

FOCUS ON EUROPE 2020

Journal for breeders and producers of plant material

Prophyta

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On the cover:
Cut cocktail tomatoes from
the Heartbreakers series of
Prudac have a heart shape

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Prophyta expands editorial board

CHAIRMAN THEO RUYS (Moerheim Roses & Trading India) and secretary John van Ruiten (Director Naktuinbouw) welcomed three new members to the editorial advisory board: Sally van der Horst, Erik Toussaint and Marien Valstar. In daily life, Sally van der Horst is Secretary General of Fleuroselect, the international organization for the ornamental plants industry. At Fleuroselect, industry professionals have joined together to test and evaluate new pot and bedding plants, promote award winners and protect member varieties. Erik Toussaint is Communication Manager at Keygene. This Agbiotech company specializes in crop improvement by molecular breeding. Marien Valstar is President of UPOV and Senior Policy Officer, Seeds and Plant Propagation Material, at the Ministry of Agriculture, Nature and Food Quality of the Netherlands.

Together, this team forms the eyes and ears of Prophyta in the field. The editorial board welcomes suggestions for articles about various aspects of plant breeding, variety protection, seed production, seed treatment, etc. Do you have any suggestions for an article or something that the entire seed industry should know, please let us know at info@prophyta.org.



The photo contest of the FAO aims to raise awareness about the importance of plant health

FAO starts photo contest

THE UN'S FOOD and Agriculture Organization (FAO) invites professional and amateur photographers to submit their pictures of healthy and/or unhealthy plants. The contest is organized on the occasion of the International Year of Plant Health 2020 to raise global awareness on how protecting plant health can help end hunger, reduce poverty, protect the environment and boost economic development.

Photographs in the unhealthy plants category could depict insects, viruses, bacteria, nematodes or invasive plants attacking plants, or show the damage being caused. In the healthy plants category, photographs that capture the natural beauty of plants and reflect their importance as the source of the air we breathe, our food and as protectors of our environment could be submitted.

The winners of each category - unhealthy plants and healthy plants - will be invited to an important plant health event, such as the International Plant Health Conference, or an event at FAO headquarters. The deadline for submitting photographs is 15 January 2021.

More information: www.fao.org/plant-health-2020/photo-contest/enter-the-contest/en

Seed experiment will last a century

SVALBARD GLOBAL SEED Vault is starting a seed experiment that will last for 100 years. The aim is to establish how long seeds can stay alive. That question is crucial for seed genebanks and research institutes working with plants and seeds. The seed longevity research is focused on 13 globally important crops. The first experimental seed samples arrived at the Svalbard Global Seed Vault last August. These first test sets consist of seeds

from barley, pea, wheat and lettuce, produced at the German genebank IPK, in Gatersleben. During the next 2-3 years, seeds from 9 additional crops will be produced and put into the -18°C seed storage in Svalbard. These are samples of rice, maize, chickpea, soybean, groundnut, pearl millet, pigeon pea, cabbage and timothy. "This experiment is one of its kind. It will provide future generations with valuable information about seed viability and more precise

knowledge of how often seeds need to be regenerated," says Åsmund Asdal, Seed Vault Coordinator at Nordic Genetic Resource Center (NordGen), the genebank responsible for managing the project. So far, more than 1 million seed samples from 87 different institutes and organizations have been deposited in the Seed Vault for safe, free-of-charge and long-term storage.

Bumblebees enforce flowering



The bumblebee does not benefit herself from the early flowering, as the lifespan of a worker is short

CAN BUMBLEBEES stimulate plants to flower four weeks earlier than normal? In other words: can bumble bees act as gardeners in a symbiotic relationship with some plant species? Interesting research carried out by Pashalidou et al. (published in *Science* in May 2020) suggests that bumblebees that are facing shortages in food supply (less pollen available) can induce or accelerate flowering. Normally, flowering will be induced by daylength, light intensity or temperature, but also certain stress conditions can bring plants to flower sooner. In the research project undertaken, it was significantly proven that bumblebees can actively and purposely damage leaves from test plants in a characteristic way (puncturing

holes in it), which resulted in earlier flowering of the damaged plants by as much as 17 days (*Brassica nigra*, black mustard) or even 30 days (*Solanum lycopersicum*, tomato). Mechanic damage of leaves of plants in the same plots, created by researchers themselves, did not show comparable effects. Ecologist Professor Chittka writes in a short article in the same *Science* edition that further research must be done to reveal what distinct method (or stimulus) is used by bumblebees. It is even possible that the bees inject specific chemicals to promote flowering of the plants. The evolutionary advantage for both plants and bumblebees also needs to be further examined, he writes.

A herd of elephants

The famous South African Nobel Prize winner, Desmond Tutu, once asked: 'How do you eat an elephant?' And his answer: 'One bite at a time!', meaning that everything in life that seems daunting, overwhelming and even impossible, can be accomplished gradually by taking on just a little at a time.

A lesson to take to heart, as the seed world is not just facing a single elephant, but a whole herd of the huge creatures. The first hurdle this sector must take is to adapt to the new reality of a worldwide spread of a virus that hampers human contact and obstructs travelling. A quick return to the 'old normal' is not at all certain. Will people be travelling all over the world again, or will face-to-face get-togethers be replaced by virtual meetings? Will going to the office be replaced by the 'home office' at the kitchen table? Will the daily small talk at the coffee machine be replaced by a WhatsApp message? And more importantly: what will the effects be on business results. The next elephant is climate change. Not every politician might be convinced that the increased heatwaves, droughts and sudden torrential rains are here to stay, but scientists are. The migration to the North of crop wild relatives in Europe is evident writing on the wall. And migration is only the best outcome, as extinction threatens several plant species. It requires a huge effort for breeders to adapt crops to the new climate conditions.

Then the Access and Benefit Sharing-system, better called 'no access and thus no sharing', as outlined in the Nagoya Protocol, seems to be unworkable in daily practice. Genetic resources have become unattainable for breeders as the governments in the countries where the species are present have unrealistically high expectations of the value of their vegetal possessions.

Another elephant: Brexit. Negotiators from both sides put pressure on each other in the hopes of a more profitable deal. It seems realistic that they will not succeed in coming to an agreement in time. Imagine long rows of trucks, loaded with vulnerable young tomato plants, at the border, waiting for customs inspection. It is a nightmare scenario.

Last, but not least, are the demands the first vice president of the European Commission, Frans Timmermans, poses. With the Green Deal, he demands that, within 10 years, agriculture should resemble farming practices from a century ago, while feeding three times as many people. It means there is a tremendous task ahead for breeders.

There are several elephants 'to eat' and, given Desmond Tutu's advice: the average African elephant weighs 8,000 kilos and the average mouthful is 15 grams, so it takes over half a million bites per elephant. There are challenging times ahead.

Monique Krinkels



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In Short

Bayer trials varieties with TOBRFV resistance

BAYER ANNOUNCED the final large-scale pre-launch trials of Roma-type tomatoes to test for the presence of Tomato

- Brown Rugose Fruit Virus (TOBRFV). The trials, which began last month in Mexico, will include two varieties that claim Intermediate Resistance



Bayer is using two varieties of Roma tomatoes in trials to test for the presence of Tomato Brown Rugose Fruit Virus or TOBRFV (photo Bayer)

(IR) to TOBRFV. The type of IR Bayer has seen in these varieties is commonly referred to as the 'symptomless carrier', where, despite the presence of virus particles, the crop can show little or no symptoms of the virus in the leaf and/or fruit, should the crop become infected by the virus. Adding TOBRFV in the pathogen list for tomato was discussed during the September meeting of the International Seed Federation. TOBRFV was first observed in 2014 and spread rapidly

to different areas around the world. This viral disease impacting tomato plants represents a challenge for the industry as it can be transmitted very easily through many vectors, including farming tools and equipment, workers' hands, plants, water, soil and people. Following the trials, Bayer anticipates the products will be available for commercial sale in Mexico in 2021, to be followed subsequently by offerings in other important markets around the world.

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Basic CPVR-system needs improvement

IN A JOINT LETTER, addressed to the EU Directorate-General for Health and Food Safety, AIPH, CIOPORA, Euroseeds and Plantum have requested that the European Commission considers reviewing the Council Regulation (EC) No 2100/94 (Basic regulation) on the protection of Community Plant Variety Rights (CPVR). The joint effort was prompted by the non-inclusion of the Community Plant Variety Rights (CPVR) system in the EU IP Roadmap, the document that draws a plan for the improvement of IP protection laws and mechanisms in the EU[1]. Pointing out a number of provisions in the Basic Regulation that require improvement, the organizations argue that, however robust in international comparison, the 25-year-old CPVR system fails to adapt to the latest developments in global agriculture, horticulture and plant breeding technologies. Already in 2011, the final report of the Evaluation of the Community Plant Variety Right Acquis had requested an improvement of the Basic Regulation, but no legislative actions have been taken since.



The 25-year-old CPVR system fails to adapt to the latest developments in plant breeding technologies

The recent decision of the European Court of Justice (CJEU) in case C-176/18 (Nadorcott) - regarding mandarin trees that were commercialised by a licensed grower without permission of the breeder in the period between the application and the grant of the right - exposed the weakness of the provisional protection and the protection of harvested material under CPVR. This does not provide an incentive for breeders to commercialize their varieties before a PVR is granted. Especially in the case of fruit trees, this is a serious problem, as the testing period needed before the right is granted can easily take six years.

Furthermore, the limited scope of protection for harvested material is particularly disadvantageous for horticultural varieties that are grown in territories outside the EU, with low-level or no IP protection, and are subsequently sold in the EU. This equally affects European breeders and growers, depriving particularly the latter of their competitiveness against cheaper, IP non-compliant imported products. Breeders have also called for better enforceability of the Farm Saved Seed provision regarding the payment of the remuneration and for a longer duration of CPVR protection for woody crops, flower bulbs and Asparagus.

Breeders Trust invests in Geo4A satellite technology

THE BRUSSELS-BASED Breeders Trust signed a major contract with Geo4A, a subsidiary of the Austrian company GeoVille. The Geo4A satellite technology will help Breeders Trust to receive more information about the varieties and the cultivated hectares, anywhere in the world. Initially, the organisation will start with five varieties, which will expand further in the coming years. In the first phase, Breeders Trust will mainly look at specific variety characteristics, taking into account the different growing conditions and soil types. The system is self-learning, so the results will become more and more reliable. This principle is also applied in crop recognition, with which experience has already been gained. "The intention is to use this form of variety recognition as one of the enforcement instruments in our toolbox. It will make our search for illegal propagation and royalties' payments more efficient and provide a more complete picture for our breeders," says Geert Staring, General Director of Breeders Trust.

'You have to **take away risks** you don't yet know'

Tijs Kierkels

8 Due to the corona crisis, the special attention to plant health in the International Year of Plant Health is not clearly outlined. In any case, this crisis clearly illustrates the risks of international movement. These risks also apply in respect of plant pests and diseases. Nico Horn, director of EPPO, explains the developments.

The United Nations established the International Year of Plant Health. The aim is to make everybody aware that plant health is in everyone's interest. Not something that farmers and horticulturalists have to pull off, but also crucial for tackling hunger and poverty. 40% of food is currently being lost to pests and diseases. Many products do not reach the consumer in ornamentals either. Surely that can be improved. It requires better disease control in the fields and in the greenhouses, also after the harvest. But preventing the introduction and spread of new diseases and pests is just as important. This requires clear and sometimes strict rules where there is significant international trade, in order to prevent major damage. "The sharp increase in international trade clearly carries higher risks. The same applies to the relocation of production to, for example, Africa and Central America. As a result, diseases sometimes arrive that you did not expect at all. Europe is a very open economy. Hence, this is where you notice the effects the most," says Nico Horn. He has been director of the European and Mediterranean Plant Protection Organization (EPPO) since January 2019.

Closed markets

Europe's position in the world is actually quite unique. "Most countries are, in fact, more closed. With any new trade, you must request market access there. There are certainly countries which do that in order to protect their own products, but usually to prevent bringing in new diseases. Thereby they also protect their own products of course. The boundary between those two reasons for import obstacles is sometimes not entirely clear," says Horn.



It is not yet clear what the influence of the COVID-19 Pandemic will be on international trade

One consequence may be that traders must have extra checks performed for each consignment or have strict guarantee systems in place. "The tendency is that these kinds of obstacles need



Nico Horn: 'You sometimes see that the national interest in the short term is given priority, but in the EU, you have to pull it off together'

to be evermore scientifically supported. That certainly applies within the EU," he observes. Due to the increased risks, the new EU Plant Health Regulation has been in force since December 2019. As a result, Horn expects better protection against pests and diseases. The plant passport, the import ban on certain woody crops, the new classification of dangerous organisms and better traceability play an important role in this. "The challenge is: you have to eliminate risks that you do not yet know. Hence the import ban on certain woody crops as these crops have the highest unpredictability. Until the risk per crop and country of origin is evident, these woody crops are not allowed to enter the EU. Ultimately, you need to get a picture of all trade flows with the highest risks. Some we know: large trees with a substantial root ball, for example, present a great risk," he says.

Successful approach

The EPPO director mentions a large number of plant health measures that worked out well. "The EU has already had a restrictive policy for import of seed potatoes for a long time. Nothing may enter from other countries, except Switzerland. That worked very well to keep out new diseases. Another example: the far-reaching measures in Spain and Portugal ensured that the pine wood nematode did not become a bigger

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The new EU Plant Health Regulation provides better protection against the import of pest and diseases

EPPO

The European and Mediterranean Plant Protection Organization (EPPO) is an intergovernmental organization responsible for cooperation in plant health with 52 member countries located in Europe, the Mediterranean and Central Asia (countries of the former USSR). EPPO is the oldest and one of the leading international organizations in the area of plant diseases and plant protection products. EPPO assesses risks, follows developments and warns and advises governments. It creates and manages databases for, amongst others, plant names, phytosanitary and plant protection information.



problem. And in the Netherlands: the approach to the Asian longhorn beetle (*Anoplophora chinensis*) and brown rot (*Ralstonia solanacearum*). This did cost a lot of money, but resulted in eradication.”

A challenge is to implement the Plant Health Regulation in the same way in all EU countries. In practice, it appears that countries which border the EU or are important trading partners of the EU are also more or less conforming with EU rules. These are, for example, Switzerland, Turkey, Norway, Balkan countries and Israel. In addition, there is the question of how other trading blocs will react. For example, the Eurasian Economic Union, the largest countries of which are Russia, Belarus and Kazakhstan. The advantage is that these countries are also members of EPPO. They attend EPPO meetings and know the background of the EU rules. This does not apply to other customs unions, such as Mercosur in South America. They are also working on common systems to prevent the introduction of pests and diseases.

Strong together

Horn is actually more concerned about two other challenges: retaining expertise and strengthening international cooperation. “You see an ageing among the experts; the influx of young people is too small. As part of the international year of plant health, EPPO is starting a fund for a ‘fellowship’. This will allow young people to gain international experience. That is urgently needed.” EPPO is the most important platform for international exchange for the EU and the neighbouring countries. The employers of the experts and representatives in EPPO must approve their participation in EPPO meetings.

In addition, national politics must also recognize the importance of plant health. And the role that the exchange of knowledge plays in this. “You sometimes see that national interest in the short term is given

priority, but in the EU, you have to pull it off together. You have common external borders and you must make decisions together based on risk analysis. Positive developments towards more cooperation are the EU reference laboratories and scientifically based risk analyses.”

Vulnerability

The biggest concern remains: what all are introducing in your country. “The corona crisis illustrates clearly that the countries with the most international travel are the most affected. This also applies to plant diseases,” says Horn. The Netherlands Food and Consumer Product Safety Authority is developing contingency plans in order to be prepared for the most dreaded pests and diseases. And yet unexpected things do happen. A good example is the box tree moth. This East Asian insect does not do much harm in its region of origin, but in Europe it does. Its arrival was not noticed at first, so that it spread uncontrolled. Entrepreneurs sometimes experience new rules, for example for the plant passport, as a burden, he thinks. “But the rules provide better protection and certainly also opportunities for Dutch agriculture and horticulture. The Netherlands is strong in quality control and quality systems and has a good system of inspection services. The companies are good at meeting the quality requirements. The UK, for example, has left the EU but will adhere to the EU regulations until the end of the transition period on 31 December 2020. It wants to regulate the import of tree nursery products with quality systems. Dutch companies can respond well to that.”

Risk management

It can also mean that you no longer do some things, he says. “For example, production of cuttings in a country with low wages, at a company where you have



We share Jose's eagerness to grow and develop

"After studying agronomics in Santiago, I returned to the village where I'd been raised and still felt at home. I started working at Rijk Zwaan, and just two years later I was asked to become Station Manager. It was a tough decision for me because I knew I had to move away from my village. But in the end I went for it, and I'm glad I did. I've been able to strongly develop personally and the combination of working with plants and people is perfect for me. When I look back on my time at Rijk Zwaan, I feel really thankful for the steps that I've been able to take – and I'm still only 31 years old and see so many possibilities ahead of me!"

Jose Marcelo Caro Tobar is Station Manager for Rijk Zwaan in Chile. He seizes the opportunities that come by and thus keeps on developing. Rijk Zwaan – a worldwide player in vegetable breeding – shares this approach. We are working together towards a healthy future. Learn more at rijkzwaan.com

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**‘The question :
is how :
everyone will :
behave after :
the crisis’**



II

Exotics are a threat, for example the box tree moth does little harm in East Asia, but it does in Europe

no insight into the risk of new pests and diseases. You then opt for low wages and higher risks. The basic question should really be: when do you incur costs? By producing a little more expensively, but playing it safe? Or producing more cheaply with the risk that your own company and the sector could suffer substantial damage?”

The case of *Ralstonia solanacearum*

In Europe, about 180 organisms have quarantine status. After its discovery, the organism must be eradicated and its spread prevented. An example is the outbreak in the Netherlands of the tropical variant of the bacterium *Ralstonia solanacearum*. Where the European variant is mainly known as the cause of brown rot in potatoes, the tropical variant is a much greater threat with many host plants, including tomato, pepper, aubergine, Anthurium, Gerbera, Curcuma, Pelargonium, but especially roses. The bacteria spread through feed water and plant sap. In 2015, the tropical variant was detected at a Dutch Anthurium grower. The first outbreak in greenhouse roses followed a month later. The impact of this disease was enormous. All greenhouse rose growers were inspected. At companies where the contamination was detected, the crops were immediately destroyed, in accordance with the plant health directive 2000/29/EC. The affected companies were hit by major financial problems due to the contamination. The outbreak was declared ‘eradicated’ in 2019.

Certain trade flows eventually become more complicated to mitigate risks. Especially when the climate changes as this may present additional risks and obstacles. Horn is convinced that, in that case, trade will find its way. “The Dutch trading spirit is driven by creativity. You saw that some years ago, when there was a ban on Acer trees from China. Trade from Eastern Europe came about quite quickly then,” he says. To maintain the open economy, the government can do even more in the phytosanitary domain, says Horn, e.g. perform more tests and detect risks at an early stage. “And where I personally see opportunities is that, as a government, you can make more use of the expertise of the business operators. There are currently insufficient incentives for operators in the regulation, they can do much more themselves. As a government, you do then have to be very resolute with punishment if people withhold information.”

Corona

The corona crisis has dominated in recent months. Horn finds it difficult to predict what the consequences will be with regard to plant pests and diseases. The virus has clearly shown that internationalisation comes at a price. That goes for human diseases, but just as much for plant diseases. “But the question is how everyone will behave after the crisis. Are we going to travel less, will there be less international trade, will we weigh up the environmental effects of internationalisation more? Or are we going ‘back to the old normal’?”

No Green Deal without the seed sector

Niels Louwaars

12 Frans Timmermans, first vice president of the European Commission, proudly presented the Green Deal in December 2019. It was followed in May by the presentation of the Farm to Fork and Biodiversity strategies that are intended to guide the EU policies for the coming years. Here, a first look at the Farm to Fork Strategy.

• **Key aspect of the Farm to Fork (F2F) strategy**
• is the ambition to make Europe the first climate neutral continent by 2050 with a new, sustainable and inclusive growth strategy that supports health, nature and quality of life, whilst 'leaving no one behind'.
• With regard to agriculture, the strategy focuses on food security, sustainable production and food chains, and healthy consumption. The Biodiversity strategy focuses, among others, on diversity in agricultural systems in connection with nature management. These are laudable goals, which require very substantial changes in our current society.

Brave New EU

Commendable, courageous and brave for politicians to dare to map out such a new future for Europe, tackling major issues such as our current hunger for non-renewable energy, for unhealthy food and for depleting our natural resources. Commendable, but will this 'Brave New EU' look back at the pre-Timmermans era with apprehension, or even horror, just like in Aldous Huxley's future? Will the words 'intensive agriculture', 'chemical crop protection' and 'uniform variety' that were common back in 2020 be declared taboo in 2050? Some may read the 'Green Deal' as a dystopian future.

It is, however, not the picture of what the world should look like that worries most, but rather whether such a world is possible, and how and how fast we will work towards that new situation. The ecological footprint of agriculture has to be reduced - fine! Food production should lead to neutral or positive impacts on the environment - agree! - which needs to be achieved through reduction of chemical fertilizer and crop protection - would be great. Goals are set for substantially increasing organic and 'agro-ecological' production methods. At the same time, we need to reduce the imports of soy and replace it with home produced proteins, stimulate industry to use more renewable (plant-based) ingredients in the 'circular economy', increase both biodiversity in farming systems and space for nature, and secure nutritious and healthy food.

Many wonder how those different claims on our limited space will work out and which uses of land will be prioritized in the end. The organic sector itself is worried about the projected increase of their sector.



Will the price markups of organic products remain possible when the label becomes mainstream? Moreover, there is a task for us to increase organic seed production six-fold to cater for this increase, in addition to ending derogations for the use of non-chemically treated conventional seeds.

The roles of the seed sector

Plant breeders and seed producers produce the best possible options for their clients, the farmers. What their needs are depend on the farming systems that they use and the markets they supply. If the Green Deal does impact farming systems, there will be a tremendous task ahead for breeders. If the Green Deal does lead to different crops and a different composition of harvested products, breeders will adapt these crops to growing conditions. And if the Green Deal does indeed increase organic production areas, breeders will be needed to provide the best seeds. I often say that whatever can be prepared in the seed, does not need to be corrected later. This is true for pests and diseases, abiotic stresses and even for food processing qualities. Uniform, high-input agriculture can correct problems better than low-input systems, so demands for robust and resilient crops will actually increase with the trends that the Green Deal represents.

The fear of massively increased areas managed like we did 100 or 200 years ago is not realistic. Such

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The timeline Frans Timmermans has set might cover more than a political lifetime, but it still means a race against the clock for plant breeders

(photo: Jennifer Jacquemart, EC Audiovisual Service)



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‘ancient’ farming systems cannot be tolerated under the Green Deal, because they will require much more scarce space which we should reserve for wildlife and other uses. The Green Deal has food security and the affordability of food for all as an overarching goal. Small operators clearly have an important role – the Deal wants to support them to meet the high standards of the market.

Breeders thus need to respond to changing and diverse farming systems and to the specific needs of value chains and consumers. Strategic choices will have to be made now by breeders to meet these new realities already by 2030.

We are ready, but...

Breeders and seed producers are ready to live up to the task. We have been central in modernizing agriculture in the past, responding to changing farmers’ needs. We were central in increasing the yield potential of crops, notably over the last 75 years, necessary to feed the continent, while important land areas had to be re-designed for expanding cities and infrastructure. We were central in making a healthy diet available at reasonable prices and we were able to increase diversity among crop varieties in our continuous search for improvement, and a much broader choice of products for consumers, notably in horticulture.

We have the vision, the tools, and the resilient commercial seed systems to continue to do that – also in times of radically changing policy priorities. The main question is whether we can do that in the limited time that policy makers give farmers to change. The 30 years until the climate neutral objective of the

Green Deal are more than a (political) lifetime for a policy maker; the ten years till 2030 (crop protection and sustainability goals) means a race against the clock for breeders and for those who will create alternative crop protection strategies, and the technology and artificial intelligence needed for the new sustainable farming systems - and for the farmers to redesign their operations and acquire the necessary smart equipment. Looking at all these needs, we do indeed wonder whether this timeline is realistic.

...more efficient breeding

Speeding up breeding to respond to the new societal priorities requires availability of both technology and genetic resources by all breeders. There is a (brief and cautious) mention of plant biotechnology in the Farm to Fork strategy, but we should have high expectations of the current debates around the GMO-legislation in relation to gene-editing and other recent breeding methods when the Green Deal enters the debate.

Another essential element is access to genetic resources, which is very poorly described in the Biodiversity Strategy and not at all in F2F. It is essential that Europe acts in international negotiations in accordance with the Green Deal and it will strongly vote against undue limitations to the access to and use of genetic resources, including the associated ‘digital sequence information’! Only with access to diversity can we produce the necessary diversity.

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No Green Deal without the seed sector

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- an early spread of pests and diseases. It is very important that our solutions (to produce and protect quality seeds) are not removed from the market before good alternatives are available; and Europe will have to secure a level playing field, at least within the Union, while taking into account the needs of the rest of the world, with regard to seed health guarantees. It is rational to apply a systems approach in the search for limiting the impact of crop protection on the environment. Where chemicals are the best option, their use in small quantities in seed production and seed treatment should be preferred to large-scale applications in crop production fields.

...innovation policies

The Green Deal mentions a need for innovation. As an innovation-driven sector, we cannot disagree. We play a central role in innovation, but we cannot do that on our own. Investments in fundamental plant research have to fill the innovation pipeline that reaches farmers in the form of seeds. The genetic regulation of complex traits and metabolic pathways, advances in phenotyping and related machine learning, the identification of the physiology of resilience factors, and seed-microbe and root-microbiome interactions require fundamental insights that go beyond the investment capacity of the sector. Many of such research fields are even more essential for making both organic and other farming systems more sustainable. The sector needs both a solid knowledge infrastructure and an effective intellectual property system that supports investment in innovation by a diversity of seedsmen.

The Green Deal

The Green Deal presents a challenging broad future for the EU. Its implementation still raises a lot of questions, but it will undoubtedly redirect relevant policies in the EU and challenge many operators. Also, the crop production sectors will be affected, not just those catering for security, quality and diversity of food, but also floriculture (part of the health objectives) and industries that will increasingly look for plant-based raw materials. Seed is the starting

In short

Frans Timmermans: 'The coronavirus crisis has shown how vulnerable we all are, and how important it is to restore the balance between human activity and nature. At the heart of the Green Deal, the Biodiversity and Farm to Fork strategies point to a new and better balance of nature, food systems and biodiversity; to protect our people's health and well-being, and at the same time to increase the EU's competitiveness and resilience. These strategies are a crucial part of the great transition we are embarking upon.'

In order to achieve these goals, the following measures have to be taken:

- Reduce by 50% the use and risk of chemical pesticides by 2030
- Reduce by 50% the use of more hazardous pesticides by 2030
- Reduce nutrient losses by at least 50%, while ensuring no deterioration in soil fertility
- Reduce fertilizer use by at least 20% by 2030
- Aim for 25% of total farmland to be organically farmed by 2030
- Create a healthy food environment which makes the healthy and sustainable choice the easy choice
- Enforce harmonised front-of-pack nutrition labelling and a sustainable food labelling framework that covers the nutritional, climatic, environmental and social aspects of food products
- Halve per capita food waste at retail and consumer levels by 2030
- The EU will support this with €10 billion through Horizon Europe to be invested in R&I related to food, bioeconomy, natural resources, agriculture, fisheries, aquaculture and environment
- The EU will collaborate with third countries and international players to support a global move towards sustainable food systems

point for all the crops that will have to meet increasingly challenging standards. Breeding combines the diversity of qualities of the plant and its products that are assembled in the seed.

The Green Deal challenges all of us to shape those changes; we challenge the authors of the Green Deal to provide us with the policies and tools to contribute. Mr Timmermans needs to realize that there is no Green Deal without the seed sector.

ECHA challenges Europe's chemists

Monique Krinkels

16 Developing microplastic-free seed treatments is easier said than done. Not only should a film coating glue the plant protection chemicals as effectively as today's polymers, it should also not interfere with the health, shelf life and germination of the seeds. Besides, different crops, as well as different plant protection products, react differently to any coating. A challenging puzzle to solve.

• **There are now 5.25 trillion macro** and micro
• pieces of plastic in the world's oceans and 46,000
• pieces in every square mile of ocean, weighing up
• to 269,000 tonnes. Each year, 8 million tonnes are added to the 'soup', according to the United Nations Environment Programme (UNEP). "Seed companies are only a minor contributor to the microplastic waste," says Rob Pronk, vice chairman of the Seed Applied Technology Commission of the International Seed Federation and marketing manager at Incotec. "The seed industry's share of the total emissions of microplastics that end up in nature is only 1%. By comparison, half of those emissions are caused by the wear of car tyres and a quarter by washing our clothes."

On average, 0.81 kilograms of car tyre rubber per person enter the environment every year. Machine washing and drying clothes is also a major source of microplastics pollution. Five kilograms of synthetic clothing releases an average of nine million microfibers that are carried down the drain with the rinse water. That other sectors are far worse does not mean, however, that seed companies can sit back, since the European Union is planning a ban on the use of all microplastics.

Robust

Seed treatment has evolved tremendously over the years. From simple formulations consisting of colour and a simple binder in the late seventies to the present advanced formulations which focus on handling safety, improved germination, plant protection and growth stimulation. "None of it would be possible without careful selection of the right polymer from a broad range of available polymers chemistries," explains Marta Dobrowolska, research & technology manager at Incotec. "So, the questions really are: Can the new microplastic-free formulation address those challenges as well as its predecessors? Can we expect that a microplastic-free formulation which eventually degrades in the environment will still be robust enough to protect the seed, the farmer, the environment and the factory workers?"

The fossil-based seed coatings can be replaced by, for instance, natural polymers. These are inherently biodegradable and, therefore, should not be considered microplastics. Also, there are polymers

European Union

In 2018, at the request of the European Commission, the European Chemical Agency (ECHA) proposed to ban the deliberate addition of microplastics to cosmetics, detergents, paints and agricultural and industrial products. Microplastics are solid particles up to 5mm in diameter, composed of mixtures of polymers (the primary components of plastics) and functional additives. These microplastics find their way into the environment and pose a risk to the environment and human health. The Committee for Socio-Economic Analysis (SEAC) is evaluating the socio-economic impact of possible legislative actions. It is expected that between 2027 and 2030, the use of polymers in (amongst others) seed coatings will be banned by the EU. The rest of the world will probably follow suit, as the United Nations Environment Programme (UNEP) is investigating the matter.

that are water soluble, will remain soluble after release into the environment and therefore will be unlikely contributors to microplastic concern. Additional data on the release to the environment and biodegradability might be required for the exemption to the future EU rules on the application of microplastics.

Mission Zero

Incotec has committed itself to make the company substantially more sustainable. While seed coating in itself helps reduce the use of crop protection products by up to 90%, the use of polymers causes an environmental problem. Incotec is, therefore, developing alternatives to replace microplastics in coatings. Besides, extending the range of organic products, promoting the application of biologicals and scoping the possibilities for biodegradable coatings form part of Mission Zero.

The endeavour meets with success. Examples are the organic pills for lettuce, chicory and celeriac, as well as a wide range of priming products for spinach, squash, tomato, brassica, carrot, parsley, pepper and *Solanum torvum*. Last year a number of X-ray based organic upgrading products for tomatoes and peppers were added. The latest is the introduction of two microplastic-free film coatings for sunflower, Disco



Rob Pronk and Marta Dobrowolska: 'If it had been easy, it would not have taken us one and a half years to introduce the two first microplastic-free film coatings'

Blue L-1501 and Disco Purple L-1601. Microplastic-free film coatings for maize and vegetable seeds are expected shortly.

Right combinations

Even though many seed treatment producers started research programmes to find good alternatives, many of them have been proven to not work as well as existing solutions, thus jeopardising seed quality. It takes a long time to find the right combination, ensures Rob Pronk. "We want to eliminate hazardous agents from the ecosystems, but that needs research. If it had been easy, it would not have taken us one and a half years to introduce the two first microplastic-free film coatings. And we use at least a hundred different film coating worldwide, so that will keep our chemists busy for the years to come. But we will be ready well before 2027," he predicts.

"The current solutions in seed treatment may contain difficult to degrade polymers, which are water dispersible but not soluble. They have been designed as film-formers that ensure good adhesion of all components onto the seeds which also need to allow the optimal movement of water in the seed coating and must be non-hazardous for the seed as well as for the growing plant. This delicate balance needs to be translated into the new solutions and as they need to

be much more biodegradable or soluble than current ones, we must ensure that this will not create new problems with on-shelf stability for both formulations and coated seeds or ease of application. Finding the best solution will be demanding but not impossible," adds Marta Dobrowolska.

Finding alternatives

The first new products which Incotec will commercialise, according to the recently published ECHA guidelines, are for sunflower seeds. Potentially, they could be used for some other crops, but that still needs to be validated. "The next field crop product we are targeting is maize. But also for various vegetables, we're making good progress, and we should be able to provide high-quality solutions in 2021. Time will tell if a single solution will be able to satisfy various seed types, seed treatment equipment and plant protection products," says Rob Pronk.

"Microplastic-free is not only a trend, it's here to stay and we can be certain that we will see the seed industry move towards microplastic-free film coatings, pellets and encrustment technologies. Regulatory restraints might be the catalyst for the move but now, more than ever, we should make sure that we take the right decisions for the future of our planet," concludes Marta Dobrowolska.

Genebanks face complex ABS regulations

Martin Brink and Theo van Hintum

18 From the early nineties onwards, international agreements have been concluded to protect biodiversity and regulate Access and Benefit Sharing. However, within the rules of these international agreements, countries can follow their own interpretations and establish their own rules and regulations. As a result, genebanks are facing increasing difficulties in adding material to their collections. To prevent a further decrease in access to plant genetic resources, complexity must be fought.

Genebanks play a key role in conserving plant genetic resources (PGR). By conserving plant collections, carrying out collecting missions and exchanging material with other genebanks, genebanks are a source of valuable plant characteristics. As plant genetic resources are indispensable to address climate change and other challenges to food production and food security, the restricted access to plant material is a dangerous development. Given climate change and the resulting genetic erosion that can be expected to occur, collecting and subsequent conservation in genebanks is essential for limiting losses of valuable PGR.

Obtaining PGR

The Convention on Biological Diversity (CBD) and the Nagoya Protocol recognize that countries have sovereign rights over their genetic resources and provide a framework for domestic legislations on Access and Benefit-Sharing (ABS). However, within the rules of these international agreements, countries can follow their own interpretations and establish their own rules and regulations. This has resulted in restricted access to genetic resources and limited benefit-sharing, effects that are contrary to the objectives of these agreements.

Centre for Genetic Resources the Netherlands

The CGN genebank for plant genetic resources consists of over 23,000 accessions of some 30 different crops. The regular collection includes commercial varieties, landraces, farmer varieties and crop-related wild species from over 100 countries. With over 2,500 different accessions, it has the world's largest and best documented lettuce collection.

In addition to its regular genebank collection, CGN also offers seed samples from 'special collections' that have been developed for specific purposes targeting specific user groups, such as a collection of 73 re-sequenced tomato lines and a collection of 470 single seed descent (SSD) lines of lettuce.

Besides managing the genebank of agricultural and horticultural crops, CGN is involved in many other genetic resources related activities. These include the management of the Dutch animal genebank, support to the forestry genebank, support to Dutch NGO's, international collaboration, various research activities, and policy advice and development. CGN is largely funded by the Dutch government.

Consequently, plant genebanks face increasing complexity in their operation as adding material to genebank collections has become more difficult. Collecting missions, for instance, need to be negotiated with national and local authorities. To complicate matters, the procedures and responsibilities within provider countries are often unclear and efforts to gain more clarity are often unsuccessful. Acquiring material from other collections has also become more complex. It is only possible if the origin of the material is properly documented and is done in compliance with ABS regulations.

Sharing characteristics

In the past, it was fairly easy for a breeder to acquire material from a genebank to improve his own varieties. That is no longer the case. Today, genebanks may only provide access to their own collections if the material that is to be released is distributed in compliance with the conditions under which the material was received and the national laws of the country where the genebank is located. For instance, if a genebank acquires material under the condition that it can only be used for non-commercial purposes, the genebank cannot make this material available for commercial breeding.

The only way genebanks can deal with the increased complexity is by setting up procedures to properly document the origin of every accession and the conditions for its use and further distribution. This information needs to be made available to potential users. Genebanks will also need to use and store Material Transfer Agreements (MTAs) when material is distributed from the genebank to users. As a result, the volume of paperwork required in the material distribution process has increased significantly.

FAO

While the CBD was primarily focused on wild species, it was recognized at an early stage that it would also affect the exchange of plant genetic resources for food and agriculture. Therefore, FAO

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This article is a summary of: Genebank operations in the arena of Access and Benefit-Sharing policies, published in Frontiers in Plant Science 10 (2020).

Uzbekistan is since ancient times famous for its melons. In 2017 CGN undertook a collection mission to that country



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developed the International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA). The objectives of the ITPGRFA are very similar to those of the CBD, but focus on Plant Genetic Resources for Food and Agriculture (PGRFA): the conservation and sustainable use of PGRFA and the sharing of the benefits arising from their use. PGRFA are defined as: 'any genetic material of plant origin of actual or potential value for food and agriculture'. The ITPGRFA confirms the sovereign rights of countries over their genetic resources, but aims to facilitate the exchange of PGRFA by the establishment of a Multilateral System of Access and Benefit-Sharing (MLS), in which PGRFA are exchanged under a Standard Material Transfer Agreement (SMTA), instead of under the prior informed consent and mutually agreed terms prescribed by the CBD. The MLS is a global pool of PGRFA, meant to facilitate access to these PGRFA, as well as to achieve fair and equitable sharing of the benefits arising from their utilization.

Research

As the large majority of the users of material from genebanks are involved in research, breeding and training for food and agriculture, genebanks can often make use of the MLS of the ITPGRFA, which facilitates the access to material. This facilitated access involves the use of a standardized contract (SMTA) and procedures, instead of the bilateral, case-by-case contracts and procedures arising from the CBD and Nagoya Protocol. Furthermore, the SMTA can also be used for non-MLS material.

The European Cooperative Programme for Plant Genetic Resources (ECPGR) stated in 2016 that "It is recommended that all ECPGR member countries, as

appropriate and in line with national legislation, use the SMTA for distribution of both Annex I and non-Annex I ECPGR accessions independently of whether material is conserved in ex situ collections or held in situ." Annex I comprises of 35 food crops and 29 forages, selected because of their importance to food security and interdependence. Various countries have already declared that PGR under their management and control and in the public domain are made available by them under the SMTA, irrespective of whether these PGR are of a species contained in Annex I of the ECPGR.

In the EU, the ABS Regulation that implements the compliance aspects of the Nagoya Protocol applies to the utilization of genetic resources and not to their possession. The Guidance published by the EU explicitly states that activities such as the management of a collection for conservation purposes are not considered to be utilization. However, genebanks typically aim to make genetic resources available for utilization in breeding and other research and development activities. Therefore, it is good practice for genebanks to support users through seeking, keeping and transferring all relevant information, including access permits and contracts.

Dutch example

The Centre for Genetic Resources, the Netherlands (CGN), managing the Dutch national plant genebank, may serve as a specific example of how genebanks cope with increased regulation of access to PGR. CGN operates on two principles: follow the rules and be transparent. The aim is that the origin of all PGR in the CGN collection and the legal basis of their acquisition is traceable. CGN distinguishes three



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Accessions are carefully selected and described, optimally conserved and evaluated for their usable properties in close cooperation with breeders and partner genebanks



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categories of PGR germplasm in relation to its legal status:

1. Genetic resources of crops listed in Annex I of the ITPGRFA and forming part of the MLS. Access to these collections is provided under the SMTA of the ITPGRFA;
2. Genetic resources not listed in Annex I of the ITPGRFA and acquired by CGN before the CBD entered into force. In principle, CGN will provide this germplasm to the user under the SMTA, unless contractual obligations agreed upon during acquisition of the material by CGN require additional conditions;
3. Genetic resources not listed in Annex I of the ITPGRFA and acquired by CGN after the CBD entered into force. These are subject to the national sovereignty of the country of origin. Where possible, CGN provides access to these genetic resources under the SMTA, but where needed, CGN adapts the SMTA to incorporate additional conditions set by the provider country or contractual obligations agreed upon during acquisition of the material by CGN.

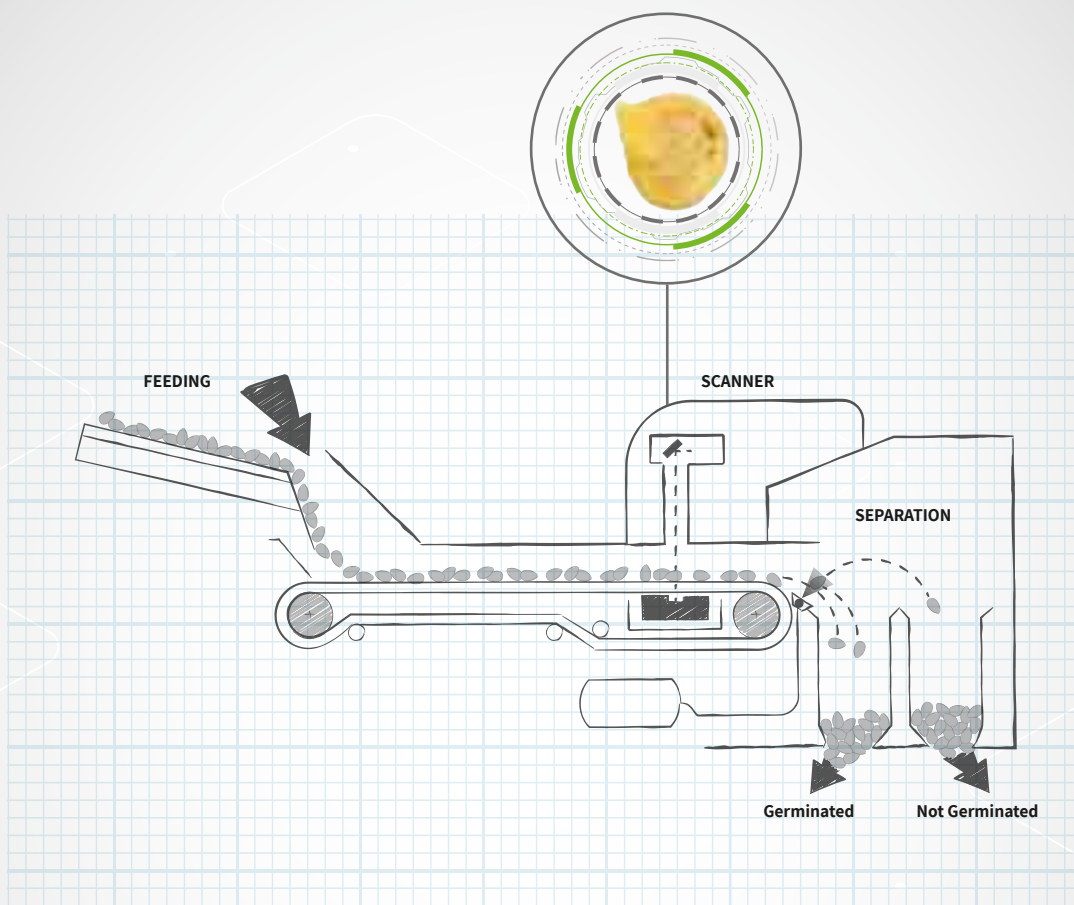
CGN's aim is to be able to make its regular PGR collection available in perpetuity, with all material being fully and freely available under SMTA (where it is to be used for research, breeding, or training for food and agriculture purposes), as the use of the SMTA reduces complexity and the free availability reduces transaction costs. To achieve this, CGN makes all possible efforts to acquire, and only include in its collection, material that can be distributed in this way. This means that collecting missions are undertaken after signing an agreement in which the Competent National Authority of the country where the collecting takes place agrees with the subsequent distribution of

collected material by CGN under the terms and conditions of the SMTA.

The modalities are laid down in a Memorandum of Understanding between CGN and the Competent National Authority of the country of collection. The Memorandum of Understanding may cover a single collection mission or various collection missions over an extended period of time, as CGN strives to establish multiyear collaborations with countries. With respect to the benefit-sharing component of the agreements, CGN aims to include a substantial capacity development component. This may, for instance, include participation of representatives of the provider country in international courses on the conservation and use of PGR or the organization of tailor-made PGR courses in the provider country itself by CGN staff.

Unfortunately, not all countries or institutes from which CGN would like to acquire material are willing to allow incorporation of these PGR in the CGN genebank under the conditions of the SMTA. Some countries, for instance, are not comfortable with the associated multilateral character of monetary benefit-sharing and prefer bilateral sharing of monetary benefits instead. In these cases, the material cannot be acquired under the conditions of the SMTA and will thus not be included in the regular CGN collection. Since the material might still be valuable to some users, the possibility of creating a special collection for that material exists, but this is only done in exceptional cases. These special collections with material that can only be distributed under additional conditions are generally maintained on the principle of cost recovery, and access may need to be negotiated (possibly even with the donor of the material).

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'Never underestimate the pioneering power of small breeders'

Monique Krinkels

Twelve years ago, Prudac's Director, Ard Ammerlaan, decided to become a plant breeder. A complete change of career, as previously he worked as marketer and production manager. His goal: to create appealing, hybrid, compact tomato varieties, with attractive colours and great flavour. Today, his greenhouses are filled with many 'dwarf' varieties of several crops.

No, the word 'dwarf' is not one that Ard Ammerlaan likes to use to describe his varieties. Although their mini sizes are genetically determined, 'compact plants' is what he calls them. And compact they are: tomatoes, sweet and hot peppers in a 12 cm pot, a mini cauliflower with a diameter of only 25 cm, tasty Alliums and peppery Violas that will brighten up any salad.

Broad gene pool

Edible ornamentals, that was the first target that Ard Ammerlaan set himself when he started Prudac. The



Ard Ammerlaan: 'Pot plant growers should not have to prune or trim the plants'

abbreviation stands for Production and Research for Urban Decoration And Consumption. "For a consumer, a tomato plant should be compact, have small leaves and the fruits must be well visible. And it must be a plant that is genetically compact. Pot plant growers should not have to prune or trim the plants," he explains. "Our varieties only need a

plant support stick." To breed a compact tomato, he used a wide range of parental plants. "Most tomato breeders only have a small gene pool to choose from. I decided I would like to have as many tomatoes as I could manage."

In order to obtain varieties and species, he contacted the University of California at Davis, USA. Professor Charles M. Rick (30 April 1915-5 May 2002) collected nearly a thousand cultivated and wild tomato species during expeditions to locations in the Andes and the Galapagos Islands. To honour him, the vegetable crops department of that university named its living genebank of wild relatives, monogenic mutants and miscellaneous genetic stocks of tomato after him. Many primitive varieties and wild species in this largest known collection of tomato seeds in the world are now extinct in their native habitats.



When sliced, the variety 'Heartbreaker' shows its attractive heart-shaped form (photo: Jos Kok)

wide variety of tomato plants, including hanging as well as upright growing branches.

Disappointment

The next step he had to take – having the varieties registered in the EU variety list – proved a setback. "A variety with a turnover of € 500 already requires registration. This can be the death knell for an innovative new crop. In my opinion EU registration is necessary, we have had this system for more than 50 years, but the turnover threshold should be higher, starting from € 500,000." Ard referred to his background in flower breeding where PVP and F1 hybrids are the only methods of protection. "These are excellent alternatives."

Ard Ammerlaan soon expanded his breeding efforts. For consumers, he created small container tomatoes for in the kitchen and larger container tomatoes for hobby-gardeners in the garden. But he also has varieties destined for the professional grower. "For me, breeding is using your senses," he claims. "For breeders in the large seed companies, it is a numbers game." Today, the tomato breeding is left to Nathalie Escalon, as Ard Ammerlaan has shifted his attention towards several other crops.

Since 2014, he has been breeding sweet peppers and, in the meantime, six varieties have been registered. A miniature cauliflower is also one of his favourites. "The small cauliflowers you see in the supermarkets

"The name tomato is derived from the Aztec word for the fruit: tomatl. Especially bush tomatoes have a rich diversity in characteristics. But I also crossed with high-wire varieties. It took us nearly two years to create the first three hybrids that met our expectations. They had the model, flavour, colour and resistances I was aiming for."

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For the last five years Nathalie Escalon is responsible for the tomato breeding programme

are the leftovers after harvesting. Ours are really compact.”

As a true marketer, he developed two concepts: the ‘cauliflower for starters’, meant for the amateur gardeners, that can be harvested between 60 and 160 days after planting, fitting with a varying diet. The cauliflower concept for professional growers is characterized by its low water use. “Our cauliflower varieties have short, blue-green leaves. This reduces evaporation and gives our varieties the smallest water footprint in the industry. This is ideal for professional growers with limited water regulation or an eco-focus.”

Vertical farming

To supply the growing populations in cities with fresh vegetables, vertical farming seems to be the future. Land and water use decline enormously, and pesticides and shipping across large distances are a thing of the past. Researchers all over the world are looking at how vertical farming can be more energy efficient, and the vegetables even more nutritious and tastier.

The compact varieties were originally meant for consumers, but the latest developments in growing techniques have widened the scope for Prudac. The varieties react well to LED lighting and the size makes them ideal for vertical farming. Students of the HAS University of Applied Sciences tested Prudac tomato varieties under LED-light. Especially the ‘Ponchi Re’ F1 variety, with its height of only 25 cm, a high

disease tolerance and high chlorophyll levels, showed promising results. 25

Rocket science

The varieties of Prudac can be found all over the world. Besides the European countries, distributors sell his seeds in North America, Africa and Asia. The increasing sales in the USA led to an unexpected turn of events. The compact form came to the attention of the National Aeronautics and Space Administration (NASA), responsible for the civilian space programme, as well as aeronautics and space research. Fresh fruits and vegetables have been in demand by astronauts since the early Shuttle days. Several crops were first flown on the Challenger in April 1983. Today, for instance, tomatoes are sent with each Progress shipment to the International Space Station (ISS). ISS crew members report that the fresh fruits



In the future, Prudac’s cauliflower variety ‘Baby’ might be grown on the moon or even on Mars (photo: Elke Über, Prudac)

and vegetables from Shuttle and Progress add variety to their diet and increase crew morale. Since distant space travel and a semi-permanent stay on the moon, and eventually on Mars, are no longer science fiction, NASA wants to prepare itself. After all, future astronauts will need to have fresh food and, so far, the on-orbit shelf life in the International Space Station is two to three days for most fresh fruit and vegetable items, because there is no refrigeration. The compact peppers and cauliflowers of Prudac

seem a perfect solution to the NASA research team. Last month, the seeds were sent off to ISS to look at the influence of space radiation on quality. Why only cauliflowers and peppers? “Unfortunately, tomato plants are unsuitable for growing in a spaceship, as the pollens clog the air filters of the ventilation system, NASA informed us.” Maybe that can be solved in future by breeding male sterile tomato plants.

A land of honey, cotton, wine and potatoes

John van Ruiten

26 **Agriculture and Malta. What kind of combination is that? Malta, whose name is said to have been derived from Melite, Greek for honey, is not particularly known as an agricultural country. And that is right of course. But still, the island has a long history, in which some agricultural commodities have played an important economic and cultural role. A brief introduction to the agricultural heritage of this smallest EU member state.**

• **The tiny island Malta** (only 316 km², half a million inhabitants) in the Mediterranean Sea, just 100 km south of the Italian (Sicilian) coast, has always been in a strategic spot. Archaeological examinations have proven that the island has been inhabited since 5,000 BC. In the 7,000 years since, it has been under the influence, or under the reign or under the occupation of quite a number of empires, kingdoms or countries. Because of these influences, one might say that Malta is an interesting mix of British, Italian, Spanish, Arab and Greek character. Take its language: traditional Maltese is a so-called Sicilian Arabic language, and nowadays it is the only actively spoken survivor and descendent of this language group. It is very different from the Italian and Sicilian languages! Many words with an English history have also been integrated.

Bee-keeping

In Phoenician times (800-200 BC), the island became an important harbour. And it was probably in this period that honey production and beekeeping already became an important activity. The Phoenicians introduced new bee-keeping techniques, storage jars and apiaries, many of them carved out in rocks (mighba's). Some of these apiaries have been used for thousands of years. One of them, originating from Roman times, is the one in Xemxija, which can still be visited. Also, quite remarkable is that a specific sub-species of the regular honeybee, *Apis mellifera ruttneri*, was endemic to Malta only, not occurring elsewhere.

Combined with the abundant available specific (wild) flowers growing on the island (thistles, sulla,

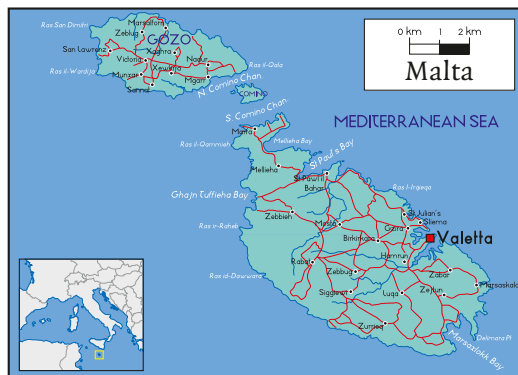
borage, dandelion, mustard, thyme, citrus), a very good quality honey was produced. It became a major trading item too, which remained so throughout the centuries. It is very sad that after the new occurrence of the Varroa mite also on Malta in the beginning of the 1990's and the introduction of new breeds/queens of honeybee, the populations of the original Maltese bee were decimated. That honey has always been important and can still be seen in the annual day of Saint Anna, where it plays a central role, when a spring honey event is organized.

Wines

Like in most countries around the Mediterranean Sea, wine production belongs to the old culture of Malta. Probably also introduced in Greek/Phoenician times, there are some nice things to note about traditional winegrowing and making. On around 800 hectares, mainly relatively small terraces, grapevines are still produced and some renowned wine houses bottle and market some very specific wines.

About half of the acreage nowadays is planted with well-known varieties like Merlot, Chardonnay, Syrah and Cabernet Sauvignon, but the other half with varieties that are very specific to the island. These varieties are only grown there and nowhere else. But even more remarkable: the origin of these local varieties has until now not been exactly clear. DNA evaluation has shown that these Maltese varieties form a specific group, not directly related to any other (commercially) grown variety. It is said that there used to be almost 40 local selections/varieties on the island. Research is ongoing to unravel the background and history of these grape varieties, like Girgentina (for white wine) and Gellewza (for red wine). There is new interest to grow these varieties for the unique flavour they have.

Wine production was huge during Roman times, but in the Muslim/Arab era (800-1100 AD), grapes were used less for wine production, but were eaten as fresh table grapes, for which they can also be used (dual purpose grapes). Wine production and trade flourished, particularly during the reign of the British Knights of St John Order in the 16-18th centuries. After that period, wine production decreased and was replaced by cotton in around 1900, due to heavy Phylloxera infestations.



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Malta has only one agricultural export commodity: spring potatoes

The Arab period of Malta has been important for the cultivation of another (surprising) crop that has been on the island for a very long time: cotton. It was introduced around 900 AD, and, supported by an already long tradition of weaving and cloth making on the island, cotton became an important commodity, both grown and traded. Three types of cotton were cultivated: *Gossypium religiosum* (red cotton), *G. hirsutum* (white cotton) and *G. herbaceum* (Levant wild cotton, a perennial bush). The production and trade of cotton was successful and economically very important for Malta. It flourished at the end of the 15th/beginning 16th century, leading to a considerable source of income for the country until 1813. That was a dramatic year for this industry. There were three reasons for the quite sudden disappearance of the cotton industry:

- there was more and more international large-scale production in countries like India, Syria, Egypt and all that material was available relatively cheaply on European markets;
- the Maltese government ended the legislation that, for a very long time, protected and promoted the use of local Maltese cotton as a source for textiles; and
- the occurrence of a bubonic plague around Europe had dramatic consequences for Malta: quarantine procedures for many years (until 1826; hardly any

ship could enter harbours) caused an absolute breakdown of any trade.

After that period, the commercial cultivation of cotton never returned to the island.

Small-scale

Agriculture on Malta in the 21st century is a small-scale activity. It supplies approximately 20% of the local demand for food. The island is, therefore, in fact completely dependent on imports for feeding people. Fisheries are still very important. Less than 2% of the population has a job in food and agri.

On around 11,000 hectares, crops are produced by more than 10,000 owners. Only 500 of these owners have an area bigger than 5 hectares. Most production is local household production, mainly vegetables (cauliflowers, tomatoes, melons and grapes). Commercial vegetable production adds up to a total value of €30 million.

Currently, there is only one export commodity (and its importance is diminishing): spring potatoes (the variety most grown is Alfa), of which around 5,000 tons were sold every year to the Netherlands, but the quantity is going down. Growing potatoes is a hard task, it is risky and many farmers feel that, in comparison to growing other crops or to sale of the land, it is not worth the effort anymore.



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DNA evaluation has shown that Maltese grape varieties form a specific group, not directly related to any other (commercially) grown variety

That has also ended a 30-year long tradition, in which every year in the last week of March, the minister of Agriculture of the Netherlands received a bag of new Malta's, starting the season of the sale of fresh potatoes.

Vegetables (melons, artichoke, tomatoes) are produced on irrigated (small) fields. Rainfall on Malta comes in the period from October to February, on average 500mm a year. During summer, hardly any rain falls. The effects of a changing weather pattern over the last years has caused even more droughts.

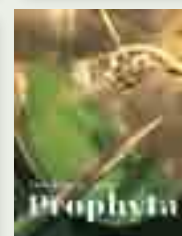
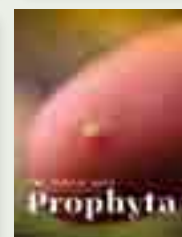
New era

As a consequence of entry to the EU in 2004, the protective measures for growing and marketing local island grown products have disappeared. The local agriculture and horticulture simply cannot compete in any way with produce from elsewhere. The price of agricultural land for example is around €250,000-300,000 per hectare! Many owners sell their property or keep it as an insurance for the future.

The average farmer in Malta is almost 60 years old. Their children do not have any interest in following in the footsteps of their parents. They prefer work in other sectors such as tourism, industry or finance. Many of them also leave the island to work 'on the continent'.

Nowadays, the prospect for commercial agriculture in Malta is regarded as very difficult and there are not many people hopeful for the future position. A slow death of commercial agriculture will probably take place, and only gardening as a private household activity will survive as a reminder of a long history in which agriculture has played an important role.

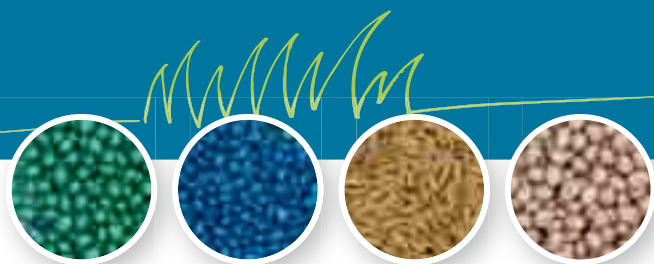
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Weed genomes unveil weaknesses and strengths

Monique Krinkels

Usually, KeyGene is involved in genome mapping of agricultural and vegetable species and often the aim is to disclose genes that are responsible for the valuable resistances breeders can use. But the opposite is also possible: mapping the genome of weeds that threaten harvests, in order to discover their weak spots.

- **Representing some of the most troublesome**
- agricultural weeds, waterhemp, smooth pigweed, and
- Palmer amaranth impact crop production systems
- across the USA and elsewhere, with ripple effects felt by economies worldwide. In a landmark study, scientists have published the most comprehensive genome information to date for all three species, marking a new era of scientific discovery towards potential solutions.

Detoxifying herbicides

The genomes for all three species could start to chip away at the problem of herbicide resistance in these weeds. More and more, scientists are uncovering evidence of non-target-site or metabolic resistance in waterhemp and Palmer amaranth, allowing the weeds to detoxify herbicides before they can cause damage. Unfortunately, it is usually very difficult to determine which specific enzyme, among hundreds, is responsible for detoxifying the chemical herbicide. With the help of the genome map, researchers will essentially be able to sort through a list to find – and possibly knock out – the culprit, with the hope of either knocking out the enzyme responsible or modifying the herbicide molecule to evade detoxification. The start of the project was the result of a lucky coincidence. Teams at the University of Illinois, BASF SE and the Max Planck Society learned about their joint interest following a conference in September 2019. They decided to cooperate to get more out of the entirety of genomic data. “These genome assemblies will greatly foster further research on these difficult weed species, including better understanding of the ways in which they evade damage from herbicides,” says Pat Tranel, professor and associate head of the Department of Crop Sciences at the University of Illinois and co-author on the Genome Biology and Evolution study.

Palmer amaranth

BASF lead scientist, Jens Lerchl, responsible for the early biology research on herbicides, coordinated the Palmer amaranth genome project with KeyGene. “We want to better understand the amaranth biochemical modes of action in order to offer farmers new products and solutions for optimal control of key weeds. In addition to this publication, BASF is also



Amaranthus tuberculatus (waterhemp), *Amaranthus hybridus* (pigweed) and *Amaranthus palmeri* (Palmer amaranth)

a founding member of the International Weed Genomics Consortium (<https://www.weedgenomics.org/>) led by the Colorado State University, aiming at the sequencing and analysis of ten further high priority key weeds,” Lerchl says.

Draft genomes have already been published for waterhemp and Palmer amaranth, but techniques used in the Genome Biology and Evolution study provide a much more comprehensive ordering of the species’ gene sequences, a requisite for many genomic studies. All three genomes were assembled using advanced long-read sequencing, which maintains the integrity and continuity of the genome. Additional sequencing strategies were also used to order the long-read DNA fragments. In Palmer amaranth, chromatin conformation capture sequencing was utilized to further order pieces of the genome that were assembled using the long-read information alone.

Can plants keep up with changing climate?

Rob van Treuren, Roel Hoekstra, Ron Wehrens and Theo van Hintum

32 Plants have to cope with a fast-changing climate. Plant breeders are being challenged to produce varieties that are adapted to these new circumstances. But will the crop wild relatives, important as genetic sources for breeders, be able to adjust to these conditions and survive? Will they be able to adapt locally, or will the plants migrate to habitats better suited to their natural needs?

• **The gene pools of many cultivated crops**
• harbour wild species that, to a greater or lesser extent,
• can be crosses with crop species. These so-called
• crop wild relatives (CWR) are recognized as important genetic resources for crop breeding purposes. Especially for crops that are suffering from a lack of resistance against biotic and abiotic stresses, CWR have proved to be rich resources of useful traits. The CWR are however poorly represented in genebank collections. At the same time, their natural ecosystems, and thus their survival in situ, are – as with so many species – being threatened.

Economically important

An earlier research identified 214 wild relatives of economically important agricultural and horticultural crops in the Netherlands, of which 53 are listed on the Dutch Red List of plant species. The Dutch Red Lists may be regarded as a national application of the IUCN Red List (IUCN 2008), but follows its own protocol. As species continue to decline and become increasingly rare, they are categorized as ‘Near Threatened’, ‘Vulnerable’, ‘Endangered’, ‘Critically Endangered’ or ‘Extinct’. For these 53 plant species, the effects of climate change were predicted in 2017 by means of ecological niche modelling.

The new research describes the expected effects of climate change on the distribution in the Netherlands for the entire group of 214 CWR, which consists mainly of grasses, legumes, crucifers and amaranths. Researchers at the Centre for Genetic Resources, the Netherlands (CGN) and Biometris of Wageningen Plant Research examined whether climate change effects can be predicted, also for species with current conservation status ‘Least Concern’. In addition, the researchers studied whether species occurring in habitats with specific ecological conditions are more prone to the effects of climate change than others.

Variation

Considerable variation in the predicted effects of climate change on the occurrence of CWR in the Netherlands was observed among the study species, ranging from (near-)extinction to more than doubling of the distribution area. For example, *Vaccinium vitis-idaea* L. (cowberry) showed a predicted loss of 97% distribution area under the optimistic climate



Daucus carota is a crop wild relative of carrot

Climate scenarios

The Representative Concentration Pathways (RCP) describe different climate futures, all of which are considered possible, depending on the volume of greenhouse gases emitted in the years to come. These scenarios vary from RCP1.9 (global warming is limited to below 1.5 °C, the aspirational goal of the Paris Agreement) to RCP 8.5 (the worst case climate change scenario).

Mean and likely range in temperature increase (°C)

	2046-2065	2081-2100
RCP2.6	1.0 (0.4-1.6)	1.0 (0.3 to 1.7)
RCP4.5	1.4 (0.9 to 2.0)	1.8 (1.1 to 2.6)
RCP6	1.3 (0.8 to 1.8)	2.2 (1.4 to 3.1)
RCP8.5	2.0 (1.4 to 2.6)	3.7 (2.6 to 4.8)

Source: Intergovernmental Panel on Climate Change, IPCC

Dr. R. van Treuren, ir. R. Hoekstra, dr. H.R.M.J. Wehrens and dr.ir. T.J.L van Hintum, Centre for Genetic Resources, the Netherlands (CGN) and Biometris, Wageningen Plant Research, the Netherlands, robbert.vantreuren@wur.nl

This article is based on: Effects of climate change on the distribution of crop wild relatives in the Netherlands in relation to conservation status and ecotope variation, published in *Global Ecology and Conservation* 23 (2020).

Alarm

The tell-tale physical signs of climate change have already alarmed many. The last three decades were the warmest in 1400 years. This year, as well as 2019, saw numerous major record-breaking heatwaves. The European Union warns that in most of Europe, less precipitation in summer and rising temperatures will lead to more frequent and intense summer droughts. The Mediterranean region is already experiencing these effects, and is expected to suffer from more extreme droughts in the coming decades, together with other regions, such as central Europe. Heavy rainstorms are likely to become more common and more intense due to warmer temperatures. Flash floods and pluvial floods, triggered by local intense precipitation events, will become more frequent throughout Europe. That does not mean, however, that the water supply will be sufficient. With fresh water originating mostly in mountain areas (e.g. 40% of Europe's water comes from the Alps), changes in the snow and glacier dynamics and in precipitation patterns may lead to water shortages across Europe.



Predicted changes in the European distribution area of *Valerianella rimosa* (broad-fruited cornsalad) in 2070 according to two climate change scenarios.

- change scenario RCP2.6, while the species is not
 - expected to persist anywhere in the Netherlands under the pessimistic scenario RCP8.5. Highly positive
 - effects of climate change were most prominent for *Petroselinum segetum* (L.) Koch (corn parsley) and *Lepidium graminifolium* L. (tall pepperwort) which are expected to expand their Dutch distribution area more than twofold for both climate change scenarios considered.
- Out of the 214 examined CWR, a reduction in the Dutch distribution area is expected for 51 species (24%) under RCP2.6 and for 119 (56%) under RCP8.5. For the entire study sample, the average predicted percentage range decline in the Netherlands was 5% under RCP2.6 and 20% under RCP8.5. Regarding the reduced CWR, 35 out of 51 (RCP2.6) and 85 out of 119 (RCP8.5) species are currently considered of least concern in the Netherlands, according to the IUCN classification system, indicating that also common species are at risk of losing distribution area due to climate change.

Endangered species

Particularly disconcerting was the finding that climate change is expected to have a relatively large effect on CWR that are already critically endangered in the Netherlands, since for this group of species 19% (RCP2.6) and 46% (RCP8.5) loss of the Dutch distribution area was predicted. Predicted effects of climate change on species occurrence in the Netherlands were not distributed evenly among plant families. Some families, albeit represented by only a single or a few species, were found to be affected by neither of the considered climate change scenarios, such as observed for the Aquifoliaceae, Betulaceae, Cannabaceae, Fagaceae and Papaveraceae. For the other families, climate change was expected to have more severe effects under RCP8.5 as compared to RCP2.6, although the increase in severity could be rather small, such as observed for the Valerianaceae. The change in effect was found to be relatively large for several families, such as that seen for the Grossulariaceae which showed a reduction in their Dutch distribution area of 3% under RCP2.6 but a 58% loss under RCP8.5. Relatively strong effects from both considered climate change scenarios were observed for the Amaranthaceae, Rosaceae and, in particular,

Table

Percentage change in the Dutch distribution area predicted for the year 2070, according to climate change scenario RCP2.6 and RCP8.5 for taxa with current IUCN conservation status 'least concern' in the Netherlands. Only taxa with more than 10% reduction under the optimistic RCP2.6 are presented.

Taxon	RCP2.6	RCP8.5
<i>Vaccinium vitis-idaea</i> L.	-96.9	-100.0
<i>Vaccinium oxycoccos</i> L.	-90.8	-100.0
<i>Barbarea stricta</i> Andr.	-86.5	-98.5
<i>Atriplex glabriuscula</i> Edmondston	-84.6	-94.3
<i>Atriplex littoralis</i> L.	-84.2	-97.0
<i>Leymus arenarius</i> (L.) Hochst.	-83.3	-95.2
<i>Lupinus polyphyllus</i> Lindl.	-82.5	-100.0
<i>Elytrigia juncea</i> subsp. boreo-atlantica (Simonet & Guin.) Hyl.	-56.3	-63.2
<i>Festuca arenaria</i> Osbeck	-50.0	-56.5
<i>Comarum palustre</i> L.	-37.3	-98.1
<i>Vaccinium macrocarpon</i> Aiton	-33.3	-84.6
<i>Allium scorodoprasum</i> L.	-20.3	-85.8
<i>Agrostis vinealis</i> Schreb.	-12.4	-99.7

the Ericaceae. The investigated Ericaceae included five species of the genus *Vaccinium*, showing more than 90% reduction in distribution area under RCP8.5. In general, species with a predicted change in distributional range due to climate change showed a geographical shift to more northern locations in the Netherlands.

Effects of climate change

To predict the effects of climate change on species distribution, ecological niche modelling or species distribution modelling is a commonly used approach. These models use meteorological and soil-related data at the collecting sites of plant specimens to predict species distributions under various scenarios of climate change. Rather than predicting whether or not a species will occur at a location, niche modelling actually predicts whether or not the conditions, in terms of the parameters included in the model, for a species are sufficiently favourable at that location. However, population biological parameters, such as

Botanical name	Common name	Related crop
<i>Vaccinium vitis-idaea</i> L.	Cowberry	Cranberry
<i>Vaccinium oxycoccus</i> L.	Small cranberry	Cranberry
<i>Barbarea stricta</i> Andr.	Small-flowered winter cress	American cress
<i>Atriplex glabriuscula</i> Edmondston	Smooth orache	Orache
<i>Atriplex littoralis</i> L.	Grass-leaved orache	Orache
<i>Leymus arenarius</i> (L.) Hochst.	Lyme grass	Wheat
<i>Lupinus polyphyllus</i> Lindl.	Garden lupin	Lupin
<i>Elytrigia juncea</i> subsp. boreoatlantica (Simonet & Guin.) Hyl.	Sand couch	Wheat
<i>Festuca arenaria</i> Osbeck	Rush-leaf fescue	Fescue
<i>Comarum palustre</i> L.	Marsh cinquefoil	Strawberry
<i>Vaccinium macrocarpon</i> Aiton	Large cranberry	Cranberry
<i>Allium scorodoprasum</i> L.	Sand leek	Onion, leek, garlic
<i>Agrostis vinealis</i> Schreb.	Brown bent	Bentgrass



Pastinaca sativa subsp. *sativa* is a crop wild relative of parsnip

level of phenotypic plasticity, competitive ability and dispersal capacity, can also be expected to contribute to the potential of establishment of a species at a location. Such variables are lacking from most niche modelling studies.

In a previous modelling study, it was shown that the prospects for continuance of species such as *Carum verticillatum* (whorled caraway) and *Valerianella rimosa* (broad-fruited cornsalad), under climate change in the Netherlands, depend on their ability to disperse. Even if species are able to migrate, the question is whether they can move to suitable habitats fast enough under the changing conditions and whether they can establish at the new location in the presence of competition with other species. Niche modelling results will also depend on how well the various niches of the distribution range of a species are covered by the collected samples. Insufficient coverage of the niches of a species may underestimate its resilience under changed climate conditions.

Migration

To assess the niches where species might occur, information from the Global Biodiversity Information Facility (GBIF) was used. In the present study, a relatively high number of 2,492 GBIF records on average per species from the entire European region were used in order to maximize the probability that the different niches of a species were included in the modelling.

Our niche modelling study on 214 CWR predicted a

reduction in the Dutch distribution area for 51 species under climate change scenario RCP2.6 and for 119 species under RCP8.5 by the year 2070. Reduced distribution areas generally shifted in a northward direction under both scenarios, the magnitude of the changes being larger under RCP8.5. Also, at the European level, shifts in distribution in northward direction were predicted in a previous study on 8 CWR. As most of the studied CWR grow in temperate climates, these predicted geographical shifts in distribution most likely represent a response to an increased temperature and decreased precipitation which are expected under climate change in the Netherlands. Analysis of botanical biodiversity using nationwide databases has shown a marked increase in the number of thermophilic species in the Netherlands, coinciding with a marked increase in ambient temperature in the country.

Thus, climate change can be expected to lead to the introduction of non-native species in the Netherlands, as well as the migration of Dutch native species from neighbouring countries in the South to niches in the Netherlands which are no longer suitable for locally adapted populations. The latter may apply to many of the examined CWR that showed stability, or even an increase, in their distribution area in the Netherlands. However, maintenance of distribution area through dispersal from neighbouring countries in the South will be problematic for species that are adapted to more temperate conditions.

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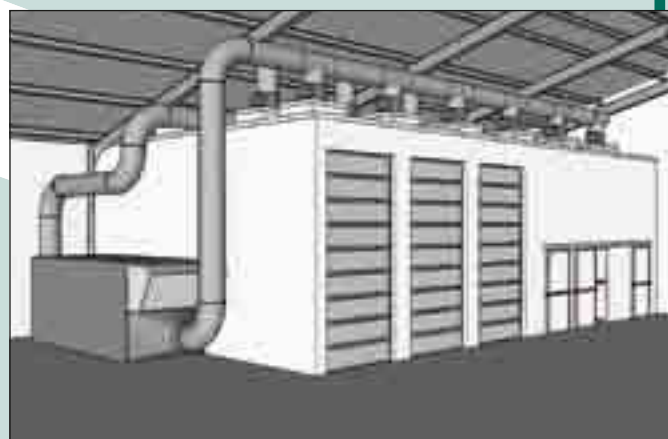
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