CROP TRUST MAGAZINE

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CONTENTS

4 Editorial: Tip of the iceberg, by Marie Haga, of the Crop Trust

Svalbard Global Seed Vault

6 Mythbusting

8 The Seed Vault in numbers

9 Fascinating facts

10 A Three-way partnership

12 A Day in the life: Q&A with Åsmund Asdal of NordGen

16 Turning ten: Celebrating a decade of the Seed Vault

20 Crop Trust timeline

22 The Crop Trust: A Prehistory

24 The big picture

26 Back from the brink: The Bermuda bean

30 Genebanks: An investment in the future of food

34 The CGIAR Genebank Platform

38 Safeguarding rice: Nothing less than forever

40 A Haven of diversity: the genebank of the Centre for Pacific Crops and Trees

46 The Plant Treaty: Q&A with Luigi Guarino, of the Crop Trust

50 Cryopreservation and the future of crop conservation

Food Forever

52 Food Forever: Biodiversity for resilience

54 The Food Forever Experience

58 Food: The world's most successful immigration story?

60 The Crop Trust endowment fund

62 Ensuring the world continues to wake up to Coffee

66 Compete to Conserve: Catan and the Crop Trust

68 Crop Wild Relatives: Q&A with Hannes Dempewolf, of the Crop Trust

74 The Squashes of Autumn

80 Credits

LEFT A genebank worker takes seed samples for storage at the genebank of AfricaRice, in Mbe, Cote d'Ivoire

TIP OF THE ICEBERG

BY STEFAN SCHMITZ
EXECUTIVE DIRECTOR, CROP TRUST

In November 2019, it was my honour to accept the position of Executive Director of the Crop Trust. While new to the role, I am already familiar with much of the Crop Trust's excellent work, not least the Svalbard Global Seed Vault, the iconic structure carved into an Arctic mountain to provide a secure back-up for the world's genebanks.

I recently visited the Vault during its largest seed deposit since it opened in 2008 and was humbled to witness organisations from all over the world depositing seeds of several hundred different species. I was struck by the enormity of the task we have in front of us.

The importance of the Vault as the fail-safe for our planet's future food supply has never been so apparent. Conserving genetic diversity has taken on a new urgency.

The COVID-19 pandemic shows with frightening clarity the vulnerability of humanity. Other developments are slower, more insidious, but they pose equally great challenges in the 21st century and beyond. The climate catastrophe and the alarming loss of biodiversity have brought a new appreciation of the world's most precious resources, and this must include the diversity of crops safeguarded by genebanks around the world.

Crop conservation is global and endless. Farmers and scientists need crop diversity to continue to innovate and future-proof agriculture if we are to feed a growing global population in increasingly unpredictable and severe climatic conditions. And genebanks safeguard the seeds they need to do this essential work. We are proud to be part of this community and movement.

This Crop Trust Magazine will give you a glimpse into the fascinating and critically important world of safeguarding crop diversity, the building blocks of our planet's agriculture.

MYTHBUSTING

THE TRUTH ABOUT THE SVALBARD GLOBAL SEED VAULT

1

It's NOT a "doomsday" vault

The Seed Vault was not established in case of a global catastrophe that requires humanity to restart agriculture. Instead, it serves as backup for genebanks around the world that contain important crop collections. Many of these genebanks face risks including mechanical failures, uncertain funding, civil strife, extreme weather, and even earthquakes. The Svalbard Global Seed Vault stores duplicates of their seeds, just in case.

2

There are NO GMOs in the Seed Vault

Under Norwegian law, it is not permitted to import seeds of genetically modified crops into the country.

3

The Seed Vault DOES NOT store crops forever

While some seeds can last for over 1,000 years in the Seed Vault, others can only survive a few decades. All seeds stored in the Seed Vault need to be taken out intermittently and regrown to ensure they are still viable. Replacement seeds are then sent to the Vault.

4

The Seed Vault is NOT located in an abandoned coalmine

The Seed Vault is actually a purpose-built cavern, with an access tunnel drilled into the side of a mountain.

5

NOT all crops can be stored in the Seed Vault

It can store lots of different crops, but not all. Crops like coffee, tea, avocado, apples, sweetpotato and others are best conserved through methods other than freezing.

THE SEED VAULT IN NUMBERS

US$9 MILLION

The cost of constructing the Seed Vault

-18°C

The temperature inside the seed rooms in the Seed Vault. This is the international standard for long-term seed conservation

OVER 1 MILLION

The number of seed samples that have been deposited in the Seed Vault, making it the world's largest seed collection

500

The average number of seeds in a sample

2.25 BILLION

The total number of individual seeds that can be stored in the Seed Vault

76

The total number of institutions that have deposited seeds in the Seed Vault

FASCINATING FACTS

THE SEED VAULT

- The Svalbard Global Seed Vault was opened in February 2008 by former Norwegian Prime Minister Jens Stoltenberg and the late Dr. Wangari Maathai, the 2004 Nobel Peace Prize recipient.
- The Seed Vault is a secure backup facility for the genebanks of the world. For many genebanks, it's actually the second backup.
- Depositors to the Seed Vault continue to own the samples they deposit and only they can retrieve the material.
- The Seed Portal is a publicly accessible list of all seeds stored in the Svalbard Global Seed Vault www.nordgen.org/sgsv/.
- The artwork at the entrance of the Seed Vault is a light installation by Norwegian artist Dyveke Sanne.

SVALBARD

- In the summer, the sun does not set on Svalbard for four months.
- Svalbard is considered a desert due to its low air humidity.
- The Svalbard archipelago has a population of 2,700 people. There are twice as many polar bears as people.
- The largest island of the Svalbard archipelago - and the one that's home to the Seed Vault - is Spitsbergen, which means "rugged mountains."
- In Svalbard, as much as 60% of the landmass is covered in ice, and less than 10% has any vegetation.
- Svalbard used to be located on the equator, but millions of years of continental drift has resulted in its location 1,000km from the North Pole.

A THREE-WAY PARTNERSHIP

The Svalbard Global Seed Vault is the largest and most secure collection of crop diversity in the world. It was established and funded by Norway as a service to the global community, and is managed and operated under a three-party agreement.

It is owned and administered by the Norwegian Ministry of Agriculture and Food. The Nordic Genetic Resource Center (NordGen) provides technical support, coordinates seed deposits and maintains a public online database of samples stored in the Seed Vault. The Crop Trust provides financial support for the operations of the Seed Vault, as well as funding for the preparation and shipment of seeds from genebanks around the world, especially in developing countries.

A DAY IN THE LIFE

An Interview with Åsmund Asdal, Svalbard Global Seed Vault Coordinator, Nordic Genetic Resource Center (NordGen)

How long have you been involved with the Svalbard Global Seed Vault?

I've been the Svalbard Global Seed Vault Coordinator at NordGen since 2015. However, to some extent I was involved earlier, as part of the Norwegian delegation to the FAO Commission for Genetic Resources for Food and Agriculture, where plans to establish the Seed Vault were launched. I was also involved in preparations for the grand opening of the Seed Vault in February 2008. NordGen itself has been involved since the beginning and is responsible for organizing seed deposits from genebanks and getting the seeds safely into the Seed Vault.

Can you describe a typical day when there are deposits to be made at the Seed Vault?

Normally, the seed boxes arrive some days in advance of the opening day, as we call it. They are securely stored in Longyearbyen – the nearest town to the Seed Vault. On opening day, the seed boxes are brought to Longyearbyen airport for security scanning – in the same way that passenger luggage is scanned. The airport staff kindly help ensure that there is nothing but seeds in the boxes.

At the airport we also check the seed boxes against the list of depositors from whom we're expecting consignments. It's always fascinating to see the different boxes and labels and know that these seeds have traveled from far away – sometimes from the other side of the world.

We never open the boxes and have to take great care with them – the seeds inside remain the property of the depositors at all times, plus they represent thousands of years of agricultural history. Once the seed boxes clear airport security, we load them into a vehicle, and drive the 3km-or-so to the Seed Vault. In winter, this drive is completely dark at almost any time of the day, and the landscape covered in snow. Occasionally I've been lucky enough to see the *aurora borealis*, or Northern Lights. During summer you get to witness more of the stunning landscapes around Longyearbyen, which experiences the "midnight sun" from the end of April until the end of August.

When we arrive at the Seed Vault we are met by representatives from Statsbygg, an agency of the Government of Norway. They are keyholders for the Seed Vault, on behalf of the government, and responsible for the security of the Seed Vault. We load the boxes onto trolleys and take them 120m into the mountain, accompanied all the way by Statsbygg. At the end of the tunnel, before we take the boxes into the seed room, we label them with unique identification numbers.

It's peacefully quiet down there, and while it's minus 18 degrees Celsius, all the heavy lifting tends to keep you warm – for a little while at least! The camaraderie is great and we all feel as though we are doing something important for humanity.

After putting the seed boxes on the shelves, we take photos of them. When we're back in the office, we send these to each depositor, confirming that their boxes are safely inside the Seed Vault. There are between four and six seed deposit occasions a year, usually involving a total of 15–25 depositing institutes.

> "The polar bears provide an unusual element of security!"

Has there been a particularly special moment for you in your work with the Svalbard Global Seed Vault?

Every deposit is a special occasion for me! But there are a few moments that really stand out. In addition to the opening of the Seed Vault in 2008, the celebration of the Seed Vault's tenth anniversary in February 2018 was very special. In particular, it was great to see all the happy faces and representatives from genebanks, many of whom had traveled almost halfway around the globe to be there. A choir of Svalbard coal miners sang at the entrance to mark the occasion, and representatives of the genebanks were invited to carry their boxes through the front door of the Seed Vault.

That day we received seeds from 23 depositors – the largest number at any one time.

Åsmund Asdal inside the Svalbard Global Seed Vault

It was great to see that a decade since it opened, there was continued, strong support for the Seed Vault, and that it was doing what the international community intended it to do.

Another special moment was when the International Center for Agricultural Research in the Dry Areas (ICARDA) made its first withdrawal of seeds from the Seed Vault. This happened in 2015, after ICARDA's genebank in Syria was unable to operate properly due to the civil conflict. Up until then, we'd only taken seeds into the Seed Vault, never out. Wheeling those trolleys of seed boxes out of the Seed Vault was a strange experience, but it proved that the Seed Vault could fulfill one of its most essential functions – to serve as a backup for the world's genebanks in case they ever experience any problems.

If ICARDA hadn't backed up its seeds in Svalbard, they might have been lost forever. Over time ICARDA has been restocking the Seed Vault with the seeds it withdrew, as it builds up the capacity of its new genebank operations in Morocco, and Lebanon.

Svalbard is known for its polar bears. Have you ever seen any?

Yes! But not near the Seed Vault, fortunately. Sometimes we've seen polar bear paw prints near the Seed Vault, probably because they had sensed human activity in the area and came to investigate. While I'd prefer not meet one face-to-face, I've seen them from afar and they are beautiful, majestic animals. The Seed Vault is one of the most secure places on Earth, so I guess the polar bears provide an unusual additional element of security!

TURNING TEN

Celebrating a decade of the Svalbard Global Seed Vault

The Svalbard Global Seed Vault marked its tenth anniversary on 26th February 2018 by receiving shipments of over 70,000 crop varieties. These deposits took the total number of unique crop varieties received by the Seed Vault to over 1 million.

Crop Trust Legacy Award recipients

Depositors from seed banks around the world delivered duplicate seeds of vital staples like rice, wheat, and maize to the Seed Vault. Other important crops like black-eyed pea (cowpea) – a major protein source in Africa and South Asia – were also deposited, along with samples of sorghum, pearl millet and pigeonpea.

Several lesser-known crops also made the journey to the Seed Vault. These included Bambara groundnut, which is being developed as a drought-tolerant crop in parts of Africa, and the unusually-named Estonian onion potato, which was deposited together with varieties of beans unique to the country.

The event also marked the largest number of institutions (23) depositing seeds at one time.

"The Svalbard Global Seed Vault is an iconic reminder of the remarkable conservation effort that is taking place every day, around the world, and around the clock – an effort to conserve the seeds of our food crops," said Marie Haga, Executive Director of the Crop Trust, in the lead-up to the anniversary event.

"The tenth anniversary of the Seed Vault comes at a time when agriculture is facing multiple challenges from extreme weather and the demands of a world population expected to reach 10 billion people by 2050. This means it is more important than ever to ensure that seeds – the foundation of our food supply and the future of our agriculture – are safely conserved."

The Norwegian Ministry of Agriculture and Food, which jointly runs the facility with the Crop Trust and the Nordic Genetic Resource Center (NordGen), described the tenth anniversary as a major milestone for the Seed Vault.

The Seed Vault first opened its doors in February 2008, as a backup facility for the world's seed banks. It received deposits of over 300,000 different kinds of seeds in its first year and deliveries have continued several times a year ever from countries far and wide, including Australia, Burundi, Colombia, Germany, India, Japan, North Korea, Russia, USA, and many others.

Legacy Awards

As part of the tenth anniversary celebrations, the Crop Trust announced the recipients of its inaugural Legacy Awards. These recognize people who have dedicated their careers to crop conservation. Several award recipients were retiring managers at the genebanks of CGIAR, which conserve and share hundreds of thousands of seeds of food and forage crops. Duplicates of seeds from CGIAR genebanks make up the majority of varieties currently backed up in the Seed Vault.

A Legacy Award was also presented to **Cary Fowler**, one of the visionaries of the Svalbard Global Seed Vault who worked tirelessly for its creation. He is currently a special advisor to the Crop Trust after serving as the organization's Executive Director from 2007–2012, a period that saw the Seed Vault being designed and constructed, as well as receiving its first shipments of seeds.

All recipients received a personalized award featuring specially commissioned artwork by Sophie Munns.

Preparing for the future

In 2017, refurbishment work began on the outer section of the Seed Vault's access tunnel to make it watertight, and prepare it for the likelihood of a warmer, wetter future on Svalbard. Funded by the Government of Norway, work includes the construction of a new, watertight access tunnel, as well as a new service building. The work is expected to conclude in 2019. Throughout the duration of the work, the seeds continue to be secure, with new deposits arriving as usual.

THE CROP TRUST LEGACY AWARDS 2018

Shown left to right in the photograph opposite

Jean Hanson
International Livestock Research Institute (ILRI), Ethiopia

Dave Ellis
International Potato Center (CIP), Peru

Ahmed Amri
International Center for Agricultural Research in the Dry Areas (ICARDA), Morocco

Cary Fowler
Crop Trust special advisor

Daniel Debouck
International Center for Tropical Agriculture (CIAT), Colombia

Hari D. Upadhyaya
International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), India

Ruaraidh Sackville Hamilton
International Rice Research Institute (IRRI), Philippines

CROP TRUST **TIMELINE**

2004

The Crop Trust is established as the world's only organization dedicated solely to conserving crop diversity in genebanks. Geoff Hawtin is appointed Interim Executive Director at its headquarters at the United Nations Food and Agriculture Organization in Rome, Italy.

2006

The Crop Trust signs its first long-term grant to support an international crop collection with the International Rice Research Institute (IRRI). This guarantees funding of a proportion of the costs of the genebank's basic operations forever. Since then, the Crop Trust has entered into similar partnerships to support a range of crop collections around the world.

2007

Cary Fowler becomes Crop Trust Executive Director. The Crop Trust launches a major project in collaboration with the Bill & Melinda Gates Foundation, with complementary funding from the Grains Research and Development Corporation. The project aims to strengthen conservation efforts and secure at-risk crop diversity held in collections in developing countries.

2008

The Svalbard Global Seed Vault opens as a partnership between the Ministry of Agriculture and Food of the Government of Norway, the Nordic Genetic Resource Center, and the Crop Trust. By the end of the year, the Seed Vault will hold 320,553 unique accessions - 75% of which were deposited with assistance from the Crop Trust. *Time Magazine* names the Seed Vault the sixth best invention of 2008.

2011

The Crop Trust begins a ten-year project on conserving and using crop wild relatives for climate change adaptation, funded by the Government of Norway.

2012

The Crop Trust opens its new headquarters in Bonn, Germany. The Crop Trust and CGIAR launch the CGIAR Research Program for Managing and Sustaining Crop Collections (the "Genebank CRP"). The five-year initiative involving the 11 international genebanks of CGIAR is led by the Crop Trust.

2013

Marie Haga becomes Crop Trust Executive Director. The Crop Trust sets a target of raising US$850 million for its endowment fund to finance a global system for the conservation of crop diversity, centered around key international, regional and national genebanks - and the Svalbard Global Seed Vault as the world's backup facility.

2015

HRH, The Prince of Wales becomes the Crop Trust's Global Patron. The first-ever withdrawals are made from the Svalbard Global Seed Vault. Retrievals of faba beans, wheat, barley, lentil, chickpea, and others are made by the International Center for Agricultural Research in the Dry Areas (ICARDA) after their genebank in Aleppo, Syria was unable to function due to civil conflict.

2017

The six-year CGIAR Genebank Platform is launched, as the successor to the Genebank CRP. The Food Forever initiative is launched to raise awareness of efforts to achieve Target 2.5 of the United Nations Sustainable Development Goals.

2018

The Svalbard Global Seed Vault celebrates its tenth anniversary. The Government of Norway announces major plans to upgrade the facility. The Crop Trust agrees to fully fund the essential operations of the genebank of IRRI in perpetuity, starting in 2019.

2019

The Crop Trust celebrates its 15th birthday. Preparatory work with the aim of upgrading several national genebanks sub-Saharan Africa begins.

THE CROP TRUST
A PREHISTORY

In the late 1990s, the International Plant Genetic Resources Institute (IPGRI)* received an urgent request from an African national genebank for support to help pay its electricity bill, because the government concerned was unable to provide the necessary funds. Without this additional money, which amounted to only a few thousand dollars, the genebank risked losing its entire crop collection.

This was far from an isolated case and it became increasingly clear that reliability of funding was a more important constraint for many genebanks, especially in developing countries, than the absolute amount available. IPGRI saw the creation of an international endowment fund as an ideal solution to this situation.

At the same time, it was proving increasingly difficult to secure the funding needed to maintain CGIAR's own genebanks, which contained some of the largest and most important crop collections in the world. In May 2000, the CGIAR Finance Committee endorsed IPGRI's recommendation to further explore the establishment of an endowment fund to help provide stable and sustainable financing for the crop collections in CGIAR centers, specifically those held on behalf of the international community, known as "in trust" collections.

The two ideas came together, and throughout the spring and summer of 2000 consultations were held with the Food and Agriculture Organization of the United Nations (FAO), various OECD countries, developing countries, the Global Forum on Agricultural Research and Innovation, or GFAR, and a number of NGOs regarding the idea of establishing a dedicated fund to support the conservation of plant genetic resources. Broad support was expressed for the idea, and in particular for IPGRI's proposal to set up an endowment fund to help develop and sustain a rational global genebank system, as called for in FAO's Global Plan of Action in 1996.

In October 2000, IPGRI commissioned an independent study to assess the feasibility of establishing such a fund, and to determine a reasonable fundraising target. Based on interviews with around 130 individuals from governments, foundations and corporations in about 30 countries, the study concluded that it should be possible to raise up to US$260 million, providing there was strong endorsement from key developing countries, FAO, CGIAR and the World Bank.

The following year, at IPGRI's request, the International Food Policy Reasearch Institute (IFPRI) and the University of California, Berkeley undertook a study on the costs of operating genebanks.

Following further discussions, IPGRI, acting on behalf of CGIAR, and FAO agreed to work together to jointly establish the Global Crop Diversity Trust (the Crop Trust), and the idea was formally presented to the World Food Summit in Rome, June 2002, where it was well received. In July, Imperial College, London, at IPGRI's request, published a report entitled *"Crop Diversity at Risk: The Case for Sustaining Crop Collections"*. The report argued strongly for the establishment of an endowment fund to support genebanks around the world. And in the following month, August 2002, IPGRI and FAO formally and publicly committed to establishing the Crop Trust at the World Summit on Sustainable Development in Johannesburg. The Crop Trust's first website *"Start with a Seed"* was launched.

Based on the recommendations of a meeting of potential donors in London in late 2002, IPGRI and FAO set up an expert panel, known as the Interim Panel of Eminent Experts, under the Chairmanship of Ambassador Fernando Gerbasi, who had earlier chaired the negotiations for the International Treaty on Plant Genetic Resources for Food and Agriculture. The Panel was charged with establishing the Crop Trust as a legal entity and it appointed Geoff Hawtin as Executive Director to manage the establishment process.

At its meeting in October 2003, the Panel approved the Crop Trust's Constitution and other legal documents. Over the next few months, IPGRI and FAO secured the signatures of 12 countries on the Establishment Agreement (Cape Verde, Ecuador, Egypt, Ethiopia, Jordan, Mali, Morocco, Samoa, Sweden, Syria, Togo, and Tonga) and on October 21st, 2004 the Crop Trust was born. The following year, the Crop Trust set up its inaugural Executive Board and Donor Council, and began to operate as an independent legal entity.

*(a CGIAR center, and later renamed to Bioversity International)

THE BIG PICTURE

The Crop Trust's Dr. Benjamin Kilian, right, with finger millet farmer Margaret Kubendepre and Crop Trust pre-breeding partner, Dr. Chrispus Oduori, of the Kenya Agricultural and Livestock Research Organization (KALRO), in Kisii, Kenya.

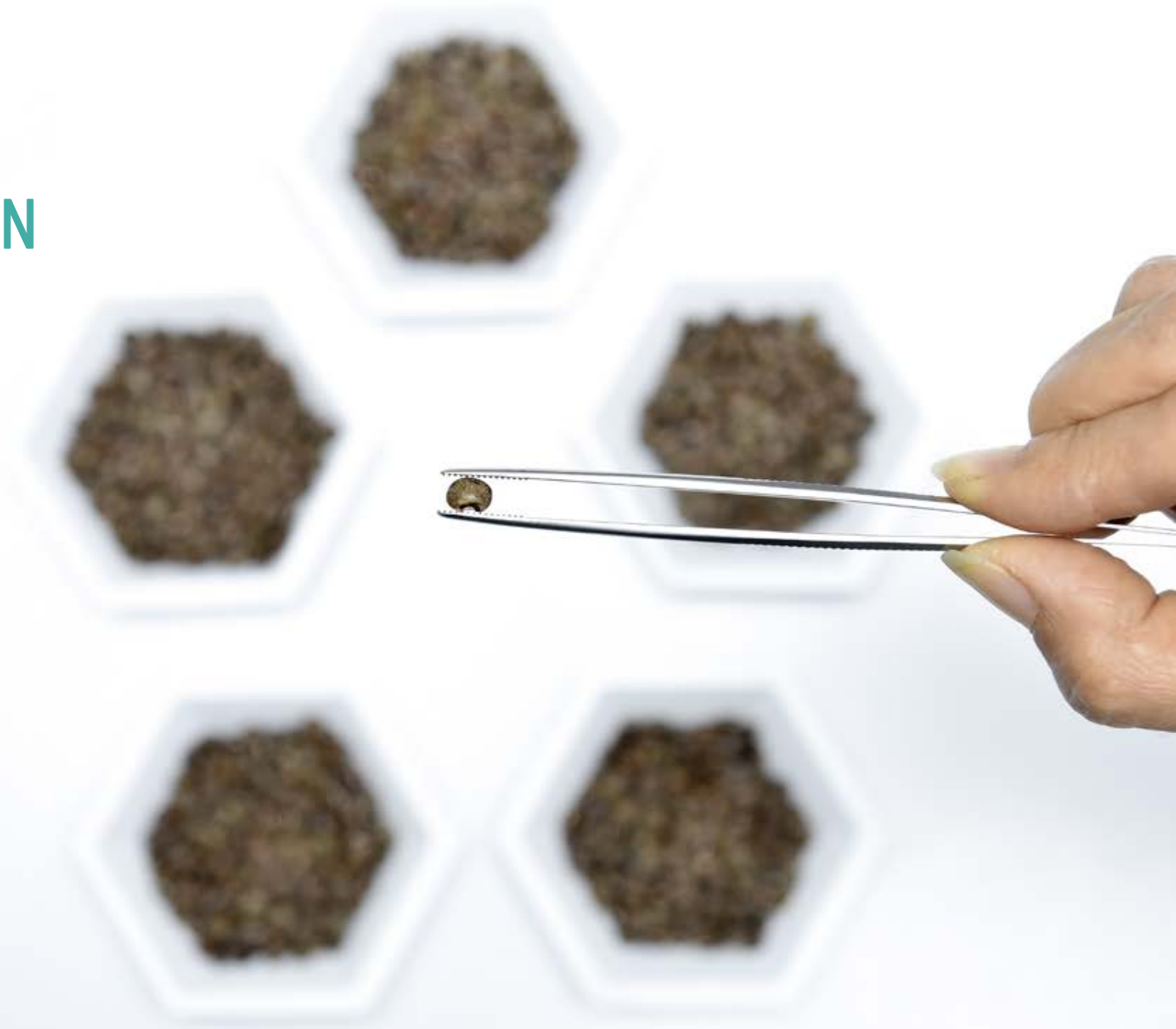
BACK FROM THE BRINK

THE BERMUDA BEAN

You might not think of Bermuda as a hotspot for wild beans, but the Atlantic archipelago 1,200km southeast of the United States is home to at least one very interesting specimen.

The endemic Bermuda bean is believed to have evolved in isolation for thousands of years. It developed special characteristics, including a vigorous rooting system, which scientists speculate could be the plant's evolutionary response to strong winds. This means it could be useful for crop breeders developing bean varieties for areas affected by storms and hurricanes.

But the bean was on the verge of extinction in the wild. In 2014, it appeared on the IUCN Red List as critically endangered, with just 29 mature plants left in its natural habitat. The expansion of the construction, tourism, and leisure industries, together with the spread of invasive plants, threatened that habitat.



But a rescue effort was already underway. A small number of Bermuda bean seeds had been conserved at the Millennium Seed Bank (MSB), Royal Botanic Gardens, Kew, in the UK. In 2012, MSB sent 15 seeds to bean experts at the International Center for Tropical Agriculture (CIAT) near Cali, in southwestern Colombia. These were planted at the center's headquarters, and at a field station it manages near the city of Popayan, an area with good conditions for growing beans. These plants produced around 6,000 seeds, 100 of which were sent to the Svalbard Global Seed Vault in October 2017. The remainder were conserved at the CIAT genebank – the largest collection of beans in the world – and a consignment of seeds were returned to MSB.

While the natural habitat of the Bermuda bean may still face serious challenges, the seeds of this fascinating plant are safe.

BERMUDA BEAN FUN FACTS

1 The Bermuda bean sends out stolons from the lower parts of the plant, which spread horizontally along the ground sprouting both new roots and new plants.

2 In a brutal proof of concept, a powerful storm hit CIAT's bean research station in Popayan in October 2017. It felled large trees, cut off the power, and tore up several screenhouses, damaging many of the bean plants being grown there. One bean plant was unaffected by the storm: you can guess which one.

3 The Bermuda bean is a perennial plant, meaning it lives for several years, rather than dying after shedding its seed. While this is not a unique trait in beans, it is one that is potentially of interest: in the future, planting beans once and harvesting over several years might be preferable to farmers, rather than planting new seeds each season.

GENEBANKS

An investment in the future of food

Anyone working in the financial sector will be familiar with the idea of spreading risk. Investing too much in a limited portfolio means you're vulnerable to a crash in the price of your stock.

Our food system is a bit like that. There are around 30,000 edible plants out there, but just a few big staples – wheat, maize, rice, and potato – provide around 60% of our calories. That's a very risky strategy: one dry year could cripple wheat production in one country; a pest or disease outbreak could quickly topple maize in another. Rice and potato are no less exposed to such risks.

And if just one of these crops were to fail, even in a limited geographic area, the fallout could be felt globally, so interconnected and interdependent is the world. Millions could go hungry, or be forced to move. The likelihood of this happening increases due to climate change. That should be enough to send a shiver down the spine of even the most bullish investor.

Fortunately, there are ways to minimize the risks.

On the one hand, we need to make the big four crops more robust – they are vitally important now and will continue to be in the future. But we also need to grow and consume

a wider range of plants. In both instances, this will depend on a very special kind of "banking" system, one which deals in seeds rather than money.

Genebanks are storage facilities that conserve seed samples over the long term. The United Nations Food and Agriculture Organization estimates there are around 1,750 of them worldwide. They range from tiny and provincial, to large and international.

Genebanks help keep seeds alive for decades, and send samples to researchers and crop breeders, who use them to develop hardier, more productive and nutritious varieties. They enable scientists to search through the 150,000 types of rice or 140,000 types of wheat, to see which ones could be used to increase resistance to drought, heat, pests, or diseases, or improve the nutritional quality of crops. Genebanks also send seeds directly to farmers, for example formerly beloved varieties that have gone out of cultivation.

As well as thousands of varieties of the big four, genebanks also contain many others crops: those from the past that we've neglected, and those of the future we've yet to embrace. They contain not only lots of different quinoas and kales, but the next quinoas and kales; the ones that will help diversify our food portfolio; the crops that thrive when others fail; those that provide a broader range of nutrients.

It means we all depend on genebanks, whether we realize it or not. Some of the ancestors of the rice you'll eat for dinner tonight probably passed through a genebank at some point:

different samples would have been used by scientists to develop improved commercial varieties. The same goes for the wheat in your lunchtime sandwich, the maize in your tortilla and – unless you're a keen forager or consume only obscure heirloom varieties – almost every other plant food you ate today.

Genebanks provide the starting capital – literally, the seed capital – for the kinds of innovations that will ensure we have enough eggs in enough baskets in the future. Just as they provided the raw materials for some of the scientific innovations of the Green Revolution several decades ago, they can provide the same for the cleaner, greener revolution we need today.

Funding genebanks forever

The Crop Trust endowment fund was set up to support key genebanks forever. Our calculations are that an investment of US$500 million is needed for the global collections of major staples conserved in the international genebanks managed by CGIAR centres. Assuming a 4% average annual investment return, this would generate the US$20 million per year they need to fund essential operations. An additional US$250 million would be needed to generate US$10 million per year to support the conservation of key collections held in national genebanks. Finally, US$100 million would be invested to generate the US$4 million required each year to fund the the Svalbard Global Seed Vault and the Crop Trust's operations, including the development of information systems bringing together data from all these genebanks. That makes $850 million in total to guarantee crop diversity will always be available from genebanks.

The good news is that we're already one-third of the way to achieving our target, with close to US$300 million currently in the fund. This is made up of donations mainly from governments but, increasingly, the private sector too.

We've already been able to provide permanent funding to the world's largest and most important rice genebank, which should be the first of several international genebanks that we support in this way. We've also provided financial lifelines to other genebanks around the world, and of course, we support the ongoing operations of the Svalbard Global Seed Vault.

But smart investing alone is not enough to make our endowment fund effective. The Crop Trust also needs to walk the walk. That's why the Crop Trust is a signatory to the United Nations Principles of Responsible Investment, and our investment strategy factors in environmental, social, and governance issues that align with our mission. For example, we invest in sectors that are expected to benefit from the shift to a low-carbon economy, including areas such as renewable energy, and improved energy efficiency.

While we're well on our way, there's still a lot to do. Each year, genebanks around the world face the risk of earthquakes, power failures, and political instability. Many are in developing countries and face daily funding shortfalls. If one of these genebanks were to fail, we would risk losing thousands of years of agricultural history – and the foundation of our food supply for the future.

By continuing to raise money for the Crop Trust endowment fund, we can help ensure the best for both people and the planet. That's surely a portfolio worth its weight in gold.

CGIAR Genebank Platform

CGIAR Genebank Platform

The CGIAR Genebank Platform:

- is a six-year initiative involving the 11 international genebanks of CGIAR – a global research network that works on a range of issues including improving food and nutrition security.
- is the successor to CGIAR Research Program for Managing and Sustaining Crop Collections which concluded in 2017.
- contributes to Targets 2.5 and 2.a of the United Nations Sustainable Development Goals.

MAKING THE GRADE: CGIAR GENEBANK PLATFORM STANDARDS

- **90% of accessions are healthy and available for immediate distribution.**
- **90% of accessions are safety duplicated.**
- **90% of accessions are documented to facilitate their use.**
- **Quality Management Systems are in place in all genebanks and germplasm health units.**
- **All acquisitions and distributions comply with international policy.**
- **Genebanks that meet and maintain these standards are eligible for permanent funding of their essential operations from the Crop Trust endowment fund.**

CASE STUDY Kasetsart 50

Kasetsart 50 (sometimes known as KU 50) is an improved cassava variety developed by the International Center for Tropical Agriculture (CIAT) in Colombia, Kasetsart University in Thailand, and Thailand's Ministry of Agriculture and Cooperatives. It is grown on over one million hectares in Thailand and Vietnam and is expanding to other countries in Southeast Asia. KU 50's pedigree traces back to a traditional cassava variety from Venezuela known as CMC 76 that was collected in 1967 and conserved in the CIAT genebank. Breeders crossed CMC 76 with a cassava variety from the Virgin Islands which had been introduced into Thailand. Breeders then crossed the offspring with a well-performing Thai variety. The resulting KU 50 is a vigorous, high-yielding, cassava variety that is adapted to a range of growing conditions and produces roots with a high starch content. Adoption of KU 50 is believed to have generated in excess USD 97 million.

VISIT www.genebanks.org

We would like to thank all funders who support the CGIAR Genebank Platform through their contributions to the CGIAR Trust Fund: www.cgiar.org/funders/

The following governments have directly supported the CGIAR Genebank Platform: Switzerland, The Netherlands and the United Kingdom.

The following governments have provided support for the Crop Trust's contribution to the CGIAR Genebank Platform: Germany, Switzerland, Finland and the European Union.

Genebanks supported by the CGIAR Genebank Platform

GENEBANK	CROP
AfricaRice Côte d'Ivoire	Rice
International Institute for Tropical Agriculture Nigeria	Cowpea, Yam, Cassava, Soybeans and Bambara Groundnut
Bioversity International Belgium	Banana
International Maize and Wheat Improvement Center Mexico	Maize and Wheat
International Center for Agricultural Research in the Dry Areas Morocco and Lebanon	Barley, Chickpea, Faba Bean, Forages, Lentil, Wheat and Grasspea
International Center for Tropical Agriculture Colombia	Bean, Cassava and Forages
International Crops Research Institute for the Semi-Arid Tropics India	Chickpea, Groundnut, Minor Millet, Pearl Millet, Sorghum and Pigeonpea
International Livestock Research Institute Kenya	Forages
International Potato Center Peru	Andean Roots and Tubers, Potato and Sweetpotato
International Rice Research Institute Philippines	Rice
World Agroforestry Centre Kenya	Agroforestry Trees

FAST FACTS CGIAR GENEBANKS:

1 Conserve some of the world's most important crops, trees and their wild relatives, including rice, wheat, maize, potato, cassava, bean, banana, and many others.

2 Distributed more than 700,000 samples of plants and seeds to requesters between 2012 and 2017. About two-thirds of all samples distributed outside CGIAR go to developing countries.

3 Are typically located in centers of crop diversity. For example, the maize genebank of International Maize and Wheat Improvement Center (CIMMYT) is located in Mexico, where maize is believed to have originated, and contains nearly 30,000 maize samples.

4 Monitor, test, germinate, multiply, characterize, clean, document, store, and distribute plant samples in accordance with agreed standards of operation.

5 Employ around 400 people.

CGIAR Genebank Platform

SAFEGUARDING RICE

Nothing less than forever

October 2018 marked an important milestone in the history of the Crop Trust. The organization took the decision to fully fund a genebank with the longest possible time horizon - forever.

The partnership agreement with the International Rice Research Institute (IRRI), a not-for-profit international agricultural research organization with its headquarters in the Philippines, was the first of its kind. It guarantees permanent, full funding for the essential operations of IRRI's genebank which, with around 136,000 different kinds of rice, is the largest and most important rice collection in the world.

Many samples from the genebank have already been used to help rice producers respond to the challenges of climate change; others hold promise for improving rice production in the coming decades. With around 3.5 billion people around the world consuming rice each day – a number that is expected to rise – safeguarding IRRI's rice collection is an important step towards ensuring a more sustainable and resilient food system.

The agreement was made possible only through the combined efforts of Crop Trust and IRRI. The Crop Trust's coordination of the CGIAR Genebank Platform supports the operation and upgrading of the 11 CGIAR genebanks – including that of IRRI – ensuring that they meet international standards, as published by the United Nations Food and Agriculture Organization, and specific performance targets.

Over several years, the IRRI genebank has maintained these performance targets, which include being able to make more than 90% of its rice samples immediately available to requesters, and ensuring they are safely backed up and properly documented.

As well as great news for IRRI, the agreement was also a proof of concept for the Crop Trust endowment fund, which was established in 2004 as a mechanism to provide stable, long-term funding for crop conservation. Ensuring the other ten CGIAR genebanks and other international genebanks are similarly supported will require US$500 million in the endowment fund.

This is also an important contribution by the Crop Trust and its partners to Target 2.5 of the United Nations Sustainable Development Goal on Zero Hunger, which seeks to safeguard "seeds, cultivated plants, farmed and domesticated animals and their wild species" by 2020.

A HAVEN OF DIVERSITY

When we talk about the Svalbard Global Seed Vault being the tip of the iceberg of a global system of crop conservation, the tropical islands of Fiji might not immediately spring to mind.►

This South Pacific nation around 1,000km from New Zealand is located in a globally important region of diversity for some key crops that can't be backed up in the Arctic.

The Centre for Pacific Crops and Trees (CePaCT), near the capital Suva, looks after more than 2,000 unique samples of banana, breadfruit, yam, sweetpotato, cassava, and the world's largest collection of the starchy staple, taro. It will soon expand its conservation work to include another iconic crop in the region: coconut. CePaCT works mainly with countries and territories in the region, but freely distributes thousands of samples to requestors all around the world, particularly in developing countries, every year.

All of the plants in the CePaCT genebank are vegetatively propagated, meaning they are not best conserved by freezing their seeds. Instead, they are maintained as living plantlets in test tubes and jars (called *in vitro* conservation), or as mature plants and trees in special fields.

This kind of permanent life support system requires much more daily care and attention than dry, frozen seeds. Plants in field collections are also more prone to the vagaries of the weather, as Cyclone Winston demonstrated when it struck the region in 2016.

As CePaCT's genebank manager and head of genetic resources at SPC Michel Ghanem says, "We may not be managing as many accessions as other genebanks, but we are dealing with some quite challenging crops. There is no low-hanging fruit in the CePaCT collection: each and every accession requires painstaking attention to ensure they are safely conserved, free of pests and diseases, and available for use."

The plants in CePaCT's collection could help farmers and scientists respond to a range of challenges facing the region and beyond, including drought, salt water intrusion, and unhealthy diets.

The Crop Trust provides long-term financial backing to CePaCT's taro and yam collections, and has supported work to move material from the field to its *in vitro* genebank. Past projects also include the evaluation of CePaCT's core taro collection in Papua New Guinea to see how the plants fare under drought conditions and in atoll environments, and the center's work to put together a comprehensive collection of Pacific bananas.

Taro leaf blight

Taro is an important staple found all over the Pacific island countries, as well as parts of Asia, the Americas, and Africa. Nigeria is the largest producer, with a global share of 32%, followed by China, Cameroon, Ghana, and Papua New Guinea.

Taro was the second largest export earner for Samoa in 1993, when it was struck by an outbreak of taro leaf blight (TLB) – the most severe disease of taro, causing huge yield losses and post-harvest decay of the edible corms. The disease affected all 11 types of taro grown in the country. Work to collect taro diversity from the Pacific region and beyond resulted in the establishment of a collection of 196 taro accessions at CePaCT, and the discovery of a source of resistance to TLB.

Partners at the University of the South Pacific in Samoa and elsewhere used TLB-tolerant varieties to breed new taro plants that were both tolerant and tasty. These new varieties are also conserved at CePaCT.

Following more recent outbreaks of TLB in West Africa, CePaCT provided 50 different kinds of taro to 15 countries in Africa (Burkina Faso, Ghana, Kenya, Madagascar, Nigeria, and South Africa), Latin America (Costa Rica, Nicaragua), the Caribbean (Cuba, Trinidad and Tobago), Asia (India, Indonesia, and the Philippines) and the Pacific (Papua New Guinea and Vanuatu).

Cyclone Winston

When Cyclone Winston made landfall in Fiji in February 2016, it caused significant damage to homes, infrastructure, and agriculture. It also affected CePaCT's genebank, uprooting many of the breadfruit trees in its field collection, and leaving leaking air-conditioning units, a buildup of moisture in the walls of the facility, and prolonged power cuts in its wake.

This put CePaCT's globally-important crop collections at risk. With financial support from Australia's Department of Foreign Affairs and Trade, the Crop Trust was able to help CePaCT recover from the cyclone. This included restoring its breadfruit field collection and installing measures to protect them against extreme weather in the future. The project also funded the purchase of air conditioning units and dehumidifiers to ensure optimal conditions for conservation inside the facility. In addition, a new building is under construction at the site, to house duplicate plant samples as part of a backup system.

CePaCT was established in 1998 with funding from the Australian government and the European Union and is part of the Land Resources Division of the Pacific Community (SPC). It aims to assist Pacific Island Communities and Territories in the process of conservation and sustainable use of plant genetic resources. Its core aim is to assist Pacific Island countries and territories (PICTs) to conserve the region's genetic resources, and to provide access to that diversity when they need it. SPC is keen to transform CePaCT into a globally recognized Centre of Excellence within its Land Resources Division.

> **"There is no low-hanging fruit in the CePaCT collection: each and every accession requires painstaking attention to ensure they are safely conserved, free of pests and diseases, and available for use."**

THE **PLANT** TREATY

Q&A with Luigi Guarino, Director of Science, Crop Trust

What is the International Treaty on Plant Genetic Resources for Food and Agriculture?

The Plant Treaty, or Seed Treaty, as it is sometimes known, aims to improve global food security by making it easier for scientists and farmers to obtain and use seeds and other plant material for crop improvement, research, and training. It was adopted by the Food and Agriculture Organization of the United Nations (FAO) in 2001 after many years of negotiations and came into force in 2004. As of September 2018, there were 144 contracting parties – 143 countries, plus the European Union.

What do parties to the Treaty commit to?

Among other things, to sharing plant material of 64 globally important food and forage crops that is under the management and control of the national government and in the public domain, in accordance with agreed rules. These crops are listed in Annex 1 of the Treaty. The rules ensure requestors can obtain the material and that, where appropriate, they share a portion of any monetary benefits arising from their use of it. It's a bit of a mouthful, but this is referred to as the "Multilateral System of Access and Benefit-sharing".

Which crops are included in Annex 1?

Lots of our favorites, like rice, wheat, maize, potato, oat, coconut, banana, millet, yam, carrot, strawberry, and so on.

Why doesn't Annex 1 cover all food crops?

That's because everything in the Treaty was the subject of intense international negotiations among countries. Sometimes, not all countries agreed to various crops being included, so some had to be left out, most notably groundnut (peanut) and soybean.

Why is it important to have a Multilateral System?

Breeders and researchers typically need material from many different sources to get as much crop diversity into their programs as possible. This gives them a better chance of developing new crop varieties that can eventually benefit farmers and consumers. Before the Treaty, they would have had to make separate, bilateral deals with different providers to get those different samples. All that takes time and money. Don't forget: lawyers need their cut. To avoid these transaction costs as much as possible, the Treaty front-loaded the negotiations, with a ll parties agreeing to the rules from the outset. A system like this significantly speeds up the exchange of plant material, helping scientists and farmers make use of it more readily.

So can anyone, anywhere request plant material from a genebank?

Yes – if the provider is in one of the 144 contracting parties to the Plant Treaty. The requestor would need to sign something called a Standard Material Transfer Agreement, or SMTA. This ensures requestors abide by the rules set out in the Plant Treaty, including paying a portion of the monetary benefits arising from their use of that material.

Where does that money go?

Into something called the Benefit-sharing Fund, which is held by FAO on behalf of the parties to the Treaty. If, for example, you request wheat seeds from a genebank in the Multilateral System, create a new, high-yielding wheat variety, and sell this for a profit, you must pay a portion of that profit into the Benefit-sharing Fund. The Treaty then invests this money in projects that support the improved management, conservation, and sustainable use of plant genetic resources for food and agriculture around the world. So, monetary benefits are shared through multilateral mechanisms as well as seeds. Understandably, there's a lot of focus on money when people discuss the benefits of using genetic resources. But let's remember that not all of the benefits can be counted in dollars and euros. After all, what's the price of food security?

How many seeds have been exchanged under the Multilateral System?

The Treaty has facilitated the exchange of over 4 million samples of plant genetic material at an average rate of 1,000 transfers per day. That includes seeds as most people think of them, but also plantlets for crops that are best conserved as living tissue. The Multilateral System covers a global genepool of over 2.3 million samples of crop seeds stored in genebanks around the world.

Wow, that must have generated a lot of money for the BSF.

Well, the Fund has actually been receiving millions of dollars in voluntary contributions from a number of countries and others for several years, but in 2018 it received its first payment tied to use of plant material in the Multilateral System. A Dutch company used crop samples requested from genebanks in the Netherlands and Germany to develop ten new vegetable varieties. It paid US$119,083 into the Benefit-sharing Fund, in accordance with the SMTA it signed when it requested the seeds. Hopefully this is the first of many contributions to the Benefit-sharing Fund, as products incorporating material accessed over the years finally make their way to market – it can take a decade to release a new crop variety. To date, the Fund has supported over 60 projects in 55 developing countries, using USD 20 million in voluntary contributions.

Is it correct that Treaty negotiations are still going on?

Yes. A process has been launched under the Treaty to see if the Multilateral System can be revised to get more money in faster from commercial users, and also to potentially increase the scope of coverage of Annex 1 beyond the current list of 64 food and forage crops. Some want to expand the list of crops, while others want to do away with it altogether so that all food and forage crops are included. After all, we don't know which plants might become important foods in the future, so why not make sure we can use all of them? Others think we shouldn't do that until there is stronger evidence that the Multilateral System is working with the crops currently included. It is too early to tell how this process will end, but we hope it will make the Multilateral System even better!

What is the role of the Crop Trust in all this?

In order for the Multilateral System to work effectively, genebanks – which are key actors in it – need stable, long-term funding. They also need a backup – a separate location to conserve a copy of their crop collections, just to be safe. The Plant Treaty recognizes the Crop Trust as essential to this, by virtue of its endowment fund.

> "Breeders and researchers typically need material from many different sources to get as much crop diversity into their programs as possible."

This fund – made up of donations from governments, and to a lesser extent, the private sector – accrues interest, which is then used to support genebanks around the world. In particular, the Crop Trust currently supports the international genebanks recognized under Article 15 of the Treaty, and the ultimate failsafe for the whole system, the Svalbard Global Seed Vault. The Crop Trust's shorter-term projects also further the aims of the Treaty, for example enhancing crop conservation at the national level through support to seed regeneration (growing plants in order to replenish or increase seed stocks for conservation), duplication of seeds so they can be safely backed up, and collecting of crop wild relatives. We're all in this together.

What is Genesys and why is it important to the Plant Treaty?

Genesys is a free-to-use, publicly accessible, online database of plant material held in genebanks. It tells you what's in the Multilateral System and includes a simple system for requestors to order samples. It supports the aims of the Plant Treaty by helping users find the plant material they need and streamlines requests to genebanks. When a requestor places an order via Genesys, it immediately alerts the relevant genebank, which ships the material to the requestor, subject to a signed SMTA. Since Genesys was launched in 2008 it has become the preferred tool for exploring genetic diversity worldwide. It is constantly expanding and currently contains data on almost 4 million plant samples. Genesys contributes to the Treaty's Global Information System, which will cover not just material in genebanks, but also crop diversity conserved on farms and in the wild, and that's in the process of being used by breeders to make new varieties. Genesys is supported by the Crop Trust.

VISIT www.genesys-pgr.org

CRYOPRESERVATION

AND THE FUTURE OF PLANT CONSERVATION

It might come as a surprise that there are many crops that can't be conserved in the Svalbard Global Seed Vault. These include favorites like: banana, cacao, cassava, coffee, potato, sweetpotato, coconut, tea, apples, and others.

That's because some of these crops don't produce seeds at all (like banana). Others produce seeds, but the resulting plants don't always resemble their parents (like apple). That's a problem because when you conserve something, you want to be sure of what you'll get if you ever need it again. Other plants have seeds that don't react well to the conditions in genebanks. They're called recalcitrant species, to distinguish them from the ones whose seeds can be dried and stored in the cold, which are called orthodox.

All these plants need alternative methods for conservation.

This is usually done by growing seedlings in jars or test tubes, known as *in vitro* conservation, or outdoors, in what are called field collections. These methods effectively place the crops on permanent life support: they need regular human attention, and are prone to natural disasters, pests, and diseases.

But there is another way that is growing in popularity: cryopreservation. This is the process of conserving plant samples using liquid nitrogen. The samples are either suspended above or plunged into the liquid which, at minus 196 degrees Celsius, causes all biological and chemical processes in the plant to virtually stop. This results in the plants entering a deep state of quiescence. In theory, plant samples can be conserved almost indefinitely this way, but when taken out, they can be revived and carefully grown into full plants.

There are a few challenges with what's commonly known as "cryo". The lack of established protocols for some plants, and the sometimes-low revival rate of cryopreserved plants can cause many genebank managers a headache. But if these and other challenges can be overcome, cryopreservation is very likely to become routine in plant conservation efforts in the future.

In 2017, the Crop Trust, Bioversity International, and the International Potato Center commissioned an independent report into the need for, and state of, plant cryopreservation around the world. It highlighted the challenges and benefits of the technology, and called for an urgent global effort to accelerate its development and implementation, along with the establishment of a backup system for cryopreserved samples. It could lead to the creation of a global crop conservation facility even colder than the Svalbard Global Seed Vault.

FOOD FOREVER
Biodiversity for Resilience

Food Forever is here to show you that biodiversity is key

The United Nations SDG 2 is commonly known as the goal for Zero Hunger. But there's much more to it than feeding the world: It identifies a range of issues affecting our food systems, with specific targets to address them.

Target 2.5 calls for the international community to safeguard and share the "genetic diversity" of both crops and livestock by 2020.

But what does it mean? Genetic diversity is the foundation of our food supply. It includes all our food crops and their wild relatives, and all the different types of livestock. Farmers and scientists need this diversity to develop new crops and livestock breeds that can tolerate heat, drought and disease. They need it to sustainably produce enough nutritious food for a growing world population in spite of challenges like climate change. Genetic diversity can help make agriculture better, stronger, and more resilient; it can help ensure that we don't just survive, but thrive.

The Food Forever Initiative aims to raise awareness of the exciting work going on around the world in support of SDG Target 2.5. It's doing this in a number of ways: by rallying a range of stakeholders – be they politicians, farmers, chefs, or business people – to lend their voices to help drive positive changes in the way we conserve, grow, sell, and consume crop and livestock diversity. Food Forever does this through a range of creative projects such as the Food Forever Experience, regular opinion articles on the Food Forever website, the Food Origins infographic series, and more.

Food Forever comprises Champions and Partner Organizations. Champions are experts and leaders from all walks of life who are driven to speak out about the importance of food diversity. Partner Organizations are groups whose work contributes to achieving SDG Target 2.5.

Food Forever is an initiative of The Crop Trust, the government of the Netherlands and the Food and Agriculture Organization of the United Nations. Financial support is provided by the Governments of Germany, Norway, Switzerland, and The Netherlands.

VISIT www.food4ever.org

THE FOOD FOREVER EXPERIENCE

The international event series coming to a city near you

The Food Forever Experience was created to give the public a glimpse of the future of food if chefs and consumers embrace more diverse ingredients.

Just four crops account for over half of our calories. It means we're missing out on thousands of tasty, nutritious plants that could become more popular and which need to be conserved if we are to have a more sustainable food system.

By working with innovative chefs to cook up delicious dishes using some of these lesser-known ingredients, the Food Forever Experience aims to plant the seed for important conversations about a more diverse, sustainable, and exciting food future. It's all about serving up UN SDG 2.5 on a plate.

The inaugural event – the *Food Forever Experience NYC* – was hosted by Google in New York City, in September 2018. We challenged ten chefs to work with fascinating foods currently on the margins of the US culinary mainstream. These included the African grain teff, Bambara groundnut, tepary bean, breadfruit, jackfruit, and even crickets.

The results were sumptuous and spectacular, and the event was featured on national TV news.

The event was organized by the Food Forever Initiative and the Crop Trust in partnership with Google, Tender Greens co-founder and Food Forever Champion Erik Oberholtzer, and the Rediscovered Food Initiative. The *Food Forever Experience NYC* was also an official event of the United Nations Global Day of Action on the SDGs.

Look out for forthcoming Food Forever Experiences in Chicago, USA; Cusco, Peru; London, UK; and Bonn, Germany.

EXPERIENCE FOOD FOREVER NYC 2018

10 CHEFS
19 INGREDIENTS
1 DIVERSE MISSION

We challenged **leading chefs** to cook up the food of the future, using diverse ingredients.

SUZANNE CUPPS

ERIK OBERHOLTZER

FLOYD CARDOZ

UMBER AHMAD

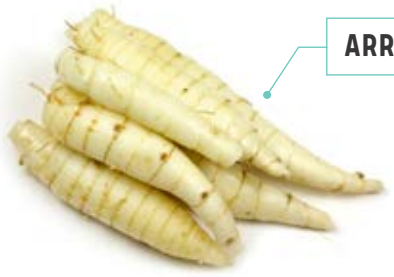
MATTHEW DELISLE

DAN KLUGER

OCA

SALTWORT

SALSIFY



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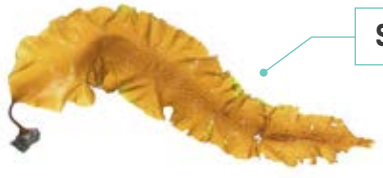


SUGAR KELP

CHAYOTE

AMARANTH

BREADFRUIT

DATE

MORINGA

TIGERNUT

FOOD

The world's most successful immigration story?

It's common to associate different countries with different cuisines. Many people associate pizza with Italy, for example, or a cheeseburger with the USA.

But the ingredients that went into making these foods often originated – in an evolutionary sense – far away, in other parts of the world. For example, wheat – used in pizza dough – though widely grown these days, originated thousands of years ago in the Fertile Crescent of the Middle East. The tomatoes in the pizza topping originated in the Andes of South America; the onions and garlic in Central Asia.

So, if you go back long enough, there's not much that's Italian about a pizza. The same applies to many of the foods we consume: they originated in certain parts of the world, were assimilated by countries and cultures elsewhere, often far away, and eventually treated as if they were native.

It makes food, perhaps, the world's greatest immigration success story.

Taking a long-term, evolutionary perspective helps us understand why, when it comes to food, the different regions of the world still need each other. They remain interdependent because the areas where crops originated are typically still home to the widest range of diversity – and to the genebanks that conserve it.

For example, there are a handful of commercially available potatoes in the world but in Peru, where potato originated, indigenous farmers still grow maybe 4,500 different kinds: purple ones; others with striped skin; some so knobbly they require an expert to peel them. Through conservation and research, some of those potatoes from Peru might help potato farmers in Africa or Europe respond to climate change. Similarly, rice conserved on farms and in genebanks in Asia might help growers in South America produce more stable yields; coffee conserved in Ethiopia might help producers in Asia or Central and South America beat pests and diseases. Multiply that across all crops and all the regions of the world and the inescapable conclusion is that everybody needs everybody else.

This means we all benefit from efforts to conserve crop diversity, no matter where we are in the world. The same goes for animal breeds. And it's through conservation and research that we have a better chance of developing more sustainable farming practices, more nutritious diets, and more resilient food systems.

Food Forever's *Food Origins* series gives a glimpse of where the ingredients in some of the world's most recognizable dishes come from, taking the long, evolutionary view. Here, we give you pizza, but you can follow the Food Forever website to see the full range of deliciousness as it unfolds.

PIZZA

TOMATO

ORIGIN South America
FUN FACT A member of the deadly nightshade family.

WHEAT

ORIGIN Middle East
FUN FACT Grown on more land than any other food crop.

PARSLEY

ORIGIN Central Mediterranean
FUN FACT Used in ancient Rome as an ingredient in salads, for garlands, and to treat hangovers.

ONION

ORIGIN Central Asia
FUN FACT Close relatives include garlic, leek, and chive.

GARLIC

ORIGIN Central Asia
FUN FACT One of the world's oldest cultivated crops.

CHEESE (COW)

ORIGIN Indian subcontinent and Europe.
FUN FACT Cows originated about 10,000 years ago and were domesticated from wild aurochs, bovines that were up to twice the size of domestic cattle.

THE CROP TRUST
ENDOWMENT FUND

The Crop Trust endowment fund generates investment income that is used to support crop conservation activities around the world. It was established in 2004 and is currently close to **US$300 million**. Around 95% of contributions received have come from national governments. The rest has come from the private sector and individuals.

Since 2004, the Crop Trust has provided over **US$36 million** in long-term grants to international research centers that help conserve collections of vitally important food crops. It has also contributed approximately **US$1.4 million** to support the operations of the Svalbard Global Seed Vault, the world's most secure backup system for protecting crops important to global food security. As of 2019, it is providing **US$1.4 million** per year to fully fund the essential operations of the genebank of the International Rice Research Institute in perpetuity.

We estimate that a Crop Trust endowment fund worth **US$850 million** would generate sufficient income to safely conserve all unique crop varieties important for food and agriculture, forever.

The Crop Trust is a signatory to the United Nations Principles of Responsible Investment and implements a Responsible Investment Policy approved by its Executive Board.

THANK YOU

Crop Trust donors include developed and developing country governments, civil society (foundations), the private sector, farmers' organizations and individuals. We are deeply grateful to all our supporters, who have helped make the work we do possible.

www.croptrust.org/about-us/donors/

MERCER
MAKE TOMORROW, TODAY

Mercer is one of the Crop Trust's investment partners, helping ensure we continue to support crop conservation efforts around the world by providing strategic asset allocation advice, ESG integration, and investment management.

The Crop Trust and its fund managers are signatories to the United Nations Principles for Responsible Investment.

INVESTING IN THE FUTURE OF FOOD

WWW.MERCER.COM

Mercer has supported the production of the Crop Trust Magazine

ENSURING THE WORLD CONTINUES TO WAKE UP TO COFFEE

Coffee is the world's second-most traded commodity after oil. Produced in 80 countries, an estimated 125 million people in Latin America, Africa and Asia depend on the crop, ensuring over 2 billion cups are served globally, each day. ▸

Of the 125 coffee species in the world, global coffee production is based on only two: *Coffea arabica* and *Coffea canephora* (commonly referred to as robusta coffee). We depend on just a few varieties of each.

But coffee faces a range of challenges: A fast-spreading disease could wipe out production entirely. What's more, arabica coffee – which accounts for the majority of coffee production – is very sensitive to changes in climate. According to the Climate Institute, around 75% of the land currently dedicated to growing arabica coffee is expected to become unsuitable within the next 50 years due to shifts in temperature and rainfall. Moving coffee production isn't an option in many places as it could put important ecosystems and protected areas at risk.

Fortunately, the coffee plant could contain the source of its own salvation: There are many coffee varieties and even species that are not commercially grown that could have useful characteristics. If safely conserved and made available for research and breeding, these could enable coffee to cope with warmer, wetter weather, and new pests and diseases. This wealth of diversity is principally conserved in genebanks in four countries in well-known areas of coffee diversity and production – Ethiopia, Costa Rica, Côte d'Ivoire, and Madagascar.

The challenge is that these coffee collections – important as they are – face their own issues. Some need more stable financial support; others need assistance to comprehensively document their collections and make them available to researchers.

The Crop Trust's *Conservation Strategy for Coffee Genetic Resources* shows what needs to be done to safely conserve and share coffee diversity. It was developed in collaboration with World Coffee Research, a non-profit organization funded by more than 30 coffee industry groups.

The Strategy estimates that a contribution of US$25 million to the Crop Trust endowment fund would be enough to generate the US$1 million needed each year to conserve these coffee collections forever. It seems like a small price to pay to ensure the world continues to wake up to coffee – and to protect the livelihoods of those who grow it now and in the future.

VISIT www.croptrust.org/our-work/supporting-crop-conservation/conservation-strategies/

OTHER CROP CONSERVATION STRATEGIES FROM THE CROP TRUST

Banana, Barley, Cassava, Chickpea, Coconut, Cowpea, Edible aroids, Faba bean, Finger millet, Forages, Grasspea, Lentil, Maize, Oats, Pearl millet, Potato, Rice, Sorghum, Strawberry, Sweetpotato, Tea, Wheat

COMPETE TO CONSERVE

Announcing the charitable board game **Catan: Crop Trust**

Makers of the award-winning board game, Catan have come up with a fun new way to learn about the importance of crop conservation, while also raising money for the Crop Trust.

In the standard Catan game, players compete for natural resources and, ultimately, control of the fictional island of Catan.

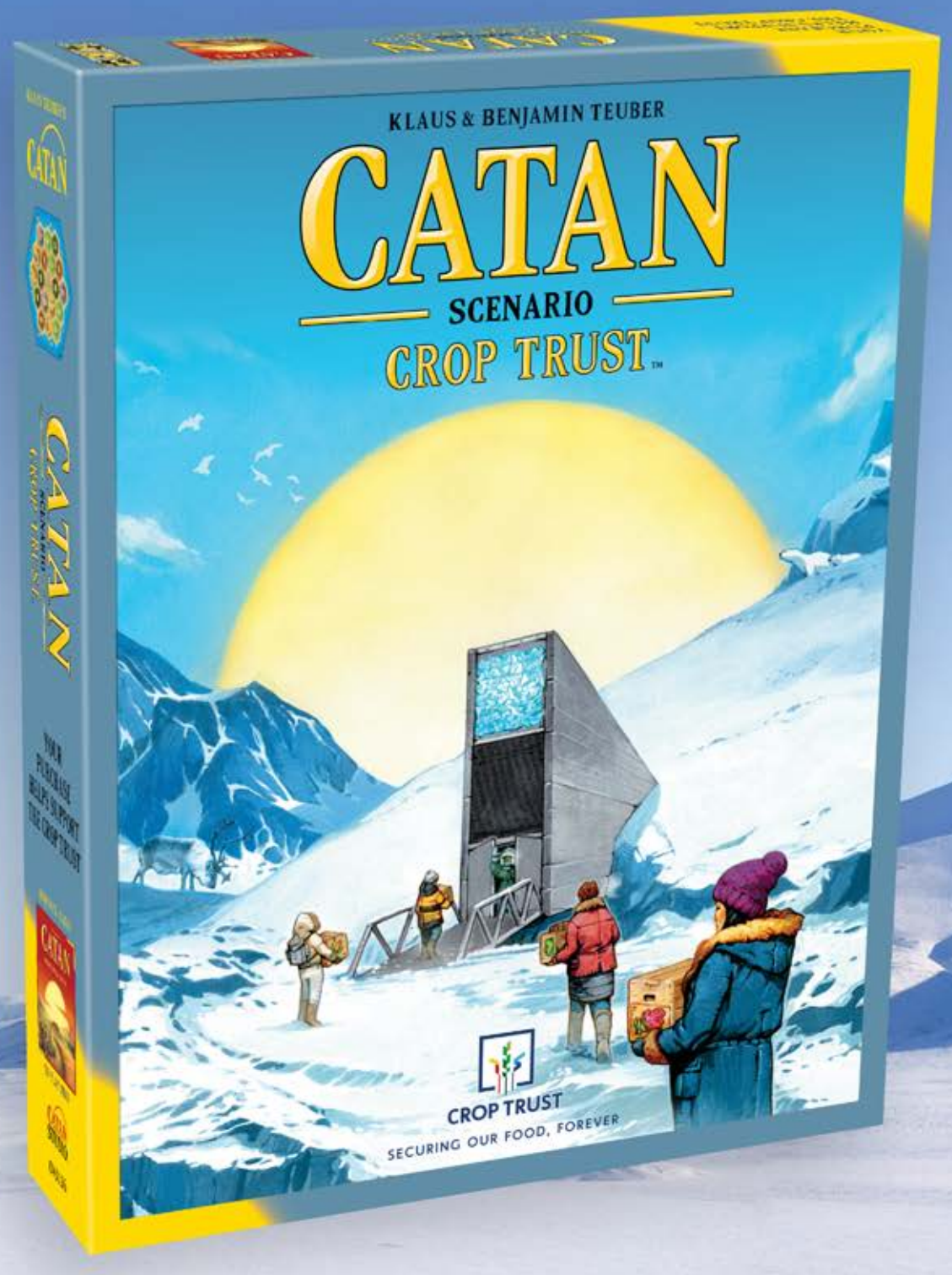
Catan regularly releases themed "scenario boards" that complement the standard Catan base game. The *Catan: Crop Trust* scenario – developed in collaboration with the Crop Trust – encourages players to cooperate to save seeds from their harvests of rice, wheat, maize, and beans in a seed vault. The game is accompanied by a booklet that describes the role of the Svalbard Global Seed Vault, the importance of conserving crop diversity, and information on the role of crop improvement in responding to the challenges facing agriculture around the world.

Catan will donate 100% of the proceeds from the game to the Crop Trust endowment fund, which supports crop conservation efforts around the world, including the work of the Svalbard Global Seed Vault. *Catan: Crop Trust* is the first offering in Catan's new charitable games program aimed at supporting organizations devoted to the conservation and stewardship of nature.

"This is in recognition of the fact that conserving crop diversity is essential for the survival of all on Catan – and of course, in the real world too," said Benjamin Teuber, Managing Director of Catan GmbH and co-creator of the *Catan: Crop Trust* scenario. "This is a completely new element for Catan players to navigate. The focus during harvesting is on cooperation as well as competition. Of course, the Svalbard Global Seed Vault is one of the world's most iconic examples of international cooperation, so the Crop Trust was a logical partner for developing this new Catan scenario."

Already available in English and German, *Catan: Crop Trust* will be launched in additional countries and languages soon.

Genebank managers, Catan staff and more play a prototype of the *Catan: Crop Trust* board game scenario in Longyearbyen, Svalbard.



CROP WILD **RELATIVES**

Q&A with Hannes Dempewolf,
Senior Scientist - Head of Global Initiatives, Crop Trust

A crop wild relative collector scans the landscape in Cayambe Coca National Park, Ecuador

What are crop wild relatives?

They are the wild and weedy cousins of our agricultural crops. They're not farmed, and sometimes they look quite different from the crops they're related to. For example, some wild eggplants are green and have leaves with enormous prickles; some wild bananas have seeds so large and hard they could break your teeth.

Why are they of interest to scientists?

Crop wild relatives occupy a fascinating world of plants that have been subject to little or no human influence, evolving in step with their environments for hundreds of thousands of years. They've repelled pests and diseases, overcome extreme weather, and endured poor soils. That means they're sturdy and resilient, even if they don't produce much in the way of food. Nevertheless, our food crops originate from wild species like these and humans have changed their evolutionary trajectories over thousands of years. That's resulted in crops that give bumper yields of tasty, edible grains, for example, but sometimes it's been at the expense of other characteristics that might also be useful – especially now – like tolerance to heat, drought, or flooding. Some crop wild relatives contain these traits, so they're potentially very useful for crop breeders looking to make our domesticated crops more hardy and productive.

Have crop wild relatives already been used to improve our food crops?

Yes, they have been used extensively, with the main focus being disease resistance. A great example comes from the 1970s, when Asian rice farmers were experiencing huge crop losses due to the brown planthopper – a bug that spreads a rice virus called grassy stunt virus. Scientists screened thousands of wild samples of rice held in genebanks and found only one with resistance to the virus – a species called *Oryza nivara*. But one was all they needed. This wild rice was crossbred with domesticated rice to produce a new, resistant variety that farmers quickly adopted.

Currently, our partners at the International Potato Center in Peru are using wild relatives to develop new potatoes that are resistant to a disease called late blight – the fungus-like pathogen that caused the Irish potato famine in the 19th century. This is still a serious potato disease, particularly in developing countries, and it's likely to become more of a problem as a result of climate change.

Other projects we're coordinating are looking at resistance to high temperatures and drought.

Where can you find crop wild relatives?

It varies. Some grow off the beaten track: on the edges of deserts or remote areas that have rarely seen a human footprint. Some are found on top of mountains or in dense tropical forests that are hard to access. Others hide in plain sight, on the edges of towns and cities, or in and around farmers' fields, growing as weeds, for want of a better term. Our partners have been collecting seeds of crop wild relatives in all sorts of places all over the world.

Why is it important to collect seeds of crop wild relatives?

On the one hand, the fact that these plants still exist in the wild means they are inherently "survivors", and potentially a useful resource for crop improvement. But the big question is how long they can continue to survive. Many crop wild relatives have become extinct as their habitats come under threat:

Wild and domesticated eggplants at the Universitat Politècnica de València, Spain

war, pollution, urbanization, deforestation, roadbuilding, and agriculture itself have all had an impact on the special habitats they occupy. Once a crop wild relative is lost, it's lost forever – that's hundreds of thousands of years of evolution wiped out in an instant. We support efforts to collect them to ensure that their survival is not left to chance. It's the first step in conserving them and making them available to farmers and crop breeders.

How do you know exactly where to collect them?

It's usually a combination of advanced computer modelling and good old human expertise. Computer models and information from past collecting efforts can help us pinpoint areas with the environmental conditions that we think might favor different species. Next, plant specialists – including local experts – the people who know how to read landscapes and look for clues – can help us find them in those environments.

We've had a lot of success with this approach. Luck also plays a role sometimes: one of our collecting partners in Italy spotted a wild relative of sweet pea (*Lathyrus tuberosus*) while looking out of a train window. For the 25 national partners we have been supporting for the past few years, the thrill of the chase can be both exhausting and exhilarating. I've joined a couple of these expeditions and these women and men are extremely passionate about their work. They have crossed alligator-infested swamps in search of wild rice in Costa Rica, and ridden elephants through tiger territory in Nepal. And when they find what they're looking for, it's an incredible feeling of excitement, but also relief.

Searching for banana wild relatives as part of a crop wild relatives workshop in Malaysia

All these activities are part of a single project?

Yes, we call it the Crop Wild Relatives Project, but it has a longer name: *Adapting Agriculture to Climate Change: Collecting, Protecting and Preparing Crop Wild Relatives*. It's a ten-year initiative – which is uncommon in today's world of short project cycles – funded by the Government of Norway. It's unique in that it includes a wide range of activities ranging from identifying places where wild relatives still grow, collecting and conserving them, to preparing them for use by breeders and farmers. As the project name suggests, we're looking for traits from crop wild relatives that – once we have crossed them with domesticated crops – allow the crops to grow in tougher environments, which many crops will likely face as a result of climate change. Through the project we work with an incredible group of partners in more than 40 countries and have been managing the collecting component jointly with our partners from the Millennium Seed Bank at the Royal Botanic Gardens, Kew, in the UK.

Which crop wild relatives is the project focusing on?

It's a big list! Alfalfa, apple, Asian and African rice, Bambara groundnut, banana/plantain, barley, bean, carrot, chickpea, cowpea, durum wheat/bread wheat, eggplant, faba bean, finger millet, grasspea, lentil, oat, pea, pearl millet, pigeon pea, potato, rye, sorghum, sunflower, sweet potato, and vetch. Some are better known than others, but they're all important in their own way, and all are listed under Annex 1 of the International Treaty on Plant Genetic Resources for Food and Agriculture.

Once the seeds are collected, what happens next?

After collecting, the seeds are conserved in national genebanks in the country where they were collected, and duplicates are sent to the Millennium Seed Bank and other important genebanks, which can make them available internationally and will ultimately back them up in the Svalbard Global Seed Vault. Once conserved, they can be researched. The process of testing, selecting, and crossing crop wild relatives with their domesticated counterparts is called pre-breeding. As part of this process, under the Crop Wild Relatives Project, scientists are, for example, crossbreeding wild carrots with domesticated varieties to make the farmed types more tolerant to drought. This can be more difficult than it sounds: some crop wild relatives are so distant from their domesticated cousins that crossbreeding them can be quite complicated. But it's through pre-breeding and evaluating the results that we hope to see which crop wild relatives hold the most promise for improving our domesticated crops. Then they can enter into formal crop breeding programmes.

Is this already happening with any of the crop wild relatives the project has collected?

It's happening for example with eggplant in Spain, Côte d'Ivoire, and Sri Lanka; with potatoes in Peru and Kenya; and pearl millet in India and Niger. Another example is the wild alfalfa being used in Kazakhstan, China, Chile, and Australia. Alfalfa isn't as widely known as a crop as eggplants or potatoes, but it's a really important livestock feed. Some of the wild relatives came from desert-like areas, and these plants show good drought tolerance. In the next few years our partners will be sharing with breeders and farmers newly developed materials that have some "wildness" in them. They will test these new plants in everyday conditions, to see if indeed they are more resilient, though still digestible and tasty for livestock.

What has surprised you the most about working on the project?

To just catch a glimpse of the sheer magnitude of biological diversity – and natural beauty – that is encompassed by the wild relatives of our crops is amazing. To then see how many populations of these wild species teeter on the brink of extinction – often as a result of human influence – is deeply troubling. And when considering the potential benefit of these species to our ability to feed ourselves, the idea of losing them is simply terrifying. The irony of how we actively destroy what could save us, is not lost on us – it underscores the crucial importance of this project.

Some of the locations where our partners have collected have also been absolutely stunning – from the lush forests of southern Nepal to the deserts of Chile, the range of environments where these wild species are found has been mind-blowing. It is really humbling to think of the thousands of years of evolution that have shaped these plants, and the results of which you're witnessing when you find a crop wild relative thriving in its natural habitat. It also gives you a lot of optimism that with each find, you could be helping to change the course of agriculture for the better.

Learn more about the project, *Adapting Agriculture to Climate Change: Collecting, Protecting and Preparing Crop Wild Relatives* VISIT www.cwrdiversity.org

THE SQUASHES OF AUTUMN

From domestication to dessert

In a field at dawn, Petra Page-Mann (pictured below) is picking squash. Although collectively known as "winter squash" for their thick-skinned ability to last right through a long continental winter, here in the United States these prized vegetables of the harvest season are inseparable from autumn - and that most culinary of holidays, Thanksgiving.

Ancient Americans, both North and South, domesticated five viny species of the genus *Cucurbita* into edible winter and summer squashes that, through thousands of years of selection, have come to show some of the most visible diversity of any global crop. Pumpkins blend so closely into this diversity that they are often hard to classify apart from other squashes; many a so-called pumpkin pie is really made from a near relative that is neither round nor orange.

Here, in a chilly upstate New York squash patch early in the morning, is a good place to reflect – on appearances, on flavors, and on a harvest that is far older than Thanksgiving. The name squash itself comes from a word used by the northeastern Narragansett People: *askutasquash*. Petra's butternut squash is a type of *Cucurbita moschata*, a species domesticated in Mexico more than 6,000 years ago and planted across North America by the time Europeans arrived.

All of this history leads up to the autumn's harvest. Yet harvest is also a beginning. Petra, the co-founder of Fruition Seeds in Naples, New York, dedicates these fields to reproducing and selling organic seeds of less-common varieties so current and future generations can grow and cook with them. She is harvesting to keep these varieties alive, and with them the traditions of organic farming and gardening.

Just 30 miles away in Geneva, New York, the United States Department of Agriculture (USDA) is participating in the same mission on a massive scale. Here in the Plant Genetic Resources Unit they have collected the seeds of some 200 vegetable species, from squashes to asparagus, radishes, and tomatillos. This nationally important collection is a linchpin in the long-term conservation and study of squash diversity. Nancy Consolie, Biological Science Lab Technician, keeps the collection in order while sending and receiving shipments of seeds from around the country. This morning, a shipment has arrived from USDA Curator Dr. Claire Heinitz in Palier, California, who has recently been multiplying warm-weather varieties that do not grow well in the New York climate.

But where do the seeds go from here? Some of them go to plant breeder Michael Mazourek at nearby Cornell University, where he and his team develop new vegetable varieties for the Northeast through conventional breeding techniques. Modern vegetable breeders tend to apply these techniques to traits like high yield and long shelf life for the needs of the industrial food system. Mazourek, on the other hand, has been breeding for the greater resilience and lesser environmental impact of crops in organic systems. And for something else: flavor.

This all began with an attempt to breed a more delicious butternut squash. The effort was a triumph: dubbed the Honeynut, it is a small but flavor-packed butternut variant with ten times the sweetness. Fruition Seeds, among many other farms, now produces the Honeynut squash, and its fame has spread among chefs. At the same time, the effort has brought about a re-appraisal of the significance of old varieties conserved in the Geneva collection and elsewhere. These old varieties may be grown by few, if any, gardeners and farmers today, but they hold uncommon traits that can tempt palates and inspire growers.

In the lab, Shane Sullivan is slicing squashes down the middle to photograph their specific attributes – "to analyze the quality of their interior, for color, flavor and nutrition," says Mazourik. Every variation is a piece of the breeding puzzle, unlocking idiosyncrasies and surprises. The old varieties may not suit the tight specifications of the modern supply chain – but a focus on flavor and diversity has brought them back to the cutting edge of squash experimentation.

Small-town America is experimenting along in places like the Hazelnut Kitchen on Main Street of Trumansburg, New York, which offers an ever-changing menu based on locally sourced seasonal ingredients. Hazelnut Kitchen's Sous-chef prepares a flavourful starter dubbed the "Plow Break Farm grown Row7Seeds Robin's Koginut Squash". Here a little pumpkin called the Koginut – bred by Mazourek, sold by Row7Seeds – is offered three different ways: roasted, toasted, and pureed, in a dragon tongue arugula salad, accompanied by an apple cinnamon compote and cinnamon vinaigrette.

Mazourek and his team work directly with farmers to put the Honeynut, Koginut and other varieties in the field. At Norwich Meadows Farm in Norwich, New York, Zaid Kurdieh has harvested Honeynuts alongside a seemingly endless variety of other shapes and colors.

Zaid loves to grow something of everything and is quick to try out new and different seeds when he hears about them, either from breeders like Mazourek or from the chefs he supplies. He'll also pick a variety out of a catalog, "just to try it out", and come harvest season, share a few samples with his customers. Now the rewards of the season lay spread out inside high tunnels, ready for the market.

Seeking diversity well beyond that found on supermarket shelves, New York City chefs tend to buy these varieties straight from farmers – sometimes ordering a whole season's worth of squash and other vegetables with payment up front, but more often seeking out the varieties they want at farmers' markets. Like most of these, Union Square Green Market springs up on a weekly schedule between apartments and office blocks.

In the city, the season of harvest can be a distant concept, diffused into whiffs of pumpkin spice coffee and tiny decorative gourds. But the real, edible truth arrives with greater substance. Here, like strange living artifacts sent from New York's periphery and its past, fabulous winter squashes have a special power to turn heads.

of unfamiliar produce – whether the varieties are brand new or very old.

Meanwhile in Brooklyn, some squashes have been city-dwellers from the first sprout. In the neighborhood of East New York, Marlene Wilks grows a long list of vegetables in community garden lots and in her own backyard. Though she and her husband hold other, non-agricultural jobs, they spend long hours in their urban gardens. As her customers are neighbors hailing from all over the world, through the years she has grown an unusual diversity of international vegetables and herbs on her small urban plots. But close to her own Caribbean heart are Jamaican squashes, close yet distinct relatives of the butternut.

Marlene's style of urban agriculture is one of many individual efforts that have grown into an organized movement all over New York City and far beyond. She is part of East New York Farms!, one of the pioneering programs for food justice, community building, and food access. Beginning in 1998 with a single vacant lot and folding table, the program is now a focal point for residents young and old to engage in gardening and food issues – and to get ahold of just the right vegetables for their family recipes, whether for daily meals or a holiday spread.

> ‘We all depend on seed banks whether we realise it or not.’

Zaid is here with his squashes, introducing the newest ones to Jenny Jones, purchasing manager from the restaurant Untitled at the Whitney Museum of American Art. For many urban shoppers, these forms can be as intimidating as they are intriguing – but the professionals see something different when they look at them. Jenny and Untitled's Executive Chef, Suzanne Cupps, are well versed in the demands and possibilities of winter squash. Their job, as they see it, is to amaze their diners with the tastes, smells, colors, and textures of the season, thereby connecting them with farmers and the land. They achieve this through their interpretations

In the kitchen of Untitled at the Whitney, Suzanne Cupps reveals one of the secrets of winter squash: how easy it really is to cook. Taking a knife to a rock-hard butternut or pumpkin is a daunting start to any recipe, but it doesn't have to be. For many uses, in fact, a squash can be baked or roasted whole until it's buttery soft. This preparation hearkens back to the oldest American roots of this crop, and to stuffed, spiced pumpkins baked in the coals of a fire – the colonial precursor to the Thanksgiving pumpkin pie.

Today's pumpkin pies are just as often baked from pre-processed pumpkins or brought home from the store. But experimentation with, and appreciation for, local squash diversity is back in a big way.

#CropsInColor is made possible by the generous support of Corteva Agriscience.

#CropsInColor celebrates the critical importance of crop diversity and its beauty and cultural relevance across different landscapes. It highlights many key actors in our food systems - from consumer to farmer to seed bank - who are doing their part in safeguarding, making available, and using crop diversity.

For their unconditional support during our recent **#SquashInColor** trip to the northeast region of the United States, we would like to thank the following: East New York Farms!; Fellenz Family Farm; Frerichs Farm; Fruition Seeds; Gramercy Tavern; Hazlenut Kitchen; MazLab Seed Farm, Cornell University; Norwich Meadows Farm; Row7Seeds; Stony Brook WholeHeartedFoods; Untitled at the Whitney Museum; and USDA ARS.

VISIT www.croptrust.org/our-mission/cropsincolor/

Suzanne Cupps, Executive Chef of Untitled at the Whitney Museum of American Art, prepares freshly-harvested squash

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