in a recent report on the latest research projects. In some countries' authorisations, it has become a customary practice to continue the use of banned neonics. The European Court recently ruled that emergency authorisations should be a last resort only. Another threat are substitutes that exploit the same insect neural mechanisms. New molecules that inhibit nicotinic acetylcholine receptors might have similar broad ecosystem effects as neonicotinoids. The report 'Neonicotinoids and their substitutes in sustainable pest control' supports the continuation of existing restrictions and of measures to minimise future use.

EASAC is formed by the national science academies of the EU Member States, Norway, Switzerland and United Kingdom, to collaborate in giving advice to European policymakers. Halving the use of plant protection products in agriculture is part of the EU's 'Farm to Fork' strategy.

South Africa promises growth and **opportunities**

Monique Krinkels

Finally, seedsmen from all over the world will gather in Cape Town, South Africa. It was on the agenda for 2020 but, due to Covid-19, it had to be postponed to this year. David Malan, Chair of the National Organizing Committee of the South African National Seed Organization (SANSOR), hopes to welcome 1,200 delegates.

The theme of the World Seed Congress 2023 is 'Shared Roots, Greater Heights'. The organizing committee has chosen this topic to underline the importance of access to quality seed and innovation through sustainable seed systems and private sector engagement in Africa and beyond. "The goal of achieving 1,200 delegates might be too optimistic, but we remain hopeful that many people will come to South Africa to conduct successful business, but also to experience the unique South African culture," says David Malan. It has not yet been disclosed who the lucky delegate is who registered as number 1,000 and who has won the prize of a safari to one of South Africa's nature reserves.

Large population

There are approximately 35,000 professional farmers in South Africa, of which 5,000-7,000 produce 80% of all the food. In addition, there are approximately 2 million subsistence or smallholder farmers. Many of these are cattle farmers. David Malan: "More and more of the farmers that are into arable crops, are seeing the benefit of using good quality seed from a trusted source, as opposed to farm saved seed. However, due to the poverty levels in some communities, farm-saved seed is still used."

But South African seed companies do not produce seeds solely for their domestic market. "South Africa is an important exporter of seed to other African countries. Most of the larger South African seed companies are very well represented in the rest of Africa and are exporting and distributing a lot of seeds. Furthermore, technology and experience has also been transferred into neighbouring countries to support local seed production. This will help to alleviate seed shortages in Africa," he states.

Klein Karoo is famous for its succulents, but the arid Mediterranean climate is also ideal for the production of high-quality vegetable seeds

Africa is the second largest continent on Earth, after Eurasia, and 10 of the top 20 fastest growing populations is found in Africa. UN demographers expect a population growth of between 3.5 and 5.5 billion by 2100. That means that 40% of the world's population will be living in Africa by 2100, and one in every two children will be born there. "A lot of seed will be sold in Africa in the future and because it has the resources in land and water, a lot of food will also be produced in Africa. This is truly the continent of growth and opportunity."

Important crops

Field crops, such as maize, sunflower, soybeans, wheat and potatoes, are by far the biggest crops in South Africa. On the vegetable side, crops like tomato, onion, carrot, lettuce and pumpkin will top the list. "Breeding in all crops is an important activity with most of the bigger companies. Of course, we also have an excellent Intellectual Property Right (IP) protection system for protection of genetic material in South Africa. All locally bred and imported varieties have to pass a stringent system of variety listing in South Africa before sales can commence and this will include DUS testing of new varieties entered for variety listing."

Wine is a famous export product of this country. "Much of the arable land is used for wine, citrus, table grapes and apples. Vegetables are produced large scale in all provinces of South Africa in more confined regions suitable for vegetable seed production. Ornamentals are produced around the bigger cities in net houses and greenhouse. In vegetable seed production, the biggest crops in South Africa produced for seeds and export of seed, remain onions, carrot, bunching onion, leeks, pumpkin and others."

New Breeding Techniques

In general, people in South Africa are quite willing to accept the concept of GMOs. "Like in all developing countries, feeding your family is a priority. Of course there are people everywhere that aren't comfortable with it, but the majority are," says Magdeleen Cilliers, Policy and Research Manager at SANSOR. Currently, gene edited crops are classified as GMOs in South Africa. This decision is being appealed by the industry. "Legislation is not always well-adapted to the changes in what we have seen in new breeding techniques," adds David Malan. "Like the rest of the world, we feel that GMOs and New Breeding Innovations, such as CRISPR, should not be under the same umbrella since

David Malan: 'We remain hopeful that many people will come to South Africa to conduct successful business, but also to experience the unique South African culture'

they are significantly different from one another. It should, therefore, be governed by different rules and legislation. We think that PBI (Plant Breeding Innovation) is fantastic technology that will go a long way to feeding a world which is threatened more and more by poverty and famine."

In vegetables, South Africa is currently producing non-GMO seeds. "We focus on the production of OP and hybrid vegetable seeds for export to the world. The areas in which we produce vegetable seed are free from any GMO crops and we can assure GMO-free seeds."

Organics

Organic seed is currently not big in South Africa but, like the rest of the world, healthy eating and the need for organic products is definitely growing. "It will, however, not be as big as in Europe in the foreseeable future. On the vegetable seed production side – which is mostly for international companies – we can see

'We think that Plant Breeding Innovation is fantastic technology that will go a long way to feeding a world'

that the need for organic products is increasing." The challenge remains to produce seed in true organic fashion. "But that is still not feasible, as the seed yield in organic production is still significantly lower than in conventional seed and we find that companies are still reluctant to pay the higher cost for organic seeds." In South Africa, the regulations for organic products do not require the use of organic seeds. This means that producers can still get clearance to produce organic product from conventional seeds, making organic seeds less important.

Klein Karoo

Besides Chair of the National Organizing Committee, David Malan is also Managing Director of Klein Karoo Seed Group in Oudtshoorn. It is one of three subsidiaries of the Klein Karoo Co-operative. The company is named after the region where it is located. The Little or Klein Karoo is a long valley bordered by the Swartberg and the Langeberg Mountains in the Western Cape. It has an arid Mediterranean climate which is ideal for the production of high-quality vegetable seeds.

"Klein Karoo Co-operative was established on 22 April 1945, just after the war. The first activity the Co-operative dealt with was with the production and distribution of beans, peas and lucerne seed.

In 1980, Klein Karoo Seed Production was formed, when its activities were expanded to professional seed production for sales and breeding companies around the world. The company fully owns Klein Karoo Seed Production and Agrofors, a forage and pasture seed company."

The most important vegetable seed products for local seed production will be the whole group of Alliums, including onion, bunching onion (Allium Festilosuim), new bunching onion (Cepa Festilosium cross), leeks, shallots and chives. "We also produce a lot of kuroda and some Nantes types of carrots. Some of the smaller crops include lettuce, some cabbages, beets, radishes, pumpkins, OP tomato and peppers, as well as a range of smaller crop types."

On the forage and pasture seed side, Agrofors focuses on lucernes, forage sorghums, grasses and cereals. This subsidiary is currently focused on distribution in the local markets, but will export to various destinations in Africa and Asia in the future.

South Africa

Agricultural sector is the **backbone** of the economy

Monique Krinkels

10 **The South African agricultural sector (including forestry) accounts for 2.5% of the Gross Domestic Product, but the value for the entire economy is many times greater. Agriculture is a major employer in a country with 33% unemployment, accounts for 10% of export earnings and provides food for a country where 1 in 10 people go hungry.**

Rooibos

Rooibos (Aspalathus linearis), meaning 'red bush', is a plant that grows in the South African fynbos. It has been used for herbal tea since 1890, but has gained international popularity since the 2000s. The reddish-brown colour of the tea is obtained by oxidating the leaves. Rooibos tea does not contain caffeine, has low tannin levels, has a high vitamin C content and contains antioxidants, hence its healthy image. The name rooibos tea has a 'protected designation of origin' in the EU, meaning that only Aspalathus linearis leaves that are cultivated in the Cederberg region can be sold under that name.

Rooibos is grown in the deep sands and loamy soils of the rugged mountainous areas on both sides of the Olifants River Valley, 200 kilometres north of Cape Town. It grows in a symbiotic relationship with local micro-organisms. About 500 farmers cultivate the bushy plant, producing 15,000 tonnes of tea leaves.

The first country outside Africa to experience rooibos tea was Great Britain, where it debuted in 1907 at the South African Exhibition in London. Today, rooibos is exported to more than 30 countries across the globe. The two leading importing countries by per-capita consumption are Germany and the Netherlands, with the UK, USA and Japan following suit. Last year, the rooibos industry made history when it disbursed the first round of benefit-sharing funds to the National Khoi and San Council and the South African San Council as part of an Access and Benefit Sharing agreement. It is the only ABS agreement which encompasses the entire industry, ensuring all volumes of rooibos sold are levied through one process. A benefit sharing levy of 1.5% of the farm gate price will be paid annually. In August 2022, the two Community Trust accounts each received 6,138,961 Rand (nearly 340,000 Euros).

South Africa has the largest agricultural land on the African continent. With a surface of 1.2 million km², it is a sizeable country: from north to south, it measures nearly 1,600 kilometres and the distance from the Atlantic to the Indian Ocean is about the same at its widest point. As of 2020, the country's agricultural land amounted to over 96 million hectares, representing almost 80% of the total land area. Of those, around 87% were classified as land under permanent meadows and pastures, while nearly 12.5% of the agricultural land was arable land. Over 800,000 of the nearly 60 million inhabitants work in the food chain. There are no official statistical data on the number of farms, as there are many subsistence farmers, but there are 40,000 active VAT-registered agricultural entities.

Food market

South Africa is a net exporting country of agricultural produce. Citrus, table grapes, apples and wine are the main export products. As of 2020, the export reached 9.8 billion Euros and the import was 5.4 billion Euros. The main imported products are wheat, rice and oilseeds. Horticultural crops are the most important export products, worth 5.5 billion Euros. Of the staple foods, maize is the major exported product.

The South African food market is made up of 3 elements – on the one hand, a large formal market divided into local and export, and a fragmented, often unregulated, informal market with street vendors selling food in stalls or markets. The informal market offers less wealthy consumers the opportunity to buy food from the estimated 400,000 street vendors. Over half of the population live in poverty and these consumers buy small quantities here. This is important because they usually do not have enough money to buy larger quantities at a time. In addition, they often have no space for storage and no refrigerator.

One of the biggest issues at the moment is the energy shortage, which is having a destructive impact on agriculture, food, fibre and beverage production. The daily power outages have started to disrupt the production of even essential food items. At primary production, farmers using irrigation systems face production difficulties in the current environment.

Fynbos is known for its exceptional degree of biodiversity and endemism, consisting of about 80% (8,500 fynbos) species of the Cape floral kingdom, where nearly 6,000 of them are endemic

The persistent power cuts put the growth prospects of the country's economy in 2023 at risk.

Seeds

The agricultural sector is going through challenging times. As in many countries worldwide, South African farmers are suffering from the aftermath of Covid-19, erratic climate conditions and, due to the geopolitical situation in Eastern Europe, soaring costs of fertilisers and fuel. In South Africa, the situation is further complicated by slow economic growth, infrastructure decay and unreliable electricity supply.
The seed industry in South Africa is quite mature and serves the commercial farmers, with over 100 seed companies who are part of the South African National Seed Organization, SANSOR. The organization was established in 1989 and has its offices in Pretoria. SANSOR is the national designated authority regulating seed certification, supports the seed industry on policy matters that affect the industry, such as the Plant Improvement Act and Plant Breeders' Rights Act, and trains seed trade personnel through courses and workshops.
According to market researcher, Mordor Intelligence, the seed market in South Africa is estimated to register a compound annual growth rate (CAGR) of 5.2%. Maize is the country's most important crop, followed by wheat. The increasing consumption, along with the increasing population, is necessitating the increase in productivity. Increasing export from the country is another factor that is driving the growth of the seed market.

Trade in seeds for sowing

	Vegetables	Flowers	Potatoes	Trees	Total
Import Quantity					
Metric tons	60.130	836	8		60.974
Value x million $	79	40	1		120
Export Quantity					
Metric tons	118.223	2.034		15	120.272
Value x million $	77	44	7	0,6	129

Source: ISF compilation based on official statistics and international seed trade reports (2020)

The dormant buds will produce new growth after a wildfire

Protea

The king protea (Protea cynaroides) is the national flower of South Africa. This remarkable plant is widely distributed in the fynbos region. Fynbos - Afrikaans for fine plants - is a small strip of natural heathland in the Western and Eastern Cape provinces. This area is predominantly coastal and mountainous with a Mediterranean climate. Fynbos is known for its exceptional degree of biodiversity, with about 80% (8,500 fynbos species) of the Cape flora, of which 6,000 are endemic species. The kink protea is well adapted to survive wildfires with its thick underground stem, which contains many dormant buds; these will produce the new growth after the fire.
Indigenous flowers, like those in the Proteaceae family, are increasingly popular on the export market. About 80% of South Africa's exported flowers are proteas and fynbos, with the rest being mainly chrysanthemums and lilies. The king protea has several colour forms and horticulturists have recognized 81 garden varieties. The flower was discovered in 1597, when a Dutch trade group collected the oleander-leaf protea (Protea neriifolia). In 1953, the Cape's unique flowers crossed the ocean when a bouquet of P. cynaroides was sent as a gift to Queen Elizabeth in celebration of her coronation. It was the first recorded export of fresh Protea from South Africa to Europe.
Today, South Africa is the world's leading protea exporter. Over 4.8 million stems of proteas are exported; 80% to the European Union, 10% to the United Kingdom, while the remaining flowers go to Africa, the Middle East, North America, Eastern Europe and the Far East.

Exuberant **biodiversity** attracted first farmers

John van Ruiten and Monique Krinkels

For thousands of years, the African soil was worked on by Bantu speakers. They arrived in what is today called South Africa around 350 BC and found a fertile land, flooded with exuberant biodiversity. They introduced their own crops and brought goats and sheep into the region. It marked the start of agricultural development in South Africa.

The first inhabitants of South Africa were the Khoisan. A painting discovered at Blombos Cave, 300 km east of Cape Town, is believed to be the oldest known instance of human art, dating to around 73,000 years ago. About 20,000 years ago, the Khoisan split into two different peoples. The San, who inhabited the inland, lived on the local wildlife and 'veldkos', the African word for everything edible they found. The Khoi, who lived closer to the coast, lived on marine food, such as oysters and mussels. The first colonists named the San people Bushmen, while the Khoi were referred to as the Hottentots, a word that phonetically resembles the click sounds in the Khoi-languages. The use of both the words Bushmen as well as Hottentot are today seen as deprecating and offensive. The use of Khoisan for all non-Bantu speakers is preferred.

New arrivals

Around 350 BC, African farmers entered South Africa. They moved from central Africa to Mozambique and Southern Africa and were Bantu speakers. These sub-Saharan people migrated further south in Africa over a period of thousands of years. They are the ancestors of many (Xhosa, Zulu) South African people. Archaeological and historical evidence demonstrates that they arrived around 350 BC in the northeast part of what is now called South Africa. Around 250 AD, they reached Transvaal.
These farmers brought new ideas and new crops to the region. They introduced crop cultivation, metal tools, Bantu languages and village life. The most important crops: pearl millet, sorghum and cowpeas, but also watermelons, pumpkins and beans. These new African farmers lived in larger communities than the Khoisan, building their villages around a cattle kraal (enclosure) and ruled by a chief or king. Huts were made of clay with thatched roofs. The floors were smeared with cattle dung. They used cattle skins to make clothes, thongs, bags and shields.
Crop farming was new to the area and the soil was very fertile. Most of the farmers (it was mainly the women that did the field work) planted and harvested only for their family. The men still hunted and herded the goats and sheep. These farmers knew how to extract iron and copper by melting rocks in their furnaces. The metals were used to make tools, weapons and ornaments. They used the axes to cut down trees, and hoes to break up the soil, weed the fields and harvest the crops. Their weapons were arrowheads, knives and spears.

The manor house at Groot Constantia, the oldest and most historic of South Africa's wine farms, built in 1684

Changes

The ox-plough was brought to South Africa by European settlers/colonists in the 17th century. It changed the society of African farmers. Women were not allowed to handle cattle and ploughing became a man's job, like gradually also other field work. This meant that the women could no longer work in the field and that weakened the position of women in that society.
Often it was the wealthiest man who became chief. He made the decisions for his people. A council of elders ensured the chief took the needs of his people into account. A 'sangoma' was the medicine man or woman of the village. He or she used local plants as medicine. These traditional healers throw bones, play drums and dance to assist in diagnosing an illness. The sangoma would also perform rituals to contact ancestors.
These old traditions and communities still exist in Kwazulu Natal local societies, but they are disappearing. This agriculture (mainly practised in the northeast part of the country) could be regarded as the traditional agriculture.

Colonists

The present agricultural system was developed after the colonisation of South Africa by Dutch colonists. On 6 April 1652, Jan van Riebeeck arrived at the

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Historical San rock art near the Stadsaal Caves in the Cederberg, Western Cape

Cape of Good Hope on behalf of the Vereenigde Oostindische Compagnie (VOC). He had been commissioned to establish an intermediate station in the Cape region, so that the trading ships could bunker fresh food and water during their 8-month journey to the Indies. The oldest farm is Groot Constantia, a wine estate south of Cape Town, founded by Simon van der Stel, the first governor of Cape of Good Hope, in 1684. Until 1795, the VOC dominated the country, and agricultural farms and estates were founded in the south and western parts of the country.
At first, the Dutch purchased the land from the indigenous people, the Khoisan, but when the number of people grew, the VOC took land and sold it to so-called 'Vrijburgers' (free burghers or freemen). Gradually more and more trouble arose between the VOC and the colonists, and many of them decided to leave the Cape colony. The 'trekking' eastwards already began around 1700. The semi-nomadic farmers were not cultivating the soil, but lived as nomads, continuously looking for new land for their herds of cows. They lived far away from the government, were not very law abiding and (mainly Dutch descendants) enslaved many people to work for them.

Great trek

The 'Great Trek' occurred between 1835 and the 1840s. During that period, some 13,000 Boers, very impatient with British rules and opposing the decision to abolish slavery in 1834, emigrated from the Cape colony into the great plains, beyond the Orange River and across into Natal, and further to the northern part of Transvaal. These protestant farmers were known for their independent spirit, hardiness and self-sufficiency. They had cut their ties with Europe. Farming was still their occupation.
In the era of British domination after 1806, the white farmer population (Boers) moved further east/northeast and took ownership of land in the provinces of Orange Free State, Transvaal, and Kwazulu Natal. The Boers felt that the English Church was incompatible with the Dutch Reformed Church. By this time, the Boers had already formed a separate code of laws in preparation of their new society. Boers leader Piet Retief stated: "we quit this colony under the full assurance that the English Government has nothing more to require of us and will allow us to govern ourselves without its interference in the future." And as the 'Voortrekkers' (pioneers) progressed further inland, they continued to establish Boer colonies on the interior of large parts of South Africa.
At the end of the 19th century and beginning of the 20th century, two consecutive 'Boer Wars' took place before the Republic of South Africa was formed in 1902. One clause in the peace treaty between the English and the Boers would have a major influence on 20th century South Africa: black people were not given full civil rights and they were not allowed to

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A dirt road leads to the traditional rondavel huts in a small farming settlement

vote. The Apartheid system (as a result of not offending the many Boers people too much) was born.

Today

Agriculture in South Africa today developed on the premises of descendants of Dutch, French and Boers. It made the country the largest agricultural region on the continent of Africa. Nowadays, it is well known for its very wide range and diversity of produced commodities. Important products are grains (wheat, soybeans and maize), fruits (deciduous fruits like apples, pears and peaches, and tropical fruits such as bananas, papayas and mangoes), citrus, sunflower seeds, sugarcane, vegetables and, of course, grapevines.
South Africa is the world's number 8 wine exporting country. Dairy and meat products (poultry, cattle, pigs, sheep and ostriches) contribute to its position. Total production value is around 22 billion Euro. The agricultural value is 2.5% of the Gross Domestic Product. That sounds relatively low, but for the economy (10% of the income from export is generated) and for the possibilities of employment (almost 1 million people work in agriculture), agriculture is very important.
The country's land surface used for agriculture is almost 125 million hectares, which is 10% of the total land area. Over 85% is pastures and meadows, and 15% arable land for agriculture and horticulture (including viticulture). Ownership of approximately 30,000 farms is still mostly with the white community of South Africa, leading regularly to problems.

Future

During Apartheid, the South African government not only stripped black South Africans of the right to privately buy land (the Native Lands Act of 1913), but it also poured massive amounts of money into assistance programmes for white farmers. When Nelson Mandela was inaugurated as the country's first black president in 1994, he said in Afrikaans: "Wat is verby is verby" ("What is past is past"). The African National Congress (ANC) set up a policy to 'return ownership of land and farms' to the black population using the 'willing-seller, willing-buyer' model instead of seizing farmland from whites, as has been done in Zimbabwe. The ambitious goal was set to transfer at least 30% of South Africa's white-owned agricultural land to black people.
The model was replaced in 2006 by the Proactive Land Acquisition Strategy. Almost 60,000 square kilometres of land has been bought by the government and redistributed to the black population. Unfortunately, the descendants of those deprived of rural land were also the least likely to have received the education necessary to run a hi-tech farm in a globalised marketplace. More than half the current so-called beneficiaries are not reporting any substantial production. The same percentage were evaluated as having a low capacity to achieve commercial status. But, overall, it has become clear that the approach to redistributing farmland has been mostly ineffective.

Biodiversity

South Africa is said to be the 3rd most biodiverse country in the world (with Brazil 1st and Colombia 2nd). Especially the Cape Province, succulent Karoo and the East coast are known for the exuberant plant and animal diversity. The number of plants originating from South Africa is huge. Over 25,000 plant species have been identified - 9,000 of them growing in the Cape Province, of which 6,000 are unique species. The global ornamental sector would look very different without all these species. To mention just a few: Agapanthus, Freesia, Ixia, Gladiolus, Gloriosa, Kniphofia, Zantedeschia, but also Dracaena, Gerbera, Pelargonium and Strelitzia. And, of course, the Protea, the national flower of South Africa, and many Fynbos species (often used as dry flowers).
There is also a whole range of edible and medicinal plants that stem from South Africa, but remarkably, there are no arable crops, vegetables or fruits species that originate from that country.

International Seed Health Initiative on Vegetables

Celebrating 30 years of ISHI-veg

Ludivine Thomas, Rose Souza Richards, Joyce Woudenberg

Thirty years ago, the spread of *Pepper mild mottle virus* in bell pepper motivated an alliance of seed companies to share testing protocols. Today, ISHI counts 27 protocols publicly available on the ISF website, covering different pathogens in a range of vegetable plant species. These protocols present seed health testing methods that are reliable and reproducible.

Dr. L. Thomas is technical lead of the International Seed Health Initiative (ISHI), International Seed Federation, Nyon, Switzerland, l.thomas@worldseed.org; Dr. R. Souza Richards is seed health manager, International Seed Federation, Nyon, Switzerland; and Dr. J.H.C. Woudenberg is technical coordinator of the International Seed Health Initiative

In the early 1990s, standards for seed health quality were mainly set up internally by the industry. As such, seed companies were relying on their own guidelines to ensure production of high-quality vegetable seeds. The seed industry has always taken its responsibility seriously to deliver healthy seeds and was already involved in developing in-house seed health detection methods.

Origin

The spread of *Pepper mild mottle virus* (PMMoV), a Tobamovirus in bell pepper in Almeria, Spain, in 1991, was the precursor of an alliance of several Dutch seed companies and Naktuinbouw, which rapidly expanded with the addition of seed companies from four other countries: France, Israel, Japan and the United States. The goal of the group, which focused solely on vegetable crops, was simple: to develop robust and reliable official methods to test seed lots for the absence of target pests to which seed is a known pathway. These methods were intended to become standards and to grow into widely accepted procedures among the industry. Whenever possible, these methods aim to distinguish viable from non-viable pests or inactivated genetic material due to disinfection treatment. First known as the 'Study Group for Seed-Borne Diseases' and originally chaired by Gerard Meijerink, the International Seed Health Initiative (ISHI) was born and evolved with its current name in 1994.

First results of the group were presented during the International Seed Federation (ISF) congress in Oostende, Belgium, in 1994. Other initiatives, focusing on developing pest detection methods in field and forage crops, were created and coordinated by Patrick Heffer, at the time the technical manager at ISF. It was only in 1998 that, with the support of Bernard Le Buanec, former ISF secretary general, the initiative of focusing on vegetable crops was placed under the umbrella of the Phytosanitary Comity within ISF. Integration of ISHI-Veg was officialised during the ISF Congress in Melbourne in 1999 and the initiative was coordinated by Patrick Heffer until 2002.

ISHI

It started with just a handful of specialists in pathology and seed quality control from the five founding countries (France, Israel, Japan, the Netherlands and the United States). The ISHI-group evolved over 30 years to reach over 70 members in 2023 from various horizons (Chile, India, Honduras, Philippines, Spain, South Africa and Thailand, in addition to the five founding countries)

Professionalising

Upon his departure, ISF appointed Radha Ranganathan, as Director of Technical Affairs, to oversee the ISHI organisation, as well as Petra Remeeus, as Technical Coordinator, to manage projects. ISHI members were then able to focus on the scientific part. Until recently, ISHI's overall organization was chaired by a member and over the years, several experts have helped to drive ISHI's development and work, including Darrell Maddox, Ruud Scheffer, Chet Kurowski, Jim Cucuzza and Wayne Wiebe, among others. However, in 2020, ISHI's structure evolved further and, thanks to the support of the industry, ISF was able to recruit more staff dedicated to the initiative to respond to the growing demands. Today, ISHI is under the umbrella of the Coordination Group Seed Health and relies on Rose Souza Richards, as Seed Health Manager, Ludivine Thomas, as Technical Lead and Joyce Woudenberg, as Technical Coordinator, to oversee and organise the daily tasks of the initiative.

New threats

ISHI has always strived to develop seed health methods for the detection of target pests impacting vegetable seeds and which are fit-for-purpose. However, ISHI was first envisioned to develop 10-12 protocols for major threats of vegetable species and that, after four to five years, the group would be dissolved. But over the years, new threats and challenges kept arising and today, 30 years later, ISHI still exists and its necessity is stronger than ever. The ISHI community has never been so diverse, with over 70 members belonging to 45 seed companies, private laboratories and government institutes from 11 countries, representing all continents.

As ISHI grew bigger, from a round table to a meeting room as large as a theatre, the group, with the help of the ISF Secretariat and its Chairs, has become more and more structured. Work within ISHI evolved,

In 2002, Radha Ranganathan (front row, third from left) was appointed Director of Technical Affairs to oversee the ISHI organisation

besides expanding the portfolio of detection methods for different vegetable species, with the development of guidelines and best practices for quality method development, validation and execution, the writing of technical opinion and position papers and the diffusion of the point of view of the ISHI community on indirect test and high-throughput sequencing, just as a few examples.

Expanding use

Over the years, ISHI has not only developed methods for use by its members, but also for the wider community, including other seed companies and international bodies. The International Seed Trade Association (ISTA) has published methods developed by ISHI, such as the local lesion assay developed for the detection of Tobamoviruses in tomato (*Solanum lycopersicum*) and the detection of *Xanthomonas* spp. in Brassica spp. The National Seed Health System (NSHS), based in the US, has approved the Seed-Extract qPCR method for the detection of Acidovorax citrulli in Cucurbitaceae and the ELISA method for the detection of Lettuce mosaic virus in lettuce (Lactuca sativa). Finally, the Good Seed and Plant Practices (GSPP) integrates the method for detection of Clavibacter michiganensis subsp. michiganensis in tomato seed to its chain system.

Today, ISHI counts 27 protocols publicly available on the ISF website (https://worldseed.org/our-work/seed-health/ishi-methods/), covering different pathogens in a range of vegetable plant species, from bean, Brassica, Cucurbitaceae, lettuce, pepper to tomato. These protocols present seed health testing methods that are specific to a target pathogen, fit-for-purpose, reliable and reproducible. These methods typically consist of three main steps:

1. isolating/extracting the pathogen from seeds
2. detecting and identifying the pathogen
3. confirming its viability and pathogenicity

These methods are internally validated based on six characteristics (analytical specificity, analytical sensitivity, selectivity, reproducibility, repeatability and diagnostic performance), which are aligned to those used by ISTA and NSHS. The full validation process is described in the article entitled 'ISHI defines six validation criteria', also published in this current edition.

New pathogens

Nevertheless, the need for more protocols is still prevailing. Pest threats are high and new pathogens continue to emerge, posing new challenges. Currently, 24 projects are active within ISHI to either improve current protocols or develop and validate new protocols. The goal of a number of these projects is to develop a method, which will not only be sensitive enough for the detection of positive seed lots to be identified, but also to have a method that will allow for high-throughput and simultaneous detection of several pathogens. Here, the roles of the Seed Health Manager, Technical Lead and Technical Coordinator of ISF are essential, as they ensure regularity of the online and technical face-to-face meetings, where project progress can be discussed and solutions to arising problems proposed. The recent addition of an interactive ISF members' area, with an embedded social blog, promotes direct interactions and communication of project progress, events, organisation and structure all in one place, available to all ISHI members from anywhere in the world.

The members' technical expertise remains a force that needs to be used wisely and efficiently for a continued growing impact. With a constantly expanding ISHI community, management and efficiency of method development becomes more intricate and continues to be optimized, gradually becoming more

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At the last technical event in September 2022 in Zurich, Switzerland, ISHI counted over 70 members belonging to 45 seed companies, private laboratories and government institutes

coordinated and professionalized. In the last four years, the initiative has emerged with a more structured and systematic approach, notably with regards to method validation for the improvement of its standards. Recognition and acceptance of protocols by other bodies, such as NSHS, European and Mediterranean Plant Protection Organization (EPPO) and National Plant Protection Organizations (NPPOs), is also a major aspect of the current work.

Partnering

The next steps for ISHI include: wider communicating and promoting its work, partnering with authorities, developing more seed health testing methods in response to the growing number of pests, further promoting its sister, the Regulated Pest List Initiative (RPLI), and expanding to other crops, such as ornamentals and field crops in relation to increasing industry needs. Overall, ISHI will continue impacting positively on the trade of seeds and playing a decisive role for seed and overall food security.

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Geopolitical tensions hamper **food security**

Monique Krinkels

Before the war, Ukraine produced 85,338,631 metric tons of cereals. And in addition to being the world's leading producer of sunflower seeds, Ukraine also exported the highest volume of sunflower seed oil. In 2022, agricultural production has been decimated to only 40% of the year before. In 2021, Russia provided farmers with nearly 12 billion euros worth of fertilisers. The effects of the war between these two nations are strongly felt.

Russia and Ukraine play a crucial role in the international food chain as significant exporters of agricultural products. Since the Russian invasion of Ukraine on 24 February 2022 and the lasting war between the two parties, agricultural production has declined. At the Crop Innovation & Business Conference last April, Dr Louise van Schaik, Head of the Unit EU & Global Affairs at the Clingendael Institute, described the implications of the war on food security. Clingendael is the Netherlands Institute of International Relations, an independent think tank and academy on international affairs. "In 2021, Russia and Ukraine together supplied up to 6% of the food calories available on the international market," she says.

Since the invasion, the prices of food and energy have soared and farmers around the globe have to cope with substantially increased fertiliser prices. "These effects are not distributed evenly, with the Middle East, North Africa and the Horn of Africa suffering the most from the fall in grain exports from Ukraine. For millions of people, hunger and the risk of starvation are becoming a reality."

Instability

There are many countries in the world where political unrest takes its toll. Tensions are rising between China–Taiwan/USA/EU and North Korea–Japan/USA/EU, while in Yemen, Burkina Faso, Sudan, Syria and Congo (just to name a few) people suffer from internal violence. "However, the war between Russia and Ukraine has a global effect on food security, as Russia and Ukraine are particularly important exporters of sunflower seed products, wheat and maize." Furthermore, in 2021, Ukraine was the largest supplier of food aid provided through the World Food Programme of the United Nations. "According to the HungerMap of the WFP, there are 670 million people in hunger in 17 countries with a high level of hunger," Louise van Schaik adds.

To alleviate the food problem, Ukraine and Russia agreed to open a safe maritime humanitarian corridor in the Black Sea (the Black Sea Grain Initiative). Since then, over 900 ships filled with over 23 million tonnes of grain and other agricultural produce have left the Ukrainian ports of Chornomorsk, Odesa and Yuzhny/Pivdennyi en route to Ethiopia, Yemen, Djibouti, Somalia and Afghanistan. While unblocking the sea export route has helped to address the global food security crisis and lower grain prices, the export backlogs remain significant, however. Furthermore, the uncertainty surrounding the renewal of the Black Sea Grain Initiative will keep markets in turmoil. Recently, the World Bank has cautioned that global food prices, despite having fallen from historic peaks, remain high and that new export restrictions could send prices soaring again.

"An alternative way to export agricultural produce from Ukraine is by road and train. As a result, grain and sunflower seeds overflow in Eastern European markets. However, this meets with strong protests in Poland, Slovakia and Hungary. The farmers in

How the world views the war

At its resumed eleventh emergency special session on 23 February 2023, the United Nations General Assembly (UNGA) has again condemned Russia over its invasion of Ukraine, demanding that Russia immediately withdraws its forces, ends the fighting and abides by international law. A year since President Vladimir Putin ordered the invasion – or special military operation as he calls it – 141 countries backed the resolution, calling for a 'comprehensive, just and lasting peace' in Ukraine (resolution A/ES-11/L.7).

Seven countries voted against this resolution: Belarus, Democratic People's Republic of Korea, Eritrea, Mali, Nicaragua, Russia and Syria.

Thirty-two countries abstained from voting: Algeria, Angola, Armenia, Bangladesh, Bolivia, Burundi, Central African Republic, China, Congo, Cuba, El Salvador, Ethiopia, Gabon, Guinea, India, Iran, Kazakhstan, Kyrgyzstan, Laos, Mongolia, Mozambique, Namibia, Pakistan, South Africa, Sri Lanka, Sudan, Tajikistan, Togo, Uganda, Uzbekistan, Viet Nam and Zimbabwe.

Twelve countries were absent: Azerbaijan, Burkina Faso, Cameroon, Dominica, Equatorial Guinea, Eswatini (Swaziland), Grenada, Guinea-Bissau, Lebanon, Senegal, Turkmenistan, Tanzania and Venezuela.

Louise van Schaik: 'I will not deny that crop innovation is essential to enhance food production in times of war and climate change'

these countries fear that their produce will suffer from lower prices due to the overflow of cereals and maize."

Land grabbing

It is not only the raging war in Eastern Europe and the use of starvation as a weapon of war that threatens food security. "Climate change, environmental degradation, population growth, changing dietary patterns, food safety issues and malfunctioning trade flows each have an effect on the availability of food. On top of that, there are land grabs in Africa to produce staple food for Asian countries, leaving the local communities with food shortages."
Between 2013 and 2019, China lost more than 5% of its arable land, due to factors such as excess fertilizer use, salinization and land neglect. While China is the largest grain producer in the world, the country relies on the import of 26% of its needs. Since he took office in 2013, the general secretary of the Chinese Communist Party Xi Jinping has frequently said that 'the rice bowls of the Chinese people must always be held firmly in our own hand and filled mainly with Chinese grain.' "In history, famines and food crises were the graveyards for Imperial China's dynasties, so food security has always been high on the agenda," explains Louise van Schaik about this statement. Conflicts often result in reduced food availability, as agricultural assets and infrastructure are destroyed. Politicians habitually react with food subsidies to prevent riots. The ancient Roman proverb 'panem et circenses' (give the people bread and games) is still a straightforward solution. "However, hunger does not always lead to conflicts, as there are various pathways from food scarcity to protest. No totalitarian dictator has ever been overturned during or after a famine, but food security is the foundation of political stability."

Future

It cannot be predicted when the war between Ukraine and Russia will end. If we have to believe former Russian president, Dmitry Medvedev, one of Putin's closest henchmen, it might be sooner than later. He has warned recently that the planet is on the verge of a nuclear world war, and that Vladimir Putin is ready to be the first to press the atomic button. On the other hand, the EU and USA are apparently preparing for a long battle. It takes time to deliver the military aid promised to Ukraine by those countries. Some of the weapons and equipment will not be transferred until next year, so one has to assume that the generals do not believe the conflict will be resolved speedily.
Europe has woken up from its geopolitical holiday. The question is how to prepare for a future in which Ukraine and Russia are no longer important sources of staple foods. That is an important task for the seed industry. Crop innovation, breeding climate-proof crops, varieties that are resistant against diseases and pests, and producing higher yields, will scale down famine and the cost-of-living crisis. In this regard, it is good that the EU will most likely come up with a new initiative in June to allow for new breeding techniques, such as CRISPR-Cas. Since – following a verdict by the European Court of Justice – they are currently considered to be part of the GMO ban, they cannot be utilized. "Allowing new breeding techniques is part of a larger strategy in which the EU has reprioritized food sovereignty and sees new breeding techniques as enablers for more sustainable agriculture. "They may help to accelerate production, not only in Europe, but also in places where access to affordable staple foods is crucial to maintain stability," says Louise van Schaik.

Koppert Cress and Sango Seeds

Taste-driven focus on a **healthy future**

Puck Kerkhoven

This spring, the Horticultural Entrepreneur Award 2023 was awarded to Van der Avoird Trayplant from Bavel in the fossil-free greenhouse of Koppert Cress in Monster, the Netherlands. Agriculture minister Piet Adema was in the house. A candid interview with host Rob Baan, who won the entrepreneurial award in 2011. He does not mince his words, not even a tiny bit, when it comes to our health and that of our planet.

P. Kerkhoven is culinary journalist and food trendwatcher sustainability, puck@redfoxmedia.nl.

The term micro vegetables, originating in the U.S.A., better describes what Rob Baan is growing and marketing in a unique way with his sustainable horticultural company. "Koppert Cress sounds pretty good, it alliterates nicely," says Baan. "Furthermore, it provides fresh associations with garden cress and watercress; fresh sprouts with a very high nutritional value, super flavoursome and decorative. Every one of them sprouted from the brains of our product developers, including myself. Our most important clients are also our source of inspiration: head chefs, worldwide, with whom we are in constant contact. If they ask for Japanese, Thai, Peruvian, Scandinavian or, like now, Korean flavours because it's the trend, we already have it in the greenhouse."
"Other clients are catering wholesalers and exporters, who deliver the living product to chefs abroad. So, business to business. Koppert's cresses are only available in supermarkets in retail packaging around the holiday season. The growing market are the better fresh food stores that are aimed at the ambitious home chef."

Fossil-free greenhouse and so much more

Rob Baan: "In 2025, every box of cresses leaving here will be carbon neutral. That's pretty soon, yes. I'm aware of that. I am an ambitious sustainable entrepreneur, not a politician who talks about 2030 or 2035. They can hold me to it!"
How? "We would like to come back to that."

The idea

"I am originally a seed boy, still living in Enkhuizen. Travelled all over the world to establish contacts, in the meantime searching for interesting varieties and crops. That is why I am so delighted with the Plantum Sustainability Award, which I won in 2022. Recognition from my friends in the seed profession. We share our knowledge when it comes to sustainable production, that is very much appreciated." Furthermore, Koppert Cress also has its own seed company: Sango Seeds.
"I think I've probably seen 70 countries, was on the road for 30 weeks per year," Baan continues. "In Japan I went to find out why such an inordinate amount of radish seed was sent there. Do they eat so many radishes? It turned out to be the micro variant. They ate the super healthy, tasty radish sprouts at home, in huge quantities."
With four small children at home, in the late 90s, Baan had had enough of all that travel. "At that time, I liked to visit Gerrit Koppert in Monster; a real horticultural innovator, certainly on a technical level. He had invented a planting machine for radishes, planting the radish in a zigzag pattern instead of in a line, whereby you got lovely round radishes. Too many seeds landed on the heads of the planting beds. He hoed the leaves and threw them away. 'You can eat those', I said, with Japan in mind. He tasted them: it tastes like radish! He saw trade. Nice product for restaurant chefs! But they turned out not to want soil in the kitchen for hygiene reasons. So he started cultivating on substrate. Then maybe there are more tasty sprouting plants to be found that you can grow in this way. He became very busy and was looking for a director, I was looking for a job. The rest is history. In 2002, I took over the company from him. By the way, Sango is Japanese for the colour radish red."

The range sprouted...

"Pretty quickly, you might say. From the outset,

The heat from the luminaires is stored in the ground-coupled heat exchanger and can thus be reused in the winter to heat the greenhouse

we have had Shiso Cresses (and leaves), green and purple, and Daikon Cress in the collection. For sushi businesses and Asian-oriented chefs. We have also had garden cress and watercress from the beginning. And then you start looking for flavours. That's what I enjoy the most about this job. I'm totally blown away by cooking, that's why," Baan confesses. He is co-founder of TV channel 24Kitchen.

"Good chefs love a bit of acidity in their dishes. Great if a decorative cress or flower can provide that, instead of the obligatory lemon wedge or lime juice. Yka leaves for example, a sour dark purple flower from Brazil. Nature can be overwhelming."

Flavour bombs like Dushi buttons (flower bud, sweeter than sugar) brings it forth. Unique green Dutch Vanilla pods (Koppert's own cultivation, in the Netherlands), pure salty are oyster leaf and Moai caviar, sea grapes from the sea. Sechuan Cress, on the other hand, is tingling, electric and numbing. Affilla Cress, the cress of fresh peas is a real hit because it curls so erratically and produces all five basic flavours (sweet, sour, salty, bitter, umami). "Really good for a sandwich shop or vegetarian restaurant. We don't just appear in Michelin restaurants and five-star hotels. That's a misconception. Our cresses are not cheap, but they are affordable. Production is also expensive, there is a price for that. There is a market for it, that's all that matters to me," says Baan.

Division Q

"As a modern innovative company, you have to keep innovating and actively bringing in young blood. That is why we have created a new company. The name: 'Division Q'. That's right, named after James Bond's nutty gadget adviser Q."

Sustainable energy sources, automation, robotisation and social media are becoming increasingly important in horticulture. On our behalf, they are getting stuck in. But they also have the task of 'coming up with crazy things'. Can it be any broader?

During the Covid virus pandemic, a tool was launched to analyse photos of restaurant plates - the most frequently posted on Instagram worldwide. The programme 'reads and learns' what it is that lays on the plate. Whether there are micro vegetables and cresses on it, and which combinations are created. For inspiration for our chefs, but also to find restaurants which may become new customers because they are already cooking in that style."

Baan: "Strangely enough, at the Delft University of Technology (TU Delft) people don't know where to find Westland. Ask the students and they think it is far away, somewhere in New Zealand. While our second economic centre (after the ports and before Amster-

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'Let's change the way we look at fresh food and health,' says Rob Baan. He emphasizes that medical science is primarily focused on the cure for and recovery from diseases, while there is so much more to be gained at the prevention end with a healthy diet

dam Airport Schiphol) is literally within cycling distance. The problem is: they don't speak the language of horticulture at the university. By literally offering technical start-ups a testing ground, we bring them in. Here is the key to the front door, go right ahead! For example, a startup of former aircraft engineering students developed a drone that can swat insects out of the air in greenhouses. The name: Pats! Another group is testing whether coatings, which are normally found in fluorescent tubes, are also suitable for application to the glass of the greenhouses, instead of the usual chalk. So yes, a great improvement in light quality and happier plants."

Koppert Cress

The company produces natural, innovative ingredients which chefs can use to intensify the taste, aroma and presentation of their dishes. Products that meet the increasingly stringent requirements of restaurants worldwide. Cresses are freshly sprouted seedlings from 100% natural, aromatic plants. These plants offer a freshness and intensity in flavour and aroma found only in young plants. The company cultivates approximately 80 products and has a whole range of surprises in the pipeline. The company has 10 hectares of modern greenhouses in the region Westland, its own seed company Sango Seeds and works together with international licensing partners.

Refuelling at the greenhouse

Koppert Cress has come up with, and even registered, a concept for the way in which they heat their greenhouses: Omni-calore. "Not just one heat source - traditionally mostly fossil fuel and we have to move away from that quickly! - but a mix of energy sources. From the solar cells on the energy roof, natural gas and green electricity from wind energy. As well as the geothermal heat and cold pump that in summer pumps the warm water from the ditch into the ground to a depth of 170 metres and encloses it in a sand layer between two hermetic plates of clay. That is so unique about our delta, those layers," explains Baan. "In the Netherlands, we have known ice ages, in which clay, then sand, then clay, and so on, were deposited." You can also store heat that is generated when the sun is blazing down on the greenhouses.
"In a fossil-free greenhouse, you no longer open windows to let heat escape, but you conserve it for colder times." During the winter, this can be pumped up again if the need for heating increases. The only energy you use for this is that of the pump. Conversely, cold water is stored during the winter, in different layer of sand, intended for cooling during the summer. "It's actually a kind of carbon neutral giant battery."
Hence, any desired crop can be produced, also in the future. "That has always been the strength of the Dutch horticultural sector. In the greenhouses at Koppert Cress, we already recognise 15 different climate zones, including a wet one and a dark one. Very surprising, new products will come from there. Let yourself be amazed."
Another clean energy source is hydrogen gas, which is already used to run buses and some cars. "There is much to do, because we don't yet know what to do with the amount of waste produced during production: namely, hot water at 60 degrees. Indeed, in North Groningen, there isn't much use for it, but if you produce hydrogen gas in a greenhouse area, then you suddenly have an additional cheap, clean heat source there. Dutch horticulture could quickly change like this from a large energy consumer into an energy producer! I can see it now, in the near future: 'Refuelling at the greenhouse!'"

Future

Koppert Cress once employed almost 300 people. During the Covid pandemic, the company had virtually ceased. "Empty greenhouses. The hospitality industry closed, no more flights abroad where our chefs are. We are now back to more than 200 employees, with a turnover 140% higher than before Covid."
Two of Baan's four children work for the company. Daughter Bodine in general management and son Stijn in marketing and sales.
Rob will turn 67 next year, but is not thinking about retiring for even a second. "I still find it all too much fun and challenging. I am going to slow down. My wife was housebound for five years due to a serious illness. Fortunately, she is doing a lot better now; a miracle really. We have some catching up to do. We have bought a small house in Spain. We go there regularly, enjoy ourselves, cook and often eat out together."

Showcasing **South Africa**'s riches

Monique Krinkels and Alice Notten

To learn about the natural riches of a country, visiting a botanical garden is a quick way to get a good overview. In South Africa, Kirstenbosch National Botanical Garden stands out for its splendour. Set against the eastern slopes of Cape Town's Table Mountain, it offers visitors an impression of South Africa's ecosystems and species.

According to experts, Kirstenbosch National Botanical Garden is one of the greatest botanical gardens in the world, as well as one of the largest. The entrance to the 560 hectares park is located on Rhodes Drive, Newlands, Cape Town. It is one of the ten national botanical gardens, covering five of South Africa's six different biomes. Founded in 1913, on the land donated by the infamous diamond mining magnate Cecil John Rhodes, it was destined to showcase the unique plants found in the area around Cape Town. Botanist Harold Pearson designed the large expanses of lawn, interspersed with trees, roses, ponds and indigenous South African plant species. It quickly became a popular destination for locals and tourists alike.

Kirstenbosch National Botanical Garden is part of the South African National Biodiversity Institute (SANBI). The country has 20,381 plant species and this institute plays a leadership role in generating, co-ordinating and interpreting the knowledge and evidence required to support policies and decisions relating to all aspects of biodiversity. SANBI manages flora as well as fauna in ten botanical and two zoological gardens. Researchers at SANBI focus on surveying, classifying and mapping South Africa's ecosystems and species.

The threat of extinction

In the Kirstenbosch National Botanic Garden, special attention is given to plants that are on the brink of extinction or have already been lost to humanity. For many visitors it comes as a shock to see a memorial stone for *Erica pyramidalis*, pyramid heath, which has been extinct since 1907 in the Cape Town area as a result of the expanding city. And it is not the only one. There are at least 29 species in South Africa that are extinct and have completely vanished, 7 that are extinct in the wild but survive in gardens and a further 2,924 that are threatened, of which 479 are critically endangered. The garden displays some of the species that narrowly escaped total extinction, and although they have vanished in the wild, they still survive in cultivation. For instance, *Erica turgida*, Kenilworth heath, and *Erica verticillata*, whorled heath, only survived because seeds and cuttings were cultivated in botanical gardens, including Kirstenbosch. These species are extinct in the wild because their natural habitat no longer exists. Loss of habitat, i.e. the irreversible destruction of natural vegetation, caused by urbanisation, farming, forestry, mining, etc. is the leading cause of plant endangerment in South Africa.

A memorial in the garden of extinction reminds people of the plant species that have been lost to mankind forever

Labels underline the threats the endangered plant species are facing. It is hoped that visitors will become aware of the value of plants that have no obvious medical or commercial uses. "It is a challenge convincing people to care about plants that have no measurable value," says Alice Notten, interpretation officer at Kirstenbosch National Botanical Garden. She is a passionate photographer, who loves the botanical garden. "Subjects like threatened species and climate change are bad news, doom and gloom with large doses of blame and shame, which makes people either depressed and hopeless, or angry and upset." To overcome these feelings a storyboard with ideas for what people can do to address the extinction of plants and animals is placed at the exit of the garden of extinction. "It inspires people to act, to give encouragement." There might be only so much a visitor can do in daily life to conserve species, even little deeds can make a difference.

The Mathews Rockery is an intricate maze of cobbled pathways through a man-made rockery planted with many different xeryophtic plants from the dry regions of South Africa, including aloes, euphorbias and crassulas. The *Aloe arborescens* (Krantz Aloe) puts on quite a show

For a feast of weird and wonderful desert plants, don't miss the glasshouse which is packed full of them, including dwarf succulents such as the stone plants (*Lithops*, *Conophytum* and *Argyroderma*), the weird *Welwitschia* from the Namib Desert, halfmens (*Pachypodium namaquanum*) and quiver trees (*Aloe dichotoma*) from Namaqualand and the world's largest succulent, the baobab (*Adansonia digitata*)

‘All things of value are defenseless’

Lucebert

A stroll along the Fynbos Walk will take in the pincushions (*Leucospermum*), sugarbushes (*Protea*), heaths (*Erica*) and other Fynbos shrubs. Fynbos is at its best in winter, spring and early summer. Its vegetation is unique to the mountains and valleys of the Western Cape

Strelitzia reginae, the bird of paradise, at the main entrance to Kirstenbosch flowers during autumn, winter and spring

Bird watchers will have plenty to see and hear at Kirstenbosch. The Garden is a dog-free zone and borders on a natural area, so birds are ever present and remarkably unafraid. A sighting of a colourful lesser double-collared sunbird (*Cinnyris chalybeus*) perched on an overberg pincushion (*Leucospermum oleifolium*) is a sure thing. Keep a look out for the long-tailed sugarbird, endemic to this region

Although winter is the rainy season in the Western Cape, there are many clear sunny days with mild temperatures and many plants flower during the winter months, such as Aloes, Proteas and Strelitzias

The arboretum, also known as the Enchanted Forest, is home to over forty southern African tree species and displays many shade-loving plants

Castle Rock and Fernwood Peak on the eastern end of Table Mountain can be viewed from the Tree Canopy Walkway, nicknamed the 'boomslang' (meaning tree snake). It is a curved, steel and timber raised walkway that snakes its way through and over the trees of the arboretum

The 'Useful Plants Garden' displays plants that are used for medicine, for making food or drinks, dyes, ropes, baskets, mats and thatch. All the plants are labelled with their name and information about how the plants are used

ISHI's validation process

Joyce Woudenberg, Ludivine Thomas and Rose Souza Richards

Seeds are the foundation for crop production and seed health is related to food production in many ways. Healthy seeds, free from known seed-transmitted pests, are a prerequisite for sustainable food production. As seeds may present a pest risk, they are routinely tested with a seed health method to prevent the introduction of pests into new territories.

The International Seed Health Initiative (ISHI) brings together seed companies, public sector institutions and private laboratories to develop seed health methods for seed species that are traded internationally. The initiative started 30-years ago (see 'Celebrating 30 years of ISHI-Veg'), and nowadays its members account for 70-75% of vegetable seed that is traded internationally. By promoting the use of its test methods in the industry and other stakeholders, ISHI facilitates the international movement of seed, which is a pre-condition for global food security.

Validation is a critical aspect of method development and is therefore intrinsically embedded into each project within ISHI. Method validation is a documented process used to confirm that the protocol to be used for a specific method is suitable for its intended purpose. It is an essential part of method development before routine use of a method and ensures that results reported to customers are the accurate health status of a given seed lot. It provides information to assess the comparability of results from samples analysed in different laboratories and with different methods. It is aimed at new methods, modifications of an existing method, and comparison of a new method with an existing one. Different validation criteria are identified, against which the performance of the method is measured. Within ISHI, six validation criteria have been defined and are routinely used for the validation of methods (see ISHI Guidelines for the Validation of Seed Health Methods). These validation criteria are in line with those used by internationally recognised bodies for developing seed health methods.

Analytical specificity

Analytical specificity is the ability of an assay to detect the target pest(s) (inclusivity), while excluding non-targets (exclusivity). It should be evaluated with a collection of strains that represent the known phenotypic and genotypic diversities of the target pest from diverse geographical origins. In addition, the assay should be evaluated with a diverse, well characterized collection of non–targets associated with the host seed, such as those originating from the same host and location, and related species.

Analytical sensitivity is the smallest amount of the target pest that can be detected, i.e., the limit of detection (LOD). It is evaluated using a replicated dilution series of pure cultures of the target pest added to seed samples. For ISHI, the dilution with the smallest amount of target pest which can be consistently detected with 95% confidence is the LOD of the assay.

Selectivity

Selectivity corresponds to the effect of different seed matrices on the ability of the method to detect target pest(s). It is evaluated by analysing the effect of matrix variations by spiking a known concentration of the target pest in a relevant collection of differing matrices. Seed matrix variations can result from differences in crop species or varieties, and variations in saprophytic levels, and seed treatments. Different seed matrices spiked with the target pest should be tested.

Repeatability is the degree of similarity in results of replicates of the same seed lots when the method is performed with minimal variations in a single laboratory. It is evaluated by the same technician assaying replicates of seed samples (infected and healthy) using the same reagents and equipment. Replicates should be uniformly infected and drawn from seed lots with a range of infection levels, including one that is just above the determined LOD, as well as healthy ones.

Reproducibility

Reproducibility is the degree of similarity in results when the method is performed across laboratories with replicate seed subsamples. It is evaluated in a comparative test (CT) performed across experienced laboratories. The subsamples should be drawn from seed lots with a range of infection levels, with some close to the LOD. Replicates should be infected as uniformly as possible and assessed by homogeneity testing prior to the CT. Additionally, to allow for comparative analyses between the different participating laboratories, a stability test is performed by the CT organizer to take into account the potential loss in contamination rate that may arise during seed storage and transport.

Diagnostic performance is an evaluation of the ability of the method to discriminate between positive and negative seed lots. To assess diagnostic performance,

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The ISHI has a clear process for the development of its seed health methods

Definitions

Method: A collection of one or more assays that together show the presence, viability, and pathogenicity of a pest. A method is a description of how a seed health test is conducted.
Assay: A procedure for evaluating a seed sample for the presence or functional activity of a target pest (PCR assay, dilution plating assay, etc.). An assay consists of only one procedure.

the results of the method should be compared to the true disease status of the seed lot. Ideally this should be done with an independent assessment of the disease status, using a reference method or an existing validated test. When a reference standard to which the performance of the method can be compared is not available, the method developer must establish a reference that provides an independent assessment of the true health status of lots. Diagnostic sensitivity and diagnostic specificity are the two measurements used to determine the test's ability to discriminate between the presence and absence of the target pathogen. They are calculated based on the comparison between true and false results obtained with the new method against the reference method. Diagnostic sensitivity is the test's capacity to give a positive result when the pathogen is present, while diagnostic specificity is a measure of how certain a negative result is a true negative.

Clear process

The ISHI has a clear process for the development of its seed health methods and the improvement of existing ones. The different phases of the ISHI project process include project initiation, method development, a two-step method validation which consists first of in-house assessment and then of an inter-laboratory comparative test, and project finalization. The entire process of method development and method validation is conducted by a project team with a project lead. The validation of a test method by a laboratory is a mapped-out activity. The scope of the method and its validation criteria are first defined and documented in a validation plan before experimental studies commence. The minimum requirements set for each validation criterium are established and justified by the project team. The assistance of a statistician when designing the experimental studies ensures that the experiments proposed in the validation plan are statistically sound and appropriate for the analysis.
The records, results and evaluation of a completed validation programme are assembled in a validation report that is later made available on the ISF website (ISHI Method Development and Validation – International Seed Federation (worldseed.org)). The purpose is to provide a concise overview of the entire validation effort and the results obtained. Data published in scientific and peer-reviewed journals may be used in method validation if they assist in demonstrating that the method is fit for purpose. Data generated during the developmental phase of the method may also be used.
The approval of the validation report by independent reviewers from the Method Validation Team of ISHI authorizes the use of the method in routine use. The validation report should include i) a description of the validation project, including the project scope, ii) all test cases performed, including whether those test cases passed without issue, and iii) all deviations reported, including how those deviations were resolved. Internal critical peer reviewing occurs at various stages of the process by ISHI members, independent of the project team.
After a method has been developed and is in use, ISHI encourages laboratories to continue monitoring its performance and report findings that indicate it is underperforming. This is to ensure the development of fit-for-purpose methods that can be used widely and, ultimately, to secure the delivery of healthy seed to customers. These methods are publicly available through the ISF website (ISHI Methods - International Seed Federation (worldseed.org))

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Spotlight on

Sow to Grow

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

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

A planters clock

The planters clock is rather small, with a height of only 38.5 cm

Monique Krinkels

In early June, a gardener should sow his broccoli seeds. At least when he lives in or near Cascade, Idaho, USA, where the last spring frost occurs around that time. In 1975, Mechtronics Corp., Stanford, Connecticut, USA, designed and manufactured a clock with an unusual addition. It does not only tell the time and the phases of the moon, but also indicates when it is the best time to sow vegetable seeds. It is a unique find, as only a limited number were produced.
The upper half of the clock has a regular clockface, with an hour and minute hand and - in the middle - a drawing of the moon displaying its monthly phases. The electric clock has a pinewood case. The unique part is the lower half of the clock. It rotates once a year and indicates when it is time to sow beans, beets, broccoli, carrots, corn, cucumbers, eggplant, endive, kale, leaf lettuce, muskmelon, onion sets, parsley, peas, peppers, pumpkins, radishes, rutabaga, spinach, squash tomato and turnip. The setting can be customised to any location in the United States, based on the dates of first and last frost.
The American seed company W. Atlee Burpee Seeds Co., Warminster, Pennsylvania, used the clock in the seventies as a promotional gift. Besides vegetables, the company also produces herbs, fruits, flowers, perennials and gardening supplies. They had the name 'Planters Clock' replaced with 'Time to Plant Burpee Seeds.'
Today, the planters clock is a sought-after collector's item, which can, from time to time, be found on e-Bay and similar trading platforms.

Surviving the Russian **knockout** blow

Monique Krinkels

In 12 months, the price of natural gas in all EU Member States has risen by 67% to 271%. The cause: the Russian invasion of Ukraine and the subsequent use by Russia of gas as a weapon of war against the EU. For growers of vegetables and ornamentals heating their greenhouse became unaffordable. The result: for many it was no longer profitable to continue production.

While the war between Russia and Ukraine started in 2014 with the invasion of Crimea, for many the attack on Ukraine from all sides on 24 February 2024 came as a shock. The western world reacted almost with resignation to the Crimea assault; except for a few sanctions that were hardly noticeable by the general public, nothing much was done. On the other hand, the 'special military operation' as President Putin calls it, provoked a worldwide condemnation, economic isolation and united global support for Ukraine. Russia reacted with threats of all sorts and with restricting the natural gas pipelines to Europe. As a result, the price of natural gas skyrocketed.

Impossible choices

Greenhouse growers in the Netherlands faced an impossible choice, especially the ones with heat-loving plants. They either had to sell their produce below cost price or quit growing crops completely. "In July and August of last year, we noticed that suddenly 20-25% of our clients cancelled their orders," says Marc Eijsackers, marketing manager at Floricultura.

For a long time, people believed that the fragrance of a flower decreases the vase life. Not so though for 'Love Potion' in the AromorA series, whose delicate purple flowers combine both characteristics

It was an unheard-of situation. The company, specialized in breeding and propagating Orchidaceae and Araceae, saw the demand for meristems of tropical ornamentals drop by millions of plantlets. So much so, that they had to close down one of their tissue culture labs and lay off 225 employees and on-call workers.

Floricultura itself was not hampered by the rising energy costs. "For a decade, we haven't used natural gas anymore. Our 7 hectares of greenhouses in Heemskerk, the Netherlands, are heated by our own geothermal source." Marc Eijsackers continues. "We are lucky to be located above the Slochteren formation of the Rotliegend reservoirs. Boiling hot water from 3 kilometres depth is pumped up and used for heating to be returned afterwards at a temperature of 45-50˚C.

Another story

For the growers of Phalaenopsis, Anthurium, Cymbidium and Spathiphyllum, the situation was completely different. "The gas prices had already started to rise gradually since early 2021, but most growers could cope with that. It was the sudden rise after the invasion that knocked some of them out because of liquidity problems. Others could sell their long-term gas contracts with huge profits, meaning that they would cease their business operation too."
Of course, all greenhouse growers suffered from the high energy costs, but the companies that produce tropical crops have to heat their greenhouses to 24-28˚C. "We could not foresee the consequences. Growers decided en masse to stop at short notice." It sent a shock wave to the companies propagating plant material. For Floricultura disaster struck. "Producing orchids takes almost two years between receiving the order and delivery of the plantlets, so we were totally unprepared for the blow. Our greenhouses were filled to the brim with plantlets at different stages of growth." Millions had to be discarded while others could be stored for future production.
"In September, we decided that the only viable option for the Dutch operation of Floricultura to survive as a company was to reduce the number of employees and engage on a massive cost cutting scheme. One fifth of our colleagues in the Netherlands had to leave, a painful decision. About 110 people were on-call workers, but the others had been employed for many years. We offered them a financial arrangement to leave voluntarily. Luckily, they all found new jobs."

Future

"A grower who has decided to stop, or who has sold his energy contract, will rarely restart his company. Only for Anthurium do I foresee a possible growth. So even with gas prices returning to more or less 'normal', the number of clients in the EU has been decimated. On the other hand, consumer demand is rising again, as the urge to surround oneself with colourful flowers has returned. As a consequence, prices are on the up again."

The pink-coloured Phalaenopsis 'Gallery Play' flowers 150 to 169 days

The breeders at Floricultura have not waited for the circumstances to change. "One of our breeding goals is shortening the period between the arrival at the greenhouse and the moment the plant is ready to be sold. So far, we have varieties that are flowering within 24 weeks. Imagine the effect if you could shorten that period with a fortnight." At first sight it might not seem much, but two weeks times the surface of a greenhouse is a lot of work the grower saves. "Another breeding goal is to extend the flowering life of Phalaenopsis. The most promising is a variety that blossoms for more than half a year, 202 days to be exact. We have 25 varieties that flower more than 100 days," says Marc Eijsackers proudly. The flowering life value of the plants is assessed by a third party, Royal Flora Holland, the cooperative in Aalsmeer, the Netherlands.
"Our latest feat is to unlock the natural fragrance to Phalaenopsis. It has long been accepted by ornamental breeders that more scent leads irrevocably to a shorter shelf life. Consumers, on the other hand, crave flowers that add a scent to their homes, as well as colours. That is precisely what the plants of the AromorA series do. And they sometimes have a remarkable shape, like 'Love Potion'. Instead of rising spikes, it has horizontal branches. A real eyecatcher."

'Untold Stories' of the Lingua series has a noteworthy bicolour. A conservative estimate claims it blooms for over 170 days

Skyrocketing prices

In the first half of 2022, natural gas prices in the European Union suddenly skyrocketed. At the height of the energy crisis, at the end of August last year, more than 300 euros per megawatt hour had to be paid on the Amsterdam Gas Exchange. In the EU (minus Cyprus and Malta, who do not report natural gas prices in the non-household sector), the increases ranged from 67% to 271%. In Lithuania, companies had to pay 270.9% more, followed by Romania (+249.1%) and Estonia (+219.9%). Natural gas prices for the non-household sector increased the least in Germany (+67.1 %).
Due to the mild winter, the increased import of liquefied natural gas (LNG) and well-stocked gas reserves, the gas price has been falling for some time. In addition to the relatively mild winter weather, consumers and businesses also use less gas because of the high price they have to pay. This year, the gas price has already fallen 35%. In mid-February, one year after the Russian invasion, the Amsterdam Gas Exchange noted 49.50 euros per megawatt hour. Meanwhile, the prices have declined to under 40 euros.

Floricultura

The ninety-year-old Floricultura was founded by Jan H. Post as a trading business for orchids, tropical plants and seeds. Later, his son began a worldwide quest to discover new markets and quality breeders who could add to the existing range. The company became a pioneer in the revolutionary development of Cymbidium cut flowers and started growing young seedlings and vascular plants from the bottle to supply growers. The next step was the merger with the orchid nursery Klaas Schoone, an important Phalaenopsis cut flower grower. Later, the product range was supplemented with, among others, Anthurium and Spathiphyllum. Today, Floricultura is an international operating business with branches in Pune (India), Salinas (USA), Holambra (Brazil), Pila (Poland) and, Pinghu City (China). The company supplies professional growers worldwide with tens of millions of plants each year for the production of several varieties of orchids.

Temporary Immersion Bioreactors

The return of **tissue culture**

Monique Krinkels

Tissue culture has virtually completely disappeared from Western Europe. In the late nineties, the laboratories moved to locations with lower production costs, such as Poland, the Balkan states and, later, Asian countries. A new, more efficient technology, named TIB, has proven to be cost-effective, even in countries where labour is expensive.

Alewijn Broere, director/owner of SBW do Brasil, discovered the temporary immersion bioreactors (TIB) in the late nineties, when he visited the Bioplants Centre of the University of Máximo Gómez Báez in Ciego de Avila, Cuba. Back in the Netherlands, he started to test the TIB system in his own tissue culture laboratory, SBW International. He soon discovered that the technology looks simpler than it is. "The bioreactor consists of two vessels: a reservoir bottle with culture media containing the required nutrients and plant hormones, which is connected with tubes to a second bottle with plantlets. A few times each day, the medium is transferred to the plantlets, which are submerged for a few minutes, after which the medium is returned to the reservoir," Alewijn Broere explains.

"On a small scale, it works perfectly, but when you try to scale up, the problems start. For a start, liquid medium is susceptible to contamination and when you lose 25% of the plants, the technology is not profitable. And how to sterilise the bottles and tubes? Autoclaving – sterilizing the tubes with pressurised saturated steam – is not an option with large volumes."

Compensating costs

It was not his first attempt to find a way to compensate for the high labour costs in the Netherlands. With minimum wages rising in 1995 to over 1,000 euro per month, tissue culture became too expensive. "At the time, we explored how to turn the tide. For instance, we started projects to automate the cutting of the plants with robots or laser. However, this was not financially feasible," says Alewijn Broere.

Alewijn Broere and René Farenhout are convinced that their TIB system will surpass traditional tissue culture methods

SBW was founded in 1976 in the Netherlands. The initiator was the famous Professor Rudolf Pierik at Wageningen University & Research and the laboratory was supported by the Dutch testing stations for flowers, bulbs and trees as well as the Dutch inspection service. The aim was to develop tissue culture protocols for plant propagation. In addition, the organisation developed in-vitro breeding support activities, such as embryo rescue, mutagenesis and haploid culture. "Over the years, hundreds of crop protocols were developed and breeding-supportive activities were successfully introduced for dozens of crops."

The foundation was dissolved in 2000 and SBW continued as a commercial company under the name SBW International, with Alewijn Broere as director/owner of the company with facilities in the Netherlands, Macedonia and Ghana. In 2006, SBW International started a company in Brazil: SBW do Brasil. First SBW do Brasil only produced plants and flowers for the international market. Later, the local market became more important, in particular crops for bioethanol and fruit. From 2008 Alewijn Broere took over the shares of SBW do Brazil and distanced itself from SBW International.

SBW do Brasil

SBW do Brasil is one of the major biofactories in Brazil, with a production capacity of fifty million seedlings per year. The company produces meristem seedlings of ornamentals, sugarcane, banana, potato, eucalyptus, teak, fruits and many other products for the national market.

Solving the riddle

The first large scale TIB-project was with bananas. "We produced tissue cultured plants in 50 litre drums. But the risk of contamination proved to be too great." It was followed by a sugar cane project in five litre bottles, together with Syngenta. Unfortunately, only the last phase – from propagation to straightening and rooting – could be done in TIB, due to the risk of contamination."

The breakthrough came four years ago with the arrival of René Farenhout, director Production and R&D. "Upscaling is no problem anymore as we have contamination and vitrification under control. Today, we have TIB-protocols for over ten crops. The advantage is that the last propagation round – the straightening and rooting – takes place in one phase. This way, it is possible to save 80% on labour. Six years ago, we produced 5 million plants with 64 grafters per year. Nowadays, it has increased tenfold (to fifty million) with 32 grafters and less than 4% contamination."

Local

The method SBW do Brasil has developed can be used to locally produce tissue cultured plants, even in high labour-costs countries. Licences can be obtained via sister organisation MulticanaPlus. "We have Brazilian sugarcane factories as clients, but also producers of sugar cane, bananas, blueberries, papaya, potting plants and perennials. MulticanaPlus implements the TIB-system worldwide. Besides saving on labour, it also saves space in the growing cells. And as liquid medium is used, the absorption of nutrients and hormones can be precisely monitored, resulting in fewer mutations. This system is expected to bring about a considerable reduction in the production cost of cultivated tissue, and will become available to companies all over the world."

Caught between **droughts and floods**

Monique Krinkels

For most people, climate change is an alarming but distant future, with rising water levels in rivers and oceans, and extreme weather conditions. In reality, the situation is far more serious, as food security is already being affected. Farmers are caught between droughts and floods and their crops have to deal with new environmental conditions. Breeders face a challenging task.

People around the world report changes beyond the natural variation of temperatures on land and in oceans, as well as abnormal trends in the timing of seasons, in rainfall patterns and in many other systems. There is no question that these abnormal changes result from global warming due to an increased greenhouse effect caused by human activities, states the UNFCCC (United Nations Framework Convention on Climate Change). To address climate change mitigation and adaptation requires collective action, including farmers, breeders (public and private) and policy makers.

Plants need suitable soil, water, sunlight and heat to grow and most of it is climate-related. To withstand the sudden (in evolutionary sense) changes, food crops need to adapt to the new conditions. In October last year, UPOV organized a seminar on the role of plant breeding and plant variety protection in enabling agriculture to mitigate and adapt to climate change. Led by Marien Valstar, then President of the UPOV Council, nearly forty representatives of national and international organisations and governments discussed the influence of climate change on the strategies of companies.

Everyone agreed that climate change affects global agricultural productivity. The impact of climate change on plant breeding is immense: loss of genetic diversity, emerging diseases and pests, water supply issues, change in seasonality and heat stress. According to many of the speakers, it is of vital importance that plant breeders develop climate resilient varieties to mitigate the impact on global agricultural productivity. Accelerated breeding using different tools is necessary.

Besides, the agricultural practices should change, with more attention to intensification, crop rotation, cover crops and irrigation. More than 80% of the farmers point out that new improved plant varieties are important for them to respond to climate change. Furthermore, access to affordable and available seeds and solid seed legislation is a basic prerequisite, as is knowledge exchange and partnerships in the value chain. There is, unfortunately, not one single solution. Farmers and breeders have to take many factors into account.

Strategies

The EU strategy to address climate change is focused on increasing the ambitions for 2030 and 2050. Mobilising industry for a clean and circular economy,

Nearly forty people exchanged their views during the seminar on the role of plant breeding and plant variety protection in enabling agriculture to mitigate and adapt to climate change. The 3-day seminar was presided by Marien Valstar, the former President of the UPOV Council. The five thematic sessions were:
- Climate change and its impact on agricultural production
- Strategies to address climate change in agriculture
- Plant breeding for climate change adaptation and mitigation in agriculture: Crop perspectives
- Plant breeding for climate change adaptation and mitigation in agriculture: breeding strategies and techniques
- Role of plant variety protection in the development of new varieties to mitigate and adapt to climate change

Extreme weather conditions

In their report of 20 March 2023, the Intergovernmental Panel on Climate Change, IPCC, concluded that weather extremes, such as heat waves, extreme precipitation and droughts, have increased since 2014 and climate change has now led to partly irreversible consequences for people and nature. In the last decade, deaths from floods, droughts and storms were 15 times higher in regions that are highly vulnerable to a changed climate. Between 3.3 and 3.6 billion people live in conditions that make them vulnerable to climate change. Millions of people are facing acute food insecurity and many plant and animal species have already disappeared in some areas.

In 2022, climate change and climate related disasters caused approximately 31,300 deaths worldwide and the economic damage amounted to 294 billion euros.

Examples of uncommon weather extremes last year:
Hurricanes: Cuba, U.S.A. (Ian), El Salvador, Guatemala, Nicaragua (Julia)
Storms: Democratic Republic of Congo, Western and Central Europe (Eunice), Madagascar, Malawi, Mozambique, Nigeria, Zimbabwe
Droughts: Chad, China, Ethiopia, Southern, Western and Central Europe, Niger, Uganda, U.S.A.
Floods: Australia, Central African Republic, Chad, China, Gambia, India, Ivory Coast, Madagascar, Mali, Mauretania, Niger, Nigeria, Pakistan, Rwanda, Senegal, Sierra Leone, Somalia, South Africa, Sudan, Tanzania, Tunisia, Uganda, Zambia, Zimbabwe
Heat waves: Antarctic, Arctic, Central and Eastern China, Western and Northern Europe, Northern India, Pakistan
Cold waves: Eastern Australia, Northern India, Pakistan
Low sea ice extent: Antarctic and Arctic
Wild fires: Algeria, Central African Republic, France, Germany, Slovenia and Spain
Carbon dioxide concentration: Worldwide +2.1 ppm
Methane concentration: Worldwide +12 ppb

Weather extremes, such as extreme precipitation and droughts, can have irreversible consequences for people and nature

and preserving and restoring ecosystems and biodiversity are some of the goals. The EU promotes carbon farming, a green business model rewarding land managers for improved land management practices, resulting in carbon sequestration in ecosystems and reducing the release of carbon to the atmosphere.
Climate change offers opportunities for innovation. What farmers need are varieties that mature early, are drought tolerant, use nitrogen and water in an efficient manner, and are resistant against existing and emerging diseases and pests. Genomics can help to accelerate the characterisation of strategic crops. Conservation of genetically diverse populations of plants is paramount. In situ conservation will allow evolution to continue and ex situ conservation ensures the maintenance of diversity of species, especially of those from areas expected to be highly affected by climate change.
Making agriculture resilient to climate change requires the implementation of a myriad of complementary strategies. Investments in irrigation and water harvesting structures are necessary. Furthermore, applying artificial intelligence and the use of meteorological data to predict rainfall or drought, pest evasion, etc. might support the development of climate smart agriculture. Another option is to move agriculture to new locations to follow environmental changes or even utilising environments hitherto classified as not useful. Besides, there are genetic options, such as utilization of underutilised crop species, domestication of new species, improving existing crops and use of wild relatives to capture the available climate smart plant biodiversity into elite genotypes.
Climate change has impacted agriculture around the world, but some countries are more affected than others. It is clear that plant breeding and the protection of plant varieties is of great importance to mitigate the effects of climate change and enable the agricultural sector to adapt to new environmental conditions.
New rice varieties incorporate upland rice characteristics. This is useful to reduce irrigation water and improves transplanting operations in paddy fields. By reducing water requirement, CO_2 emissions to the atmosphere are lowered.
New wheat varieties can access subsoil moisture during the establishment period of crops. This enables young plants to survive longer periods of drought.
For vegetable crops, avoiding losses and waste by way of new characteristics is important. This can be achieved by maximizing plant production in protected environments (e.g. hydroponics) and by introducing characteristics such as disease resistances and longer shelf life.
Breeding for drought resistance and introducing new adapted crops is a focal point for ornamentals. The sector is intensively using plant breeding to develop varieties adapted to increased drought periods. New varieties are being developed from species more adapted to extreme environments, such as succulents and others.

Breeding techniques

New breeding techniques are widely available with a great level of precision. Take, for example, transposable elements: they occur naturally and create adapted traits, e.g. response to heat stress. Greater investment in more radical innovation in breeding strategies is needed. Public as well as private resources should invest in plant breeding, as farmers need varieties that are robust, tolerant to heat and drought, and resistant against pests and diseases. Unfortunately, certain plant breeding techniques are still heavily regulated.

At an average of 3 km a year, pests and diseases are moving away from the tropics towards more temperate areas

Applied research reveals the molecular basis of commercial traits and creates tools for breeders to deliver better varieties faster. Useful techniques that are identified are gene identification, sequencing and mapping, as well as the analysis of gene function and pathway, marker-assisted and whole-genome selection, irradiation and gene editing. Furthermore, artificial intelligence and bioinformatics can support plant breeding. This will enable more efficient and faster breeding by big data on phenotype-genotype information.

Plant variety protection is key to promote plant breeding. UPOV-based legislation secures the investments in plant breeding and research made by taxpayers and farmers. Royalties from sales and licensing are re-invested back into breeding and research, creating a self-sustaining funding environment. Researchers' exemption supports ongoing research, and scientific publication, dissemination of knowledge about the qualities/attributes of specific varieties. Breeders' exemption ensures that all PBR protected varieties are available for breeding purposes.

Regional problems

In Canada, the northward expansion of warmer weather crops is being observed. Maize and soybean, for instance, displace cereals and canola as a result of climate change. Water/heat stress may have a negative impact on yields, as have new pests and diseases. Historic drought tolerant varieties can be used as breeding material for introgression into modern high-performing varieties.

Sub-Saharan countries face other problems, such as a rapid declining soil fertility (especially nitrogen), postharvest losses and short shelf-life of produce, inherent low yields of crops, ecological concerns and loss of biological diversity. Crop production in these countries will have to double or even triple by 2050, using limited resources (land, water, nitrogen). Smart breeding has a role to play to achieve food and nutrition security. Plant variety protection has an enormous potential to improve productivity and the seed system, protect genetic diversity and empower farmers to access new markets and attract private sector investments in plant breeding.

In Japan, the average temperature has risen by 1.26°C in a century. As a consequence, agricultural production regions are expected to change with emerging high-temperature injury. The results: rice - immature starch formation in grain due to high temperatures; apple - poor or delayed colouring of fruit due to high temperature; and deterioration of fruit quality reported in grapes, peaches, etc.

Kenya struggles with extended dry periods and rainfall outside the normal seasons. It is very important for breeders to develop varieties that are resilient to these harsh agroecological conditions. Most urgent is the development of drought tolerant varieties of maize, sweet potato, cassava, sorghum, pigeon peas, amaranth and rangeland grasses. Pest and disease tolerant varieties are needed to counter emerging pests as a result of climate change.

Conclusion

"Climate change is increasingly affecting everyone around the world," concluded Marien Valstar. Farmers and breeders, as well as consumers, are confronted with the consequences. The effects are biotic, as new pests and diseases gain ground to new territories, and abiotic. "A range of strategies is needed to respond to the challenges. Plant breeding has a vital role to play in these strategies. Farmers need new plant varieties to adapt to climate change, but also to sustainably increase productivity in order to minimize climate change."

"Plant breeding is a long-term process that requires long-term investment from public institutions and from private companies. Plant breeders need a regulatory environment that promotes innovation and supports the conservation and utilization of genetic resources. The UPOV system enables plant breeders to provide farmers with the varieties they will need to feed the world in the face of climate change."

ISF Regulated Pest List Initiative

Phytosanitary regulations of **okra seeds** assessed

Bénédicte Lebas, Cherry Relevante-Belagantol, Yuji Hosobushi and Rose Souza Richards

In 2022, thirty pathogens were identified to be regulated by phytosanitary regulations for okra seeds. This significantly hampers the import and export of the seeds. According to the Regulated Pest List Initiative of the International Seed Federation, only one of these pests has okra seed as its pathway: the *Botryosphaeriaceae* fungus *Macrophomina phaseolina*.

Marika from Getty Images via Canva Pro

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Okra (*Abelmoschus esculentus*) is an annual flowering crop of the *Malvaceae* family, which is cultivated for its edible green pods. Tender leaves of okra can also be consumed. Okra is an economically important vegetable grown in tropical and subtropical regions of the world. In 2020, the world production of okra was close to 10 million tons, with more than 60% produced in India (https://www.atlasbig.com/en-us/countries-okra-production).

Like many other crops, okra is propagated through seeds. However, seeds may harbour some harmful pests, such as viruses, bacteria or insects. It is thus important to have access to quality and healthy seeds for successful crop production. Predictable international movement of seeds relies on phytosanitary measures that are scientifically justified. Thirty pests were known to be regulated for okra seed, at the time of the development of the crop list in 2022 by the regulated pest list initiative (RPLI) of the International Seed Federation (ISF; https://worldseed.org/our-work/phytosanitary-matters/pest-list/).

One fungus

This RPLI assessment concluded that okra seed is a pathway for only one of the 30 regulated pests. This pest, *Macrophomina phaseolina*, was found to be transmitted via okra seeds based on the thorough and independent evaluation of the existing scientific knowledge and experience of the seed sector. *Macrophomina phaseolina* is a soil-borne fungus with a very wide host range and a worldwide distribution. It has been isolated from okra seeds from several countries, such as India and Pakistan. The fungus causes several diseases in okra including root and collar rot, dieback and fruit rot.

Variable seed transmission rates have been recorded (ranging from 0.5% to 18%), depending on the okra cultivars, the inoculum level of the fungus and the season. *Macrophomina phaseolina* was detected in the seed coat, cotyledon, endosperm and embryonic axis of okra seed. Okra seeds infected with the fungus can appear brown to black. In the field, the primary source of inoculum is plant debris and soil, where it can survive in the form of microsclerotia for many years (see ISF regulated pest list database for the list of references).

The other 29 regulated pests (i.e. 96.5% of the regulated pest of okra) were categorized either as okra seed not being a pathway (26 out of 29) or as okra not being a host of the pest (3 out of 29). The three regulated pests for which okra is not a host are the oomycete *Peronospora hyoscyami* f. sp. *tabacina*, and the insects of the genus *Callosobruchus* and *Caulophilus*. The formae speciales of oomycetes is based on the pathogenicity to a specific plant species, which is in the case of *P. hyoscyami* f. sp. *tabacina*, tobacco.

Pulse beetle (*Callosobruchus* species) is a pest of stored pulses that feed inside seeds, while grain weevil (*Caulophilus* species) is a pest of stored grains that feed only on damaged grains. Both groups of insects may be carried along with the seed. However, no references were found indicating okra is a host for *Callosobruchus* spp. and *Caulophilus* spp., nor that okra seed is a pathway.

Not specified

Several other fungi are regulated on okra, although the specific species is not specified. These are *Alternaria* sp., *Colletotrichum* sp., *Phoma* sp., *Pythium* sp. and *Rhizoctonia* sp. These genera are large groups of fungus, some of which are mainly saprophytes such as *Alternaria*. Therefore, it cannot be concluded that okra seed is a pathway for a fungus species without its identification. Similarly, for the insect, *Trogoderma* sp., and the nematode, *Meloidogyne* sp., it cannot be concluded that okra seed is a pathway for all the species belonging to these genera. Although different *Trogoderma* species have been associated with stored products such as cereal grains, oilseeds and other vegetable seeds, no references were found indicating that seed is a pathway for *Trogoderma* spp. in okra. Regarding *Meloidogyne* spp., these nematodes are not even associated with seeds; they only affect the roots of their hosts (see ISF regulated pest list database for further details and the list of references). An assessment cannot be done at genus level as not all species within a genus can have identical transmission characteristic. Pests should be regulated at species level, as recommended in ISPM 38 – *International movement of seeds* (https://www.ippc.int/en/publications/84340/).

No evidence

Okra seed was concluded not to be a pathway for the

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If it is unlikely that a pest is transmitted by okra seeds, the phytosanitary regulations for these seeds should be adjusted

regulated bacterium *Pseudomonas syringae* pv. *syringae* and for six regulated viruses because of the lack of scientific evidence (see ISF regulated pest list database for more details and the list of references). *Pseudomonas syringae* pv. *syringae* is seed-borne; the bacterium was isolated from asymptomatic, bold discoloured and heavily discoloured okra seeds. However, the paper did not demonstrate whether *Pseudomonas syringae* pv. *syringae* is transmitted by okra seeds directly to plants growing from these seeds.

Similarly, there is no scientific evidence of seed transmission for the viruses regulated in okra. Bhendi yellow vein mosaic virus (BYVMV, genus *Begomovirus*), an important disease of okra, was found in all plant parts of okra including the seeds. However, BYVMV is not seed transmissible based on grow-out tests and molecular results. In the field, the primary mode of transmission of BYVMV is by the whitefly *Bemisia tabaci*. Similarly, for other begomoviruses regulated in okra, namely Cotton leaf curl virus (CLCuV; causing cotton leaf curl disease, which can be caused by several viruses), Okra enation leaf curl virus (OELCV) and Okra leaf curl virus (OLCV), no references indicate seed as a pathway for these viruses.

Okra mosaic virus (OkMV), a member of the genus *Tymovirus*, is transmitted mechanically and by beetles of the genus *Podagrica* but not through seeds. Although Cucumber mosaic virus (CMV, genus *Cucumovirus*) has been reported to be seed transmitted with varying efficiencies in several hosts and that okra has been reported to be host of CMV, no references have shown that CMV is transmitted in okra seeds.

Table 1. Result of the categorization of pests regulated on okra seed, based on scientific evidence*

Type of pests	*Categorization* Seed is a pathway	Seed is not a pathway	Okra is not a host
Bacterium	0	1	0
Fungus	1	13	0
Insect	0	5	2
Nematode	0	1	0
Oomycete	0	0	1
Virus	0	6	0
Total	1	26	3

Not justified

To conclude, the independent assessment shows that 29 out of the 30 regulated pests in okra seed are not scientifically justified. It is important to highlight that, according to the SPS Agreement (The Sanitary and Phytosanitary Measures Agreement), every government has the right to define its level of health protection as it deems appropriate. As clarified by the World Trade Organization (WTO), '*the aim of such agreement is to ensure that these sovereign rights are not misused for protectionist purposes and do not result in unnecessary barriers to international trade. The agreement clarifies which factors should be taken into account in the assessment of the risk involved. Measures to ensure food safety and to protect the health of animals and plants should be based, as far as possible, on the analysis and assessment of objective and accurate scientific data*'.

However, scientific evidence must be shown through the pest risk analysis (PRA), written in accordance with the guidelines of international standards on the risk of introduction and spread of a pest, as well as its economic and environmental impact via seeds for sowing.

If the likelihood of entry, exposure, establishment and spread is concluded to be negligible because the pest is not seed transmitted, then the overall risk estimation should be concluded to be negligible for seeds for sowing. And, therefore, the regulation on that seed species is not warranted for that specific pest. The goal of the ISF regulated pest list database is to provide scientific basis to regulating seed and to limit the regulation of pests to those that are necessary to protect plant health.

*See ISF regulated pest list database for more details and the list of references: https://worldseed.org/our-work/phytosanitary-matters/pest-list/

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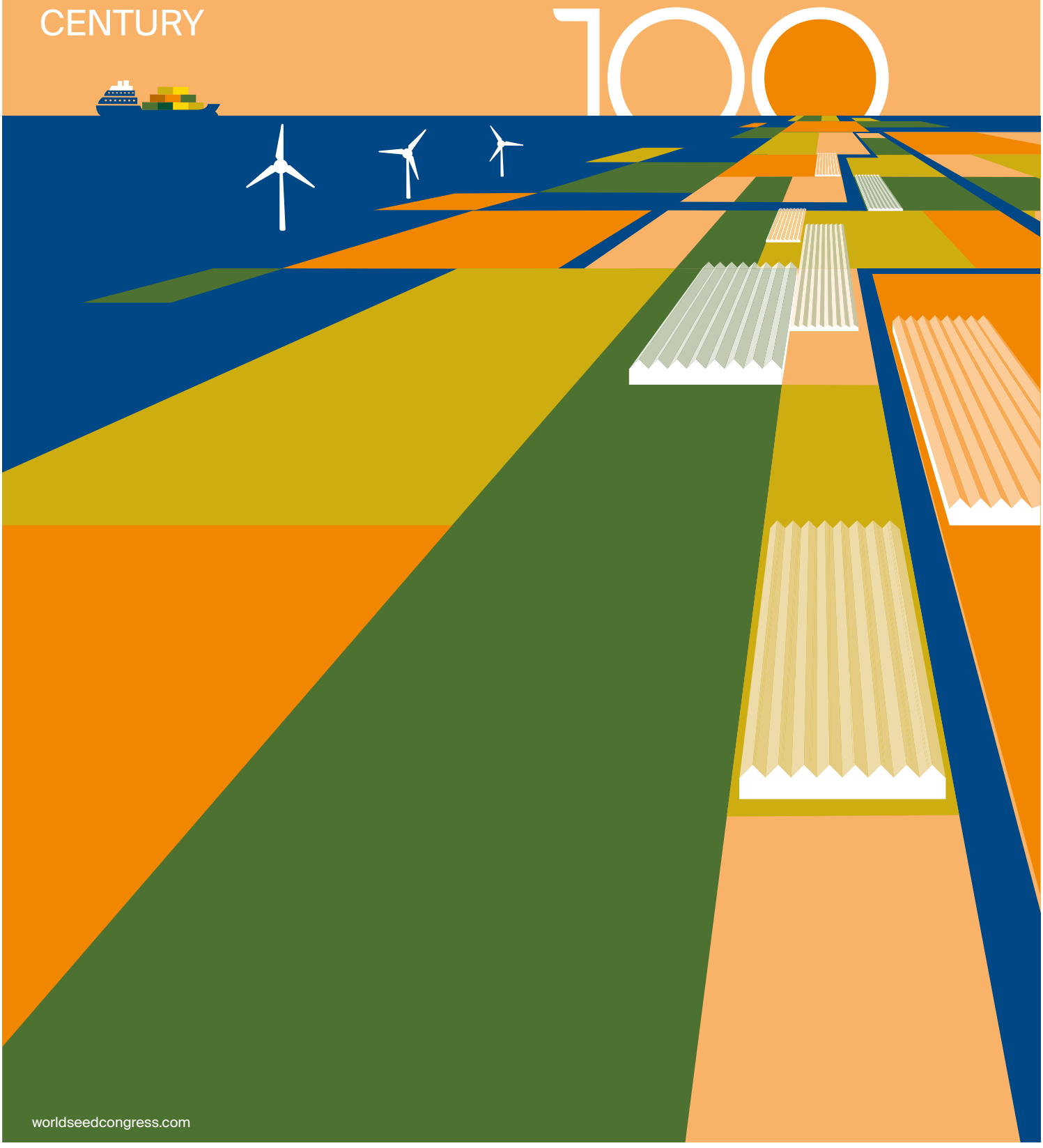

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In search of the **fuel of the future**

Monique Krinkels

Whether renewable diesel will become the fuel of the future for cars is highly debatable. For traffic on roads, electricity and hydrogen seem to have the upper hand. "But biokerosene is another story," says Robert van Loo, senior researcher at Wageningen University & Research. With 6% of the total energy demand, ships and aircrafts require a massive amount of fuel.

In his office in the Radix Building on the Wageningen Campus, Robert van Loo has an assembly of glass vessels containing a variety of promising seeds. Camelina, for instance, might be well-known by farmers as an annoying weed in flax, but thanks to its versatility and rich oil content, it is a crop with potential. The same goes for crambe, calendula, jatropha and linseed.

Palm oil

In 2006 a company named Clean Energy built a biofuel-producing factory in the Netherlands. The main raw material was palm oil. The production process was so effective that 99% of the raw material was converted into biodiesel. Unfortunately, palm oil, whether for biodiesel or human consumption, has become a highly controversial product as it is linked to environmental problems. Large areas of rainforest are being cut down and replaced with oil palm plantations, with all the consequences that entails.
In December last year, the European Commission officially approved a measure to phase out palm oil-based biofuel by 2030. "Unfair," notes Robert van Loo, "as plantation owners, who environmentally sustainable produce palm oil, are affected too. They deserve to be exempted." Palm oil is less suitable for human consumption as it contains more saturated fat than other oils. It raises LDL cholesterol and increases the risk of cardiovascular diseases.

Promising alternatives

The search for industrial crops started at the end of the 1980s. A former researcher of the Centre for Genetic Resources in the Netherlands, Loek van Soest, travelled the world to find plants containing interesting fatty acids. He came up with, among others, marigold, evening primrose, linseed and Euphorbia. "Today, biobased products have become increasingly appealing," says Robert van Loo.
One of the promising crops is camelina which contains erucic acid. "This fatty acid can be used to produce erucamide, which is commonly used as a slip additive in the plastic manufacturing industry. A slip additive prevents, for instance, sandwich bags from being sticky," he explains. Erucic acid is a monounsaturated very long-chain fatty acid with a 22-carbon backbone and a single double bond. It is

Due to its quick maturity, Camelina can replace summer rapeseed in countries with short summers, such as Canada

usually produced from rapeseed but can also be found in gold-of-pleasure, Camelina sativa. "The advantage of the latter plant is that it matures fast and can be grown during the summer on marginal lands. It is an old oil crop, mainly used in Eastern Europe. Unfortunately, there is not much camelina available, therefore companies are hesitant to use it as raw material."

New breeding techniques

Other fatty acids can be used for human consumption, especially if they contain the healthy unsaturated fatty acids. Sunflower oil contains up to 70% linoleic acid, an omega-6 fatty acid with the notation C18:2. This means it consists of 18 carbon molecules and has two double bonds, hence unsaturated.
Other promising oil-rich plants need further breeding to make them suitable for human consumption. Take for instance Abyssinian kale, Crambe abyssinica, an oil crop that can grow on saline soil and tolerates salty water irrigation. It has a mustard flavour, making it unsuitable for human consumption. "It is used as an animal feed, but it has so much more potential."
There are three genes involved in the glucosinolate production that causes the mustard flavour. "With traditional breeding techniques, it would take at least ten years to find a suitable mutant. CRISPR-cas gives us a short-cut to create a variety without glucosinolate." .

Tomato Brown Rugose Fruit Virus

EU Commission continues **emergency** measures

John van Ruiten

It is expected that the EU Commission will decide to continue the existing emergency measures for combatting Tomato Brown Rugose Fruit Virus (ToBRFV) for at least one year until 31 May 2024. The most important reason is that the Commission is not yet convinced that changing to a Regulated Non-Quarantine Pests (RNQP) status will sufficiently protect EU tomato cultivation.

Although present in almost all member states of the EU and eradication of the virus does not seem a realistic option anymore, the Commission is not in favour of deregulating the disease to a RNQP status at this moment. The virus disease has been present in the EU now for over five years and, since 2020, emergency measures have been in force. Strict measures for importing and marketing seeds and plants are in place. Also, growers of tomato crops have faced rigorous measures if they were confronted with infestations of their crops.

Damage

Gradually, those very harsh measures for growers have become less dramatic. Today, they do not have to rogue infested crops anymore and, in most cases, they can continue to grow the crop and harvest tomatoes until the end of the growing season. But with these infected crops, severe damage and big reductions in the amount and quality of harvested tomatoes still occurs. Once having had infected crops in the glasshouses or production fields, it turns out to be extremely difficult for growers to clean the property and to be sure that a problem-free new start of the next growing season is possible. Some growers had to decide to change to cultivating other crops.
Strategies to protect the crops from infections are limited. Absolute hygiene in the greenhouse is necessary. Many plant raisers and tomato growers, after experiences with Clavibacter and Pepino Mosaic Virus, have taken a lot of action. And that has worked! But ToBRFV is even more highly infectious and can enter the production areas not only with seed and plant material, but with fust, dust, knives, machinery, carried by employees on their hands and more.

Protection

Cross protection with 'mild strains' - vaccines against this quarantine pest – is not legally allowed to be used in the EU and is therefore not possible. Use of resistant varieties is now being regarded as the best option available to growers to prevent crop losses in the future. Most, if not all, tomato breeders are working to introduce resistance genes in parent lines in order to create proper resistant F1 hybrids. Since 2021/2022, these varieties (sometimes intermediate resistance IR, sometimes high resistance HR) have been introduced.
Various different genes and mechanisms can be responsible for realising lower susceptibility. The number of new varieties becoming available is expected to grow enormously. Developing (harmonized) official DUS testing protocols for ToBRFV resistance has become an important issue now for Examination Offices, like GEVES and Naktuinbouw, as it is expected that this characteristic will be decisive for varietal differentiation in the future.
In sweet pepper (Capsicum annuum), already existing Tobamo virus resistant varieties turned out to be 'immune' to infections with ToBRFV. In tomato, however, the resistance is protecting the plants very well against damage done by the virus but, under stress conditions, the virus will be able to replicate in the plants, and therefore will be present and can spread with fruit and plant material.

State of play

Most EU countries have now reported the presence of the virus in tomato cultivation. It is expected that intensified monitoring, in combination with sampling and testing, might reveal the presence of the virus in almost all areas where tomatoes are grown in a certain scale. Some of the EU countries still want to take measures to eradicate the virus from their territory. Most countries, however, are of the opinion (supported by experiences elsewhere) that once the virus occurs in cultivated crops in an area, it will be extremely difficult to get rid of it.
Although infected seeds surely have contributed to

Resistance terminology

Breeders organised in the ISF have agreed on the definitions of resistance terminology:
High resistance (HR): plant varieties that highly restrict the growth and/or development of the specified pest and/or the damage it causes under normal pest pressure, when compared to susceptible varieties. These plant varieties may, however, exhibit some symptoms or damage under heavy pest pressure.
Intermediate resistance (IR): plant varieties that restrict the growth and/or development of the specified pest and/or the damage it causes, but may exhibit a greater range of symptoms or damage compared to high resistant varieties. Intermediate resistant plant varieties will still show less severe symptoms or damage than susceptible plant varieties when grown under similar environmental conditions and/or pest pressure.

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Eradication of the Tomato Brown Rugose Fruit Virus no longer seems a realistic option

the worldwide spread of the virus, in most cases where crop infections occur, it is only possible in limited cases to find the pathway in which the crops have been infected. Seed transmission cannot be excluded, but in many cases, it seems likely that during grafting, plant raising, transportation, handling crops and working in a crop, an infection has occurred. In many instances, it turns out to be very difficult to find the exact place/moment of infection of a crop.

Local spread of the virus via people, equipment, plants, debris or other mechanical ways seems to be the most important pathway. Seeds however might also be a reason for the spread, maybe more 'long distance'.

Phytosanitary measures

The EU commission understands the actual situation and will probably realise at some stage that eradication is not an option anymore. But especially due to the high number of interceptions of seed lots from third countries that tested positive when coming into the Union, the Commission wants to prolong the quarantine status and the emergency measures for another year. The Commission is not yet convinced that deregulating this pest to RNQP status would offer enough protection to safeguard tomato cultivation in Europe.

Various countries in the Standing Committee on Plants, Animals, Food and Feed (SCOPAFF) and Euroseeds (on behalf of all the member-breeders in a formal letter of 21 March 2023) have expressed their concern on various topics. All countries and also the seed businesses underlined the need for good measures to prevent, as best as possible, the spread of infected seed and plant material. They have voted for changing to the RNQP status in order to promote the use and application of resistant varieties. In their opinion, the quarantine status damages the rapid introduction of new varieties. They also want to have proportional conditions for managing the disease.

In its letter, Euroseeds also signals the effect of the very sensitive PCR detection technique that is being applied by official testing laboratories. The question was raised if this technique and the detection values used for deciding if a sample can be regarded as 'positive = infected' is too stringent (in general above a PCR CT-value of 30). It was also questioned whether the detected positive samples are all 'biologically relevant'. This means that there are doubts expressed by the industry if all positive findings are indeed related to seed lots that will show infections when grown later on.

Less stringent

In the new draft measures, it is proposed by the Commission that less stringent requirements will apply to tomato fruit growers. They can rogue infected plants, but continue the cultivation of the crops.

The control on seed imports will be intensified. It is being proposed that 50% of the imported seed lots should be additionally sampled and tested, whereas for specific countries - certainly China, but also Israel and Peru - even 100% of the lots should be checked again at import, due to the findings that were made in import checks over the last years.

There is an ongoing debate as to whether information on the exact place of production of seed lots also has to be given to the authorities. The consequence could be that places where positive findings are made in seed lots could be 'banned from allowing seeds to come from that location'.

The final decision on EU phytosanitary policy will be made in May 2023. Certainly, in 2023/2024, further discussions on the future regulations will take place. It is envisaged that new approaches to control and contain ToBRFV will be needed.

CHIC shows benefits of CRISPR/Cas

Monique Krinkels

During the five years of the research project, the Chicory Innovation Consortium (CHIC) demonstrated that genome editing can contribute to improving a niche crop such as root chicory. The partners developed several new varieties that provide high quality inulin and health promoting terpenes. When cultivated, these new varieties could bring benefits to the economy, to farmers and the environment.

Although root chicory (Cichorium intybus L.) has high yields and low agronomic requirements, it is an under-utilized crop. It is grown on a relatively small scale for the production of inulin, which is added to food products as a prebiotic soluble dietary fibre and non-caloric sweetener. However, inulin is broken down in the roots in autumn, limiting the time window for harvesting by farmers. Chicory roots also produce a number of secondary metabolites in its latex, the so-called terpenes. Terpenes of other plant species have highly interesting properties, for instance, anti-malarial and other health promoting terpenes. The terpenes in chicory roots might also possess health properties, but they are currently separated from inulin due to their bitter taste and are discarded as waste.

Genome editing

Traditional chicory breeding is extremely time-consuming as it is a biannual plant and is self-incompatible, so the development of homozygous lines is challenging to say the least. Developing new chicory varieties with improved health properties via conventional plant breeding can therefore easily take between one or two decades. To better exploit the potential of chicory, new breeding techniques such as genome editing could make a difference.

Chicory is a relatively little-studied crop and gene editing protocols had to be developed almost from scratch. Variants of CRISPR methods were developed that differ in the extent and the way in which DNA is used to deliver the CRISPR system generating the genome edits. These methods were systematically evaluated for their efficiency and safety, studying potential off-target editing in each case. Off-target mutations caused by the CRISPR system were not detected in any of the methods used or any of the lines analysed. When DNA was used to deliver the CRISPR system via stable transformation, different edits at the target site within the same plant were observed in some plants. Apparently, the stably integrated CRISPR complex continues to make edits at the not yet edited target sites while the plant is developing, making phenotyping and genotyping more complex.

Furthermore, the in the genome integrated CRISPR system needs to be segregated to obtain plants with only edits at the target site. When DNA with the CRISPR system was delivered transiently, in addition to the intended edits, CRISPR DNA fragments were also found in some plants, unintentionally integrated in the genome. In both cases, these plants can be recognized and discarded. When the CRISPR system was delivered as a protein complex, instead of via DNA, the plant cells had not been exposed to foreign DNA and only edits at the expected target sites occurred. This makes this method extremely interesting for commercial applications.

Health-promoting compounds

The methods were implemented to generate a multitude of chicory varieties: varieties with a higher quality of healthy inulin, because inulin degradation in autumn is prevented, as well as varieties that are reduced in bitter terpenes, which greatly facilitates the extraction of inulin. For the first, 6 alleles encoding the inulin degradation enzymes and for the latter, 8 alleles encoding the enzyme which initiates bitter compound biosynthesis were inactivated, showing how effective CRISPR-Cas is in chicory. Guided by bioassays that identified terpenes from chicory roots

To inform the public a computer game has been developed

MyChicFarm

One of the elements to help inform the public is MyChicFarm, an augmented reality game. The players (farmers) wear HoloLens augmented reality headsets to grow chicory crops and make the most money out of them. The farmer starts with a certain amount of money that can be used to buy chicory seeds. Seeds have to be planted, grown, collected and sold in the market. The price in the market varies based on the quality of the crops that are affected by events such as droughts, rain or the amount of pesticide used to defend the plantation from plagues. To ensure the quality of the next crop, the player can invest part of the money in new plant breeding techniques and produce health-related products, such as inulin and terpenes. These mini-games are played using HoloLens interfaces and gestures.

The CHIC project has resulted in new chicory varieties that combine its favourable growing characteristics with improved ingredient composition

with anti-inflammatory activity and by literature data, varieties were created that accumulate specific terpenes of potential interest for medicinal use. Chicory plants were created that accumulate costunolide, a plant metabolite known for its anticancer activity. Costunolide was first extracted from Dolomiaea costus in the 1960s, a wild plant that grows in the Himalayas. It is cultivated in India as an ingredient of traditional medicine, but has a low yield. Chicory also produces costunolide, but it does not accumulate because it serves as an intermediate which is rapidly converted in the roots to other compounds. The enzyme responsible for this conversion (kauniolide synthase) was identified and blocking its six alleles by genome editing resulted in costunolide accumulation in roots.

CHIC

The Chicory Innovation Consortium (CHIC) is an international project funded by the European Union. The EU Horizon 2020 funding programme made 7.3 million euro available between 2017 and 2022 to explore the interactions between technological potential and societal acceptance of modern plant breeding techniques. CHIC was focused on the application of new breeding techniques to develop plant varieties of chicory that contain higher levels of the useful substances inulin and terpenes. The consortium included SMEs, an industrial partner, non-profit organizations and research institutes from eleven European countries and one from New Zealand and was coordinated by Wageningen University & Research, the Netherlands.

Similarly, an enzyme (lactucin synthase) somewhat further downstream in the biosynthesis pathway was identified and inactivated to accumulate 8-deoxylactucin and some of its derivatives in the roots. These terpenes were demonstrated to have anti-inflammatory activity. With these results chicory can be positioned as a multipurpose crop from which different health products can be extracted; inulin and different health-related terpenes.
Furthermore, through these experiments, scientific knowledge was generated on chicory biology and, in particular, on its bioactive compounds, their biosynthesis and storage.

Societal interaction

Genome editing frequently raises high expectations as well as strong concerns among consumers in Europe. Therefore, CHIC involved a broad range of stakeholders to discuss issues associated with genome editing and strived to communicate openly by implementing innovative communication methods. A Stakeholder Advisory Group with representatives of industry, academia, agriculture and end-users interacted with the CHIC consortium during the entire project period. In addition, consultations with a broader range of stakeholders covering the entire agriculture and food value chain, policymakers and regulators helped to clarify hindering and facilitating factors for genome-edited plants in general and for root chicory innovation in particular.
Scenarios differing in aspects, such as whether CRISPR edited chicory is regulated as GMO or not,

50 Chicory can be grown on marginal lands as it has low agronomic requirements

and what type of products are isolated from them, were evaluated for their socio-economic and environmental impacts over the whole value chain. They show that inulin and/or terpene production based on the new chicory variants creates more jobs, generates higher value added, and reduces greenhouse gas emissions and primary energy demand, compared to the current process.

CHIC also monitored regulations related to genome editing worldwide. For the EU, the European Court of Justice ruled that all genome edited plants are regulated as GMOs. The regulatory field is currently changing fast, with big differences appearing between continents and countries. The interaction with stakeholders in the project clearly shows that the promising food related applications will only be further pursued by business actors in the EU if the regulatory status for certain gene edited plants is changed.

A lot of emphasis was put on communication about the CHIC project and its aims. A website - from which flyers, newsletters and explanatory movies can be accessed - and social media channels were set up. Artists visited laboratories and created art works allowing for another type of interaction with the general public. An educational game (MyChicFarm) was developed and CHIC partners visited schools and organized panel discussions, targeting in particular young citizens.

The CHIC project has clearly demonstrated what genome editing can contribute for a niche crop like root chicory. At the start of the project, relatively few genetic and breeding tools were available and targeted genome editing methods for root chicory did not exist. Five years later, multiple improved varieties were developed with potential benefits for consumers (healthy inulin and terpenes), ingredient producers (more efficient processing and use of waste products), farmers (agricultural diversification and flexibility during harvesting), breeders (genome editing methods), the environment (reduction in primary energy demand, in GHG emissions and more efficient land use) and the economy (higher added value and more jobs).

CHIC primarily aimed at traits with health benefits for consumers. Using the knowledgebase established by CHIC, other traits could also be introduced into root chicory in relatively short time frames. In a broader perspective, CHIC demonstrated that genome editing can be a powerful tool to help to stimulate agricultural biodiversity in Europe by improving niche crops which have relatively little investment leverage. In synergism with other breeding and farming methods, this is highly relevant for maintaining food security and improving sustainable production, while at the same time dealing with challenges like those of climate change.

Chicory

Root chicory (Cichorium intybus L.) belongs to the Asteraceae family and is closely related to both the leaf vegetable chicory and endive. The wild plant is perennial and can be found throughout Europe, Siberia, North Africa and the Middle East. The cultivated plant is biannual and accumulates inulin in the root during the first year of cultivation.

In the past, the plant has been used as a surrogate for coffee. Throughout the Netherlands, but especially in Belgium and northern France, there were companies that were involved in drying and roasting chicory root for the production of surrogate coffee. In the 17th century, the leaves growing on the root were discovered as a vegetable. It laid the basis for chicory cultivation and production.

This article is based on information provided by Prof. dr. H.J. Bosch, coordinator of the CHIC Project at Wageningen University & Research and the members of the CHIC management team: Paul Bundock, Katarina Cankar, Suvi Hakkinen, Maria Hingsamer, Ingrid van der Meer, Karin Metzlaff, Matthew de Roode, Macarena Sanz, Armin Spok, Thorben Sprink and Alain Tissier, dirk.bosch@wur.nl

Seed drying & equipment

AGRATECHNIEK BV from HOLLAND is specialized in drying all kinds of seed.
We have more than 35 years of experience with Seed drying and processing technology

Individual open box dryer

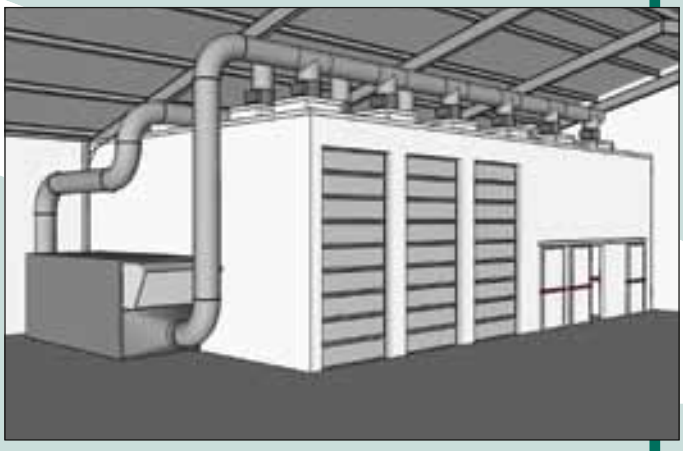
Drying of seed
(A) in boxes
(B) per box individual.
Per box a fan (C)
and heating source (D).
Extracting outside air (E),
dehumidified air (F)
or inside air (G).

Individual closed box dryer

Individual closed drying units for conditioned drying of seed in boxes.

Optimal use of dried air

Central hybrid air dryer (left) to be connected to different drying installations, drying units or drying rooms;
optimal and economic use of dried air.



Drying seeds in closed rooms and Seed vault for storage

Central hybrid air dryer for drying rooms (left) and seed vault (right). Storage of previous seed at 15°C and 20% RH or 10°C and 25% RH.

Humidification of too dry seed

Humidification unit (A) to increase moisture content of too dry seed without making the seed wet.Damp air will be distributed through the seed by any kind of aeration system. The safest way for automatically humidification of your seed

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