



SVALBARD GLOBAL SEED VAULT

# Annual Progress Report 2020

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NordGen report on the agreement on the funding, management and operation of the Svalbard Global Seed Vault.

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Front page photo: Erna Solberg, Prime Minister of Norway greets and hands over a diploma to Griselda Arrieta Espinoza and Allan Menezes representing the University of Costa Rica after their deposit of wild rice seeds in the Svalbard Global Seed Vault on the 24<sup>th</sup> of February 2020. Photo: Norwegian Ministry of Agriculture and Food/ Ragnhild Utne

## 2020 at a glance

- In total 82,501 safety duplicates from 42 depositors were added to the Seed Vault collection in 2020. By the end of the year the total holding of seed accessions in the Seed Vault was 1,074,533 samples.
- Eight gene banks deposited seeds for the first time in 2020, located in Romania, Lebanon, United Kingdom (2), Morocco, Lebanon, South-Korea, Germany, and the United States.
- A Seed Summit and a major seed deposit attended by Erna Solberg, the Prime Minister of Norway, were organized at the end of February. More than 100 participants representing genebanks, institutions and organisations working with plant genetic resources attended the events.
- During the same days, the Prime Minister hosted a meeting in the UN Sustainable Development Goals Advocacy Group. The group prepared and presented an Arctic Call to Action on Food Security and Climate Change and participated in the seed deposit and attended the Svalbard Seed Summit.
- The second meeting in the International Advisory Panel was organized in Longyearbyen back-to-back to the Seed Summit and the seed deposit events.
- The first seeds belonging to the 100-year seed germination experiment in the Seed Vault were produced by IPK, Germany, prepared and packed at NordGen in Alnarp and put in place in the Seed Vault in 2020. A project meeting, gathering representatives from all project partner institutes was organised in Longyearbyen in the end of February.

## Foreword

NordGen manages and operates the seed deposits at the Svalbard Global Seed Vault in partnership with the Norwegian Ministry of Agriculture and Food (LMD) and the Global Crop Diversity Trust (Crop Trust) and in accordance with the Three Party Agreement between the partners, signed for ten years and valid from 1<sup>st</sup> of July 2017.

The objective of the Seed Vault is to provide a safety net for the international conservation system of plant genetic resources, and to contribute to securing the maximum amount of plant genetic diversity of importance to humanity for the long term. The success of the Seed Vault has continued this year both measured in terms of participation from the global genebank community and in terms of public interest and awareness about the purpose of the Seed Vault. By the end of 2020, the Seed Vault holds 1,074,533 safety duplicates representing wide inter- and intra-specific crop diversity deposited by 87 genebanks from around the world. In fact, the number of genebanks depositing seeds this year was the highest ever in the history of the Seed Vault.

The Svalbard Global Seed Vault is a flagship project for NordGen, and 2020 was the thirteenth year of operation. We take great pride in the role we play in this project and I take this opportunity to thank our partners LMD and the Crop Trust for the good collaboration. I would also like to thank Statsbygg for the cooperation and the excellent working relationship we have at Svalbard.

It is with great satisfaction we see that the confidence and global interest for the Svalbard Global Seed Vault has increased significantly after the technical upgrade of the Seed Vault construction, that was finalized in 2019 and adequately celebrated during the Seed Summit and the seed deposits events attended by the Prime Minister of Norway in the end of February.

Lise Lykke Steffensen  
Executive director NordGen

## 1. Introduction

This annual progress report for the Svalbard Global Seed Vault gives an overview of the NordGen operation of the Seed Vault and related activities in 2020. NordGen's responsibilities are stated in the Three-Party Agreement providing for the long-term funding, management and operation of the Svalbard Global Seed Vault. The annual progress report is prepared by NordGen in accordance with obligations in the Three-Party Agreement Article 3.19.a).

The overall guidelines for the NordGen mission is to fulfil the objectives for the Svalbard Global Seed Vault as they are expressed in the standard deposit agreement between depositors and the Royal Norwegian Ministry of Agriculture and Food, saying that the Seed Vault was established with the *"objective to provide a safety net for the international conservation system of plant genetic resources, and to contribute to the securing of the maximum amount of plant genetic diversity of importance to humanity for the long term in accordance with the latest scientific knowledge and most appropriate technique"*.

The operation of the Seed Vault is a collaborative endeavour at several levels. At the management level NordGen collaborates closely with LMD and Crop Trust. At the facility operation level NordGen cooperates with Statsbygg in Longyearbyen. At the seed logistics level, we cooperate with the institutions sending safety duplicates as well as the chain of logistics and security partners involved in shipment and transport to the Seed Vault. The partnerships at all levels have worked very well also in 2020.

## 2. Seed deposits and depositors in 2020

Thanks to the Seed Vault construction upgrades that were finalized during 2019 and the special invitation to join events for paying attention to this major improvement in February, 2020 turned out to be a very active year in the history of the Seed Vault. In total, 42 genebanks deposited seeds in 2020, among these eight genebanks that deposited seeds for the first time. This is the highest number of depositing genebanks during one year since the Seed Vault opened in 2008.

The total number of deposited seed samples mounted to 82,501, which is the second highest number of deposited samples during one year since 2011, only surpassed by 2018 when the 10-year Seed Vault anniversary was celebrated.

A major part of the seed deposits in 2020 was conducted at the seed deposit event that was organized on the 24<sup>th</sup> of February, marking that the construction upgrades were finalized. In recognition of the importance of this deposit, Norwegian Prime Minister Erna Solberg invited fellow members of the UN Sustainable Development Goals (SDG) Advocacy Group to participate in the seed deposit, and then to attend the Svalbard Seed Summit to prepare and present an Arctic Call to Action on Food Security and Climate Change.

In total 35 genebanks deposited seeds in the Seed Vault at this occasion, and 28 of them were represented at the Seed Summit conference and at the seed deposit event with one or more officials. Prime Minister Erna Solberg handed over a specially designed diploma to the attending depositing institutes.

Luckily, the Seed Summit and the seed events in February were organized just in the last minute before the covid-19 pandemic caused travel restrictions that would have made it impossible to arrange such events. Only two institutes intending to participate were not able to come, due to problems related to the pandemic.

The high number of accessions and participating depositors in February was made possible because of good cooperation between several partners. In addition to the three regular partners, LMD, Crop Trust and NordGen, the Norwegian Ministry of Foreign Affairs (MFA) and the Prime Ministers' office (SMK) were active in the planning and implementation. Extra costs for the events were covered by LMD. A significant number of genebanks located in developing countries deposited seeds and were represented in Svalbard, thanks to financial support provided by MFA and organized by Crop Trust.

Besides this very successful seed deposit events in February, the year was marked by the covid-19 pandemic. However, despite difficult working conditions in most countries and restrictions to air freight and shipment options, two more Seed Vault openings were organised during 2020, comprising seed deposits from nine genebanks (table 1).

*Table 1. Seed Vault deposits and dates in 2020*

<b>Depositor / Date of deposit</b>			
<b>26th of February</b>	<b>Acronym</b>	<b>Code</b>	<b>Accessions</b>
Leibniz Institute of Plant Genetics and Crop Plant Research	IPK	DEU146	5307
The Brazilian Agricultural Research Corporation	Embrapa	BRA008	3438
National Plant Germplasm System	USDA	USA996	14492
Julius Kühn Institute	JKI	DEU451	2
SADC Plant Genetic Resources Centre	SPGRC	ZMB030	2540
Institut d'Economie Rurale	IER	MLI002	276
Crop Research Institute	CRI	CZE122	95
Centro Internacional de Agricultura Tropical	CIAT	COL003	1270
Agricultural Research Institute of Burundi	ISABU	BDI001	390
International Crop Research Institute for the Semi-Arid Tropics	ICRISAT	IND002	2840
International Rice Research Institute	IRRI	PHL001	954
Department of Agriculture, Food and the Marine	DAFF	IRL029	39

Agricultural Plant Genetic Resources Conservation and Research Centre	APGRC	SDN002	301
National Rice Seed Storage Laboratory for Genetic Resources	NRSSL	THA012	68
Institute of Plant and Agricultural Sciences	MPGRPPD	MNG003	200
Centro Internacional de Mejoramiento de Maíz y Trigo	CIMMYT	MEX002	15561
Portuguese Bank of Plant Germplasm	INIAV	PRT001	389
Nordic Genetic Resource Center	NordGen	SWE054	1956
Plant Genetic Resources Institute, National Agricultural Research Centre	PARC	PAK034	310
Warwick Genetic Resources Unit	UKVGB	GBR006	989
Margot Forde Germplasm Centre	AGRESEARCH	NZL001	442
Department of Agriculture, Ministry of Agriculture and Cooperation	DOA	THA032	23
Baekdudaegan National Arboretum	BDNA	KOR048	10
International Centre for Agricultural Research in Dry Areas	ICARDA	SYR002	9531
Centro Internacional de la Papa	CIP	PER001	236
World Vegetable Center in Taiwan	WorldVeg	TWN001	754
Lebanese Agricultural Research Institute	LARI	LBN020	453
Royal Botanic Gardens, Kew	MSB Kew	GBR004	*)
University of Haifa		ISR037	323
International Livestock Research Institute	ILRI	ETH013	382
Suceava Genebank "Mihai Cristea"	BRGV	ROM007	416
Seed Savers Exchange	SSE	USA974	89
Cherokee Nation	CN	USA1005	9
University of Costa Rica	UCR-CIA	CRI003	51
Institut National de la Recherche Agronomique	INRA	MAR123	983
<b>27th of August</b>			
John Innes Centre Genetic Resources Unit	JIC	GBR247	2922
<b>27th October 2020</b>			
National Rice Seed Storage Laboratory for Genetic Resources	NRSSL	THA012	264
Chaipattana Foundation	CHAIPATT	THA513	14
World Agroforestry Centre	ICRAF	KEN023	76
SADC Plant Genetic Resources Centre	SPGRC	ZMB030	1051
Plant Breeding and acclimatisation Institute	IHAR	POL003	1236
RDA, National Agrobiodiversity Center	RDA	KOR043	10000
Africa Rice Center	AfricaRice	CIV033	754
International Institute of Tropical Agriculture	IITA	NGA057	1065

\*) Deposit consisting of two pasture seed mixture samples not included in the Seed Portal.

Eight genebanks deposited seeds for the first time in 2020, located in Romania, Lebanon, United Kingdom (2), Morocco, Lebanon, South-Korea, Germany, and the United States. One of these, the Millennium Seed Bank at Royal Botanic Gardens, Kew deposited two samples of seed mixtures harvested at two pasture fields at Highgrove estate, which is part of the UK Coronation Meadow project maintained as an *in-situ* conservation site for biological resources and cultural landscape. These samples are not included in the Seed Portal.

By the end of 2020 NordGen has, on behalf of LMD signed Deposit Agreements (DA) with 96 institutions. Out of these 87 are active depositors, and by the end of the year the total holding of seed accessions in the Seed Vault was 1,074,533 (table 2).

Depositors not included in the Seed Portal (Millennium Seed Bank, Kew and Myanmar orchid deposit) are not included in this number. Five depositors have made organizational changes, causing that the ownership and responsibility for previous deposits have been changed. By the end of 2020, four genebanks have signed the DA, but not yet deposited seeds.

*Table 2. Deposited and withdrawn seed accessions pr year and in total for the years 2008-2020. Figures showing status at the end of each year.*

<b>Year</b>	<b>Deposited pr year</b>	<b>Deposited in total</b>	<b>Withdrawals</b>	<b>Current holdings</b>
2008	320549	320549		320549
2009	169505	490054		490054
2010	111101	601155		601155
2011	113364	714519		714519
2012	58078	772597		772597
2013	29155	801752		801752
2014	38052	839804	3 <sup>1)</sup>	839801
2015	36130	875934	38073 <sup>2)</sup>	837858
2016	42979	918913		880837
2017	64403	983316	54354 <sup>2)</sup>	890886
2018	92638	1075954		983524
2019	32572	1108526	24064 <sup>2) 3)</sup>	992032
2020	82501	1191027		1074533
<b>Totals</b>	<b>1191027</b>	<b>1191027</b>	<b>116494</b>	<b>1074533</b>

<sup>1)</sup> Three *Hordeum* accession withdrawn by NordGen for regeneration

<sup>2)</sup> ICARDA withdrawals in 2015, 2017 and 2019

<sup>3)</sup> Seven *Secale* accessions withdrawn by Agroscope, Switzerland for regeneration



A complete list of signatories and deposits are shown in Annex 1. Further details and key figures for the years 2014 to 2020 for seed deposits, stored boxes, depositors and seed deposit events are shown in Annex 3.

Twelve of the current 87 depositors are International Agricultural Research Institutes (IARCs), 67 are national gene banks and universities, two are regional genebanks and five are NGO gene bank collections. One of the depositors is a private company that has deposited seeds in cooperation with the country's government (Singapore).

Figure 1 shows the proportion and numbers of safety duplicates deposited by different categories of genebanks by the end of 2020. The largest share (58,6%) of the current holdings in the Seed Vault is deposited by IARCs represented by institutes belonging to the Consultative Group of International Agricultural Research Centres (CGIAR), the Asian Vegetable Research Centre (AVRDC) and the Tropical Agricultural Research and Higher Education Centre (CATIE), all holding collections of PGRFA in trust for the UN Food and Agriculture Organisation (FAO).

Two depositors are regional genebanks, SPGRC and NordGen, standing for 3,3% of the total number of deposited accessions.

Considering the national and subnational collections, a significant number of the depositors are located in developing regions; however, the numbers of safety duplicates sent from institutes in developing regions are smaller than the numbers sent from institutes in developed regions. 37,6% of the seed samples in the Seed Vault have been deposited by national genebanks and universities.

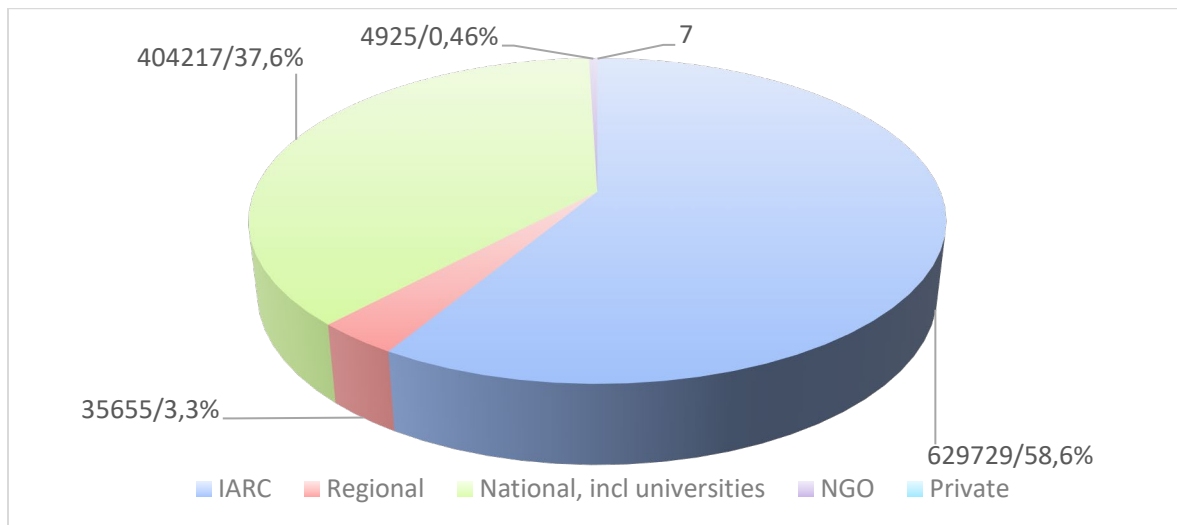
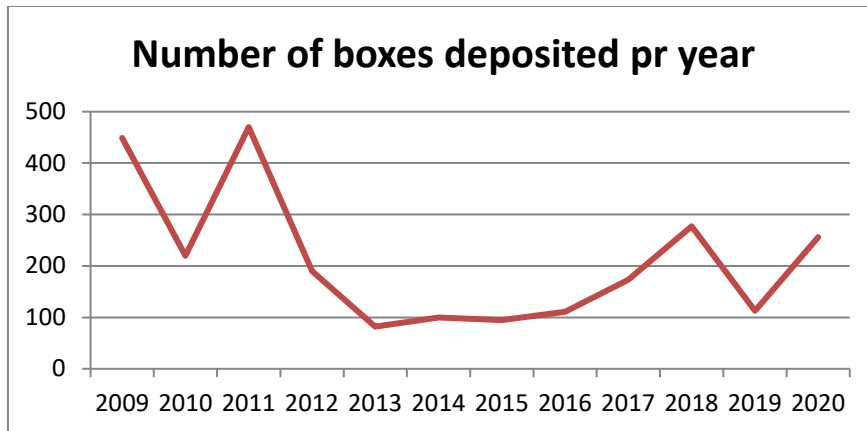


Figure 1. The proportion and numbers of safety duplicates currently deposited in The Vault at the end of 2020 by different categories of genebanks.

In total, 256 new seed boxes were taken into the Seed Vault in 2020. Over the years, 3350 regular seed boxes have been deposited in the Seed Vault, while 325 boxes have been taken out. By the end of the year 3025 regular seed boxes are stored in the Seed Vault. Test boxes and boxes with seeds not included in the Seed Portal are not included in this number.



*Figure 2. Numbers of boxes deposited per year 2008-2020. (Withdrawals not shown.) The graph indicates that special invitations and events organized in Svalbard increase the interest for depositing seeds in the Seed Vault.*

The shelves in storage hall #2, with a capacity of 2880 boxes, was filled up during the Seed Vault opening in February and shelves with the same capacity were installed in storage hall #1 and applied for the first time at this event.



*Figure 3. Storage hall #2 (left) is almost filled up to the current shelf capacity. Shelves with equal box capacity have been installed in storage hall #1, providing space for new deposits for the coming years. Photos: Riccardo Gangale and Åsmund Asdal*

Seed shipment logistics imply that depositor genebanks send their seeds directly to Svalbard. Not all logistic companies are able to bring the seed shipments smoothly through custom clearance procedures when arriving in Oslo airport. For a couple of shipments, extra actions for bringing the seeds from Oslo to Svalbard were needed. This issue will be paid attention at upcoming seed shipments, by NordGen in cooperation with partner Pole Position Logistics (PPL) in Longyearbyen.

Logistics at Svalbard have been handled in collaboration with the local logistics company PPL. Security screening of seed boxes upon arrival in Svalbard have been handled in collaboration with the authorities at Longyearbyen airport and the security company Avarn Security Aviation AS. Statsbygg has provided support with logistics and technical backstopping during deposit openings at Svalbard.

### 3. Data management

NordGen is responsible for maintaining and updating an internationally publicly accessible electronic database on the deposited material in the Seed Vault. During 2019 and 2020 a new version of the Seed Portal database has been developed and is available at <https://seedvault.nordgen.org/>. The project has been funded by LMD. All data previously registered in the first version have been transferred to the Seed Portal 2.0 that was launched and has been applied from the second half of 2020.

The new version combines functionalities that previously were divided in two databases, the Seed Portal containing information about seed deposits and stored material and the Seed Store keeping records of the location of all boxes in the Seed Vault.

The Seed Portal 2.0 includes improved routines for handling accession lists from depositors and a more modern web interface. New functionalities are included, among these routines for controlling accuracy of information in the accession lists, e.g. taxonomy. Routines for handling situations that were not high priorities when the Seed Vault was built have now been included in the database e.g. withdrawals of seeds, filling up half-full boxes with seeds from subsequent deposit events, replacing older samples with new fresh seeds and reorganization of depositor institutes. Functionalities include options for easy correcting and update of information in the database.

*Figure 4. The Seed Portal 2.0. advanced search interface where genebanks, media and others can find detailed information about the Seed Vault holdings.*

For the public, the new portal offers advanced options for filtered search on information about the current content of the Seed Vault: about samples and species, depositors, origin of the accessions and deposit events (figure 4).

NordGen has handled and uploaded 44 accession list datasets in 2020 at three different Seed Vault opening events.

#### **4. The International Advisory Panel**

The second meeting of the International Advisory Panel (IAP) was conducted back-to-back with the Seed Summit and the seed deposit events in February, on the 23<sup>rd</sup> and the 24<sup>th</sup> of February 2020.

Members of the IAP are representing depositor institutes, suggested ad hoc for each meeting by Crop Trust and NordGen and approved by LMD. In addition, LMD appoints two members representing key stakeholders. The chair of the Governing body of the ITPGRFA is invited to act as the chairperson of IAP. The NordGen Executive Director is the responsible secretary of IAP.

Members of the IAP for the meeting in 2020 have been:

- Yasmina El Bahloul, INRA, Morocco (chair)
- Ahmed Amri, ICARDA, Morocco (re-appointed from IAP 2018)
- Juan Lucas Restrepo, Bioersivity, Italy
- Godfrey Mwila, SPGRC, Zambia
- Rosa Lia Barbieri, Embrapa, Brazil
- Külli Annama, ECRI, Estonia
- Kristin Børresen, Graminor, Norway (re-appointed from IAP 2018)

IAP was informed about the upgrade of the Seed Vault construction that has been finalized and about new routines for management and increased security and policies for access and visits to the Seed Vault. The IAP discussed measures for securing transparency and conducting public outreach activities with the new routines. In addition, the IAP discussed procedures for attracting new genebanks as depositors and future strategies for increasing the number of deposited samples. The members agreed to act as ambassadors for the Seed Vault and discussed how this task can be conducted in the best possible ways.

NordGen has been staying in touch with and provided relevant information to the IAP members during the year. Some IAP members have given lectures about the Svalbard Global Seed Vault in their regions and in their professional environments, and some have facilitated contact with potentially new depositors.



*Figure 5. The Seed Vault International Advisory Panel and representatives from the three partner organisations while inspecting the Seed Vault facility. From the left Grethe Evjen, LMD, Lise Lykke Steffensen, NordGen, Külli Annama, ECRI, Godfrey Mwila, SPGRC, Bell Batta Torheim, LMD, Yasmina El Bahloul, INRA, Hannes Dempewolf, Crop Trust, Kristin Børresen, Graminor, Stephan Schmidt, Crop Trust, Ahmed Amri, ICARDA, Åsmund Asdal, NordGen, Juan Lucas Restrepo, Bioversity and Rosa Lia Barbieri, Embrapa. Photo: Thomas Sonne.*

## **5. Public awareness activities**

In accordance with article 4 in the Three Party Agreement and with the agreed work plan and budget for 2020, NordGen works considerably with public outreach activities, in cooperation with the partners. Information about the Svalbard Global Seed Vault is passed on through several platforms: responding to questions about the operation from the public and from media, presentations and lectures for different scientific and public audiences, social media posts, written articles and giving press interviews. NordGen has produced information, text and photos for information material and the Seed Vault web sites. Lectures and written articles are listed in annexes 4 and 5.

NordGen communication staff contributed substantially to the organization of the Seed Vault events in Svalbard in February, in planning and implementation and in particular by handling media during the events and providing information, photo and video to internal and external users.

NordGen has through 2020 participated in the Seed Vault communication working group consisting of the three partners; the Norwegian Ministry of Agriculture and Food, Crop Trust and NordGen organized by the Ministry.

Parts of the public awareness activities have been influenced by the covid-19 pandemic in 2020, in particular activities that include travels, like participation in conferences, giving lectures and meeting media in Svalbard. Media contact has to a large extent moved from physical meetings with journalists to interviews and responding to requests on digital platforms. However, also in 2020 NordGen staff has received media in Longyearbyen and given interviews at the seed deposit occasions. Workload related to public contact and responding to requests through email has remained at the same high level. All serious emails are responded to.

## 6. Long term seed storage experiments

The *100 year Seed Longevity Experiment in the Svalbard Global Seed Vault* started in 2020. The project includes seeds of 13 different crops and six genebanks as project partners producing seeds for the experiment. The plan is that seeds will be produced and deployed in the Seed Vault over the next 4 years, and that identical samples will be taken out and analyzed for germination every tenth year. Partners and crops are shown in table 3.

Table 3. Crops and genebank institutes included in the experiment.

Institute	Providing seeds of crops
National Rice Seed Storage Laboratory for Genetic Resources (NRSSL), Thailand	Rice ( <i>Oryza sativa</i> )
Leibniz Institute of Plant Genetics and Crop Plant Research (IPK), Germany	Barley ( <i>Hordeum</i> ), pea ( <i>Pisum</i> ), wheat ( <i>Triticum</i> ), lettuce ( <i>Lactuca</i> ) and <i>Brassica oleracea</i> <sup>3)</sup>
The International Crop Research Institute for the Semi-Arid Tropics (ICRISAT), India	Groundnut ( <i>Arachis</i> ), chickpea ( <i>Cicer</i> ), pearl millet ( <i>Pennisetum</i> ) and pigeon pea ( <i>Cajanus</i> )
Instituto Nacional de Investigação Agrária, INIAV, Portugal	Maize ( <i>Zea mays</i> )
Empresa Brasileira de Pesquisa Agropecuária (Embrapa), Brazil	Soybean ( <i>Glycine max</i> )
Nordic Genetic Resource Centre, Sweden	Timothy ( <i>Phleum pratense</i> )

A project meeting with all partners was organized in Longyearbyen 26<sup>th</sup> and 27<sup>th</sup> of February, back-to-back with to the Seed Summit and seed deposit events. The first seeds for the experiment were produced by IPK in 2019 and placed in the Seed Vault in August 2020. Identical copies of three species are placed in the NordGen steel container in the coal mine. Samples from the coal mine will be taken out for germination tests at the same intervals and results will be compared with analysis results from seeds stored in the Seed Vault.

Seed samples for the experiment are dried, analyzed for water content, prepared and packed at NordGen before storage in the Seed Vault and the coal mine. Chemical analysis have been carried out by IPK, Germany, and start germination values have been determined by Kimen SeedLab in Ås, Norway.

*Figure 6. Participants in the seed longevity project meeting in Longyearbyen on the 27<sup>th</sup> of February 2020. From the left Rosa Lia Barbieri, Embrapa, Brazil, Manuela Nagel, IPK, Germany, Kulchana Darwell, NRSSL, Thailand, Ulrike Lohwasser, IPK, Åsmund Asdal, NordGen, Vania Azevedo, ICRISAT, India, Jette Nydam, NordGen, Ana Maria Barata, INIAV, Portugal and Andreas Börner, IPK.*



The seeds belonging to the ongoing *100 year Seed Storage Experiment in the Coal Mine* are stored in the NordGen steel container in Frøyhall in Coal Mine #3 and have not been touched in 2020. Next withdrawal of seeds from here is scheduled for December 2021. As the Seed Vault is closed for visitors, bringing visitors and media into the seed container in the coal mine has been conducted at a couple of occasions.

Costs for the establishment of the project in the Seed Vault and rent for storage space in the coal mine are covered through the Seed Vault budget.

## **7. Printing accession data on nanofilm**

It has been decided to increase the security and integrity of the data about seed samples that are deposited in the Seed Vault by printing data on nanofilm. First part of the project was included in the workplan and budget for 2020. As NordGen IT capacities in 2020 have been allocated to the development of the Seed Portal 2.0 and to heavy workloads related to the implementation of GENBIS/Grin-Global the start-up of the nanofilm project has been postponed to 2021.

## 8. Financial result

Key figures for result, funding and working capital for the years 2017-2020 are shown in table 4. Account wise budget and spending for 2020 are shown in Annex 2. The financial result as the difference between funding and spending for 2020 shows a surplus of SEK 600,108. The reasons for the surplus are mostly related to changed working conditions due to the ongoing covid-19 pandemic. More details account wise below.

### Directing and interaction with partners

Total spending on this activity area has been approximately 60% of the budget. Lower meeting and travel activity due to the pandemic has reduced the spending on overall management. Meetings have mostly been organized on digital platforms, which has reduced travel expenditures and the number of working days significantly.

### Administration, planning and documentation

Administrative staff at NordGen takes care of annual budgets, financial statements and bookkeeping, and assists in the Seed Vault operations with document handling, archive and organizing events and travels. Consumption in 2020 accounts for 90% of the budget. In the budget it was planned to involve one more staff member (support project coordinator) in administrative work. During the year, this plan was changed, and tasks were taken care of by other NordGen staff.

### Liaising with depositors and handling of seeds

Total spending during 2020 is in accordance with the budget. Due to travel restrictions, handling seeds in Svalbard has, for the two last Seed Vault openings been carried out without assistance from NordGen staff located in Alnarp, Sweden. The travel costs have, however, increased, both due to higher air fares after the pandemic affected the air traffic and because Statsbygg no longer offer NordGen free of charge accommodation.

### Data management

Significant overspending in the data management activity area relates to the implementation of the new Seed Portal, which has required more working hour inputs from the Seed Vault coordinator. Implementation of the Seed Portal 2.0 implies that more work related to handling and validation of depositor accession list datasets will be moved from IT-staff to the Seed Vault coordinator.

### Communication attracting new depositor genebanks

Spending on this activity area has been approximately 50% of the budget. Planned activities included some travels, participation in conferences and meetings where genebank representatives meet and one



or two visits to potential depositor genebanks. The pandemic put an end to travels, meetings and conferences and the spending on the activity area is related to contact on digital platforms, which is less time consuming.

#### Public awareness activities

Public awareness activities involve the NordGen Communication Manager and the Seed Vault Coordinator. Total spending during the year has been around 85% of the budget. The lower spending is mainly explained by reduced travel costs and working hours spent on travels.

#### International Advisory Panel

The second meeting of the International Advisory Panel was initially planned for in the 2019 budget. However, due to the events organized in February 2020 the meeting was postponed and held back-to-back to the events. Parts of the budget for the meeting were transferred from the 2019 budget to 2020 (see table 4). In total, the meeting costs accounted for 92% of the budget, which is considered very close to plans and budgets.

#### Long term storage experiments

Due to the pandemic, parts of the new project *Long Term Storage Experiment in the Seed Vault* have been delayed. The main reason for this is that participating genebanks in Thailand and Brazil have not been able to produce and send seeds for the experiment as planned. Due to this, costs for seed analysis have been much lower than planned. Labour costs have been higher than budgeted because some unforeseen starting difficulties occurred, both related to seed production at the seed providing genebank and to the implementation of working procedures at NordGen.

Only one institute was able to send seeds in 2020, and the shipment costs were covered outside the Seed Vault budget. For the same reason, no costs for equipment purchase are entered in the accounts, because NordGen was able to fund the equipment (seed dividers) through other sources.

It is important that savings in this project in 2020 can be spent on seed analysis and handling that will be carried out in 2021 and 2022.

#### Conserving data on long-term storage medium

Due to heavy workloads related to implementation of GENBIS in NordGen in general and to development and implementation of the new Seed Portal, printing of accession data on nanofilm has

been postponed to 2021 and 2022. NordGen wants to use the amount saved in the 2020 budget for the same tasks in 2021.

#### Upgrade of the Seed Portal database and interface

The new Seed Portal was implemented during 2020. During the implementation it was necessary to engage the developer (Sopra Steria) to introduce a couple of adjustments and extra functions that were not included in the initial tender. This led to a small overspending. It is expected that during the one or two coming years, experience and daily use of the Seed Portal 2.0 will identify the need for further adjustments that will involve external consultant and some extra costs.

#### Arrangement Svalbard February 2020

NordGen contributed significantly to the organisation of the events in Svalbard in February 2020. Parts of the working time and travel expenditures were covered by the regular Seed Vault budget (administration, handing of seed shipments, public awareness and IAP). Extra need for staff, travels and material were presented in a separate event budget of SEK 192,548. The accounts show spending of SEK 230,461. Given this large, comprehensive and costly arrangement, NordGen considers the spending to be well in line with the budget.

#### Core activities vs. project activities

In total, the accounts for 2020 (Annex 2) shows a surplus of SEK 600,108 in comparing the actual funding against expenditures for the year. This surplus has two main reasons, a) reduced expenditure on core activities / basic grant mainly related to changed activity due to the corona situation and b) postponed activities in the seed longevity experiment (100 year) and on printing data on long-term storage medium (nanofilm).

Lower spending due to postponed activities in the two above mentioned continuing projects correspond to SEK 344,043. This amount should be available for covering activities in these projects during coming years.

#### Working Capital Fund

According to regulations in the Three Party Agreement the difference between total spending and funding each year will be added to the Working Capital Fund (WCF). As indicated in Annex 2, the Crop Trust contributions to the Seed Vault budgets are provided in euros, and the fluctuations in currency exchange rates Euros vs. SEK between budgeting and payment impacts the actual surplus and the WCF balance.

The calculation shown in Annex 2 and table 4 outline that SEK 600,108 is added to the WCF in 2020. The total funds received from the three parties in 2020 plus funds from the communication project amounted to SEK 4,578,741. In addition, for organizing the postponed IAP meeting in 2020, SEK 471,000 were taken from the WCF and added to the 2020 budget, taking total available funds for 2020 to SEK 5,049,741.

The difference between funding and spending for 2020 SEK 600,108 has been added to the WCF in 2020, and the total WCF balance at the end of 2020 is SEK 688,388, as shown in table 4. This includes the amount of SEK 344,043 relating to postponed activities in the two projects mentioned above. The workplans for the two multi-year projects imply that this amount is available for activities in the remaining project period years.

Table 4. Result, funding and working capital fund 2018-2020 (amounts in SEK).

	2017	2018	2019	2020
<b>Result</b>	<b>2,814,399</b>	<b>2,664,265</b>	<b>2,493,338</b>	<b>4,449,633</b>
<b>Funding</b>				
Crop Trust	352,133	1,240,675	1,309,246	1,370,571
NordGen	23,756	100,000	102,000	104,040
LMD	365,733	1,361,868	1,512,003	2,504,130
Transfer from WCF of 1st phase 2007-2017	2,163,868			
Communication project to Upgrade of the Seed Portal <sup>1)</sup>				600,000
Transfer WCF from 2019 to 2020 (IAP meeting)				471,000
<b>Total funding</b>	<b>2,905,490 <sup>2)</sup></b>	<b>2,702,543</b>	<b>2,923,249</b>	<b>5,049,741</b>
<b>Balance to Working Capital Fund</b>	91,091	38,278	429,911	600,108
Transfer WCF from 2019 to 2020 (IAP meeting)			-471,000	
<b>Total Working Capital Fund as of 31<sup>st</sup> December</b>	<b>91,091</b>	<b>129,369</b>	<b>88,280</b>	<b>688,388 <sup>3)</sup></b>

- <sup>1)</sup> Balance from the Communication project that ended in 2019 transferred to the Seed Vault 2020 account. This amount was earmarked for project activities that were not completed in 2019. Accounts for the Communication project was before 2020 reported separately and not included in the overall Seed Vault accounts.
- <sup>2)</sup> The Seed Vault budget for 2017 was partly funded by the working capital fund accumulated during the first ten year agreement period 2007-2017.
- <sup>3)</sup> Unspent budget due to postponed activities in two projects, amounting to SEK 344,043 has been added to the Working Capital Fund. Work plans for these two projects imply that this amount is available for project activities in the coming years (see text above for explanatory details).

## Annex 1. List of depositors to the Svalbard Global Seed Vault

Depositors listed in order of date of Deposit Agreement signature, updated pr 31. Dec. 2020.

Acronym	Country	Institute name	Wiews code	SDA	Accessions end 2020
WARDA	International, Benin	Africa Rice Center	CIV033	2007/2008	18454
CIAT	International, Columbia	Centro Internacional de Agricultura Tropical	COL003	2007/2008	57534
CATIE	International, Costa Rica	The Tropical Agricultural Research and Higher Education Center	CRI001	2007/2008	1314
ILRI	International, Ethiopia	International Livestock Research Institute	ETH013	2007/2008	6106
ICRISAT	International, India	International Crop Research Institute for the Semi-Arid Tropics	IND002	2007/2008	114013
ICRAF	International, Kenya	World Agroforestry Centre	KEN023	30.01.2008	1171
CIMMYT	International, Mexico	Centro Internacional de Mejoramiento de Maiz y Trigo	MEX002	2007/2008	173779
IITA	International, Nigeria	International Institute of Tropical Agriculture	NGA057	2007/2008	23333
CIP	International, Peru	Centro Internacional de la Papa	PER001	2007/2008	9442
IRRI	International, Philippines	International Rice Research Institute	PHL001	2007/2008	126447
ICARDA	International, Syria	International Centre for Agricultural Research in Dry Areas	SYR002/ LBN002	2007/2008	80760
AVRDC	International, Taiwan	The World Vegetable Center	TWN001	2007/2008	17376
NORDGEN	Regional, Sweden	Nordic Genetic Resource Center	SWE054	30.01.2008	26820
IPK	Germany	Leibniz Institute of Plant Genetics and Crop Plant Research	DEU146	30.01.2008	58862

CGN	Netherlands	Centre for Genetic Resources	NLD037	30.01.2008	20238
PGRI-NARC	Pakistan	Plant Genetic Resources Institute, National Agricultural Research Centre	PAK001	30.01.2008	4932
SSE	USA	Seed Savers Exchange	USA974	30.01.2008	3982
NGBK	Kenya	Kenya Agricultural & Live-stock Research Organisation (KALRO): Genetic Resources Research Centre	KEN015	26.02.2008	1314
NAC	South Korea	National Agrobiodiversity Center	KOR043	06.05.2008	23185
IAS	Macedonia	Institute of Agriculture Skopje	MKDxxx	11.06.2008	0
NCPGR	India	National Bureau of Plant Genetic Resources	IND001	04.07.2008	225
VIR	Russia	N.I. Vavilov All-Russian Scientific Research Institute of Plant Industry	RUS001	04.07.2008	6082
RAC	Switzerland	Station Federale de Recherches en Production Vegetale de Changins	CHE001	27.10.2008	10377
EMBRAPA	Brazil	The Brazilian Agricultural Research Corporation	BRA008	06.11.2008	4757
AFT	Ireland	Oak Park Research Centre	IRL001	16.01.2009	577
DAFF	Ireland	Department of Agriculture, Food and Rural Development	IRL029	22.01.2009	435
TARI	Taiwan	Taiwan Agricultural Research Institute	TWN006	26.02.2009	10503
UAAS	Ukraine	Institute of Plant Production n.a. V.Y. Yurjev of UAAS	UKR001	03.03.2009	2782
PGRC	Canada	Plant Gene Resources of Canada, Canadian Genetic Resources Program	CAN004	05.11.2009	32609
ILRF	Georgia	I. Lomouri Research Institute of Farming.	GEO001	23.02.2010	305

AAS	North Korea	Pyongyang AAS	PRK013	18.03.2010	5700
UNALM	Peru	Universidad Nacional Agraria La Molina	PER002	25.05.2010	1296
ICCI	Israel	Institute of Cereal Crop Improvement, Tel Aviv University	ISR003	23.06.2010	900
DELEP	USA	Desert Legume Program. University of Arizona	USA971	24.08.2010	134
ARC	Sudan	Agricultural Research Corporation	SDN034	18.10.2010	Transferred to SDN002
SPGRC	Regional, Zambia	SADC Plant Genetic Resources Centre	ZMB030	09.11.2010	8835
NAGREF	Greece	National Agricultural Research Organization	GRC035	02.02.2011	25
ICABIOGRAD	Indonesia	Indonesian Center for Agricultural Biotechnology and Genetic Resources	IDN179	02.02.2011	1050
MPGRPPD	Myanmar	Department of Agricultural Research	MMR003	23.02.2011	718
INIAP	Ecuador	Instituto Nacional Autónomo de Investigaciones Agropecuarias	ECU076	12.04.2011	168
NARO	Uganda	National Agricultural Research Organization	UGA031	26.05.2011	777
BARI	Bangladesh	Plant Genetic Resource Centre, Bangladesh Agricultural Research Institute	BGD164	10.06.2011	0
LSB	Italy	University of Pavia, Department of Earth and Environmental Sciences, Lombardy seed bank	ITA411	23.06.2011	2
NACGRAB	Nigeria	National Centre for Genetic Resources and Biotechnology	NGA010	06.09.2011	800
IRAG	Guinea	Institut de Recherche Agronomique de Guinée	GIN020	07.10.2011	0

RNGRC	Tajikistan	Republican National Genetic Resource Center	TJK027	14.11.2011	1646
AGRI	Azerbaijan	Genetic Resources Institute of the Azerbaijan National Academy of Sciences	AZE015	17.02.2012	1522
INRB	Portugal	Instituto Nacional de Recursos Biológicos	PRT005	05.03.2012	Transferred to PRT001
ISABU	Burundi	Agricultural Research Institute of Burundi	BDI003	19.06.2012	829
IER	Mali	Institute of Rural Economy	MLI002	19.09.2012	434
PSARTI	Mongolia	Plant Science Agricultural Research Institute	MNG030	02.10.2012	360
INIA La Platina	Chile	Unidad de Recursos Genéticos - INIA La Platina	CHL002	03.10.2012	Transferred to CHL044
AUG	Georgia	Georgia State Agrarian University	GEO028	15.10.2012	120
NPGRL	Philippines	National Plant Genetic Resources Laboratory	PHL129	18.10.2012	2254
ASAU	Armenia	Armenian State Agrarian University, Laboratory of Plant Gene Pool and Breeding	ARM035	16.12.2012	175
CN FCRC	Thailand	Chai Nat Field Crops Research Center	THA214	01.03.2013	150
UzRIPI	Uzbekistan	Uzbek Research Institute of Plant Industry	UZB006	01.03.2013	2038
SARDI	Australia	South Australian Research and Development Institute	AUS006	12.06.2013	Transferred to AUS167
AGG	Australia	Australian Grains Genebank/Australian Tropical Crops Collection	AUS165	26.11.2013	16769
BWPRC	Japan	National University Corporation Okayama University	JPN009	26.11.2013	5268

NRSSL	Thailand	National Rice Seed Storage Laboratory for Genetic Resources, Rice Department	THA012	14.08.2013	499
AGES	Austria	Austrian Agency for Health and Food Safety, Dept. for Plant Genetic Resources	AUT001	17.03.2014	1457
BGRIPGR	Bulgaria	Institute for Plant Genetic Resources "K.Malkov"	BGR001	17.03.2014	933
NCGRP	USA	National Center for Genetic Resources Preservation, USDA	USA996	SIGNED 18.01.2015	135237
NFSC	Norway	The Norwegian Forest Seed Centre	NOR056	08.01.2015	208
Luke	Finland	Natural Resources Institute Finland	FIN027	21.01.2015	7
CRI	Czech Republic	Crop Research Institute	CZE122	28.08.2015	1263
UCR-CIA	Costa Rica	Universidad de Costa Rica	CRI092	08.09.2015	Transferred to CRI003
PdeP	Peru	Parque de la Papa	PER862	09.09.2015	750
AGRESEARCH	New Zealand	Margot Forde Germplasm Centre	NZL001	11.1.2016	2363
CHAIPATT	Thailand	Chaipattana Foundation	THA513	11.2.2016	34
APG	Australia	Australian Pastures Gene Bank	AUS167	11.3.2016	28493
GRIBL	Bosnia & Herzegovina	Genetic Resources Institute, University of Banja Luka	BIH039	16.6.2016	921
INRA	France	National Institute for Agricultural Research	FRA040	16.6.2016	2
TLL	Singapore	Temasec Life Sciences Laboratories Ltd.	SGP008	19.8.2016	7
JHI	UK	James Hutton Institute	GBR251	09.11.2016	1033
MNREC	Myanmar	Myanmar Ministry of Natural Resources and Environmental Conservation	MMR075	09.11.2016	491



RPCNASBAF	Belarus	Scientific Practical Centre of the National Academy of Sciences of Belarus for Arable Farming	BLR011	17.01.2017	341
ETKI	Estonia	Estonian Crop Research Institute	EST019	25.10.2017	133
SVKPIEST	Slovak Republic	National Agricultural and Food Centre	SVK001	08.01.2018	630
INIAV	Portugal	Banco Português de Germoplasma Vegetal	PRT001	26.02.2018	618
INIA	Chile	Instituto de Investigaciones Agropecuarias	CHL044	06.04.2018	145
DOA	Thailand	Department of Agriculture, Ministry of Agriculture and Cooperatives	THA032	09.08.2018	55
UKVGB	United Kingdom	University of Warwick	GBR006	13.08.2018	1090
LSFRI	Latvia	Latvian State Forest Research Institute "Silava"	LVA009	28.10.2018	0
BDNA	South-Korea	Baekdudaegan National Arboretum	KOR048	03.06.2019	10
APGRC	Sudan	Agricultural Plant Genetic Resources Conservation and Research Centre	SDN002	13.09.2019	1813
JKI	Germany	Julius Kühn Institute	DEU451	30.09.2019	2
IHAR	Poland	Plant Breeding and Acclimatization Institute	POL003	09.10.2019	1642
BRGV	Romania	Suceava genebank "Mihai Christea"	ROM007	23.10.2019	416
MSB, Kew	United Kingdom	Royal Botanic Gardens, Kew	GBR004	18.12.2019	2
UCR	Costa Rica	Universidad de Costa Rica	CRI003	08.09.2015 (as CRI092)	57
LARI	Lebanon	Lebanese Agricultural Research Institute	LBN020	14.01.2020	453

ICGB	Israel	Wild Cereal Genebank, University of Haifa	ISR037	30.03.2020	1171
CN	USA	Cherokee Nation	USA1005	21.01.2020	9
INRA	Morocco	Institut National de la Recherche Agronomique	MAR123	24.02.2020	983
JIC	United Kingdom	John Innes Centre, Germplasm Resources Unit	GBR247	10.07.2020	2922

## Annex 2. Budget and spending 2020

### Budget - Svalbard Global Seed Vault NordGens management and operation 2020

Activity area/activity		Budget currency SEK	Actual currency SEK
<b>Directing and interaction with partners</b>	Management and meetings	271 469	131 207
Project no 709513	Management assistance and meetings	117 140	121 567
	Travels	45 000	9 757
	<b>Sub-total</b>	<b>433 609</b>	<b>262 531</b>
<b>Administration, planning and documentation</b>	Administration management	41 554	54 478
Project no 709524	Support accounts, archive & logistics	86 840	95 120
	Support project coordinator	55 365	0
	Documents and background information	292 849	273 601
	Travels	0	6 631
	<b>Sub-total</b>	<b>476 608</b>	<b>429 830</b>
<b>Liaising with depositors and handling of seeds</b>	Communication & Seed handling	304 563	307 474
Project no 709515	Seed handling in Svalbard	69 173	60 773
	Travel	80 000	90 483
	Contracted services	30 000	31 476
	<b>Sub-total</b>	<b>483 736</b>	<b>490 206</b>
<b>Data management</b>	Maintenance and updates of databases	54 320	57 720
Project no 709514	Preparing datasets	117 140	206 784
	Travel	12 000	0
	<b>Sub-total</b>	<b>183 460</b>	<b>264 504</b>
<b>Communication attracting new depositor gene banks</b>	Communication activities	117 140	82 735
Project no 709525	Travel	40 000	0
	<b>Sub-total</b>	<b>157 140</b>	<b>82 735</b>
<b>Public awareness activities</b>	Respond to enquiries, lectures/articles, website	368 990	316 404
Project no 709516	Serve media, produce material, website & SE	245 673	218 157
	Film	0	7 538
	Travel	60 000	31 236
	<b>Sub-total</b>	<b>674 663</b>	<b>573 335</b>
<b>International Advisory Panel (funds transferred from 2019)</b>	Secretary	301 632	286 058
Project no 709517	Secretary assistance	29 285	24 856
	Logistics arrangements	37 756	0
	Logistics arrangements	0	77 332
	Travel	140 000	86 089
	Meeting costs	120 000	104 284
	<b>Sub-total</b>	<b>628 674</b>	<b>578 619</b>
<b>Long term storage experiments Coal Mine #3</b>	Location hire (coal mine #3)	6 000	6 322
Project no 709519	<b>Sub-total</b>	<b>6 000</b>	<b>6 322</b>
	<b>Basic grants Svalbard</b>	<b>3 043 889</b>	<b>2 688 082</b>
<b>Long term storage experiments in the Seed Vault</b>	Coordination	0	0
Project no 709529	Preparing and handling of test samples (Jela)	81 753	149 513
	Seed technician (Jette)	30 000	28 045
	Contracted seed analysis program	157 000	7 230
	Equipment	50 000	0
	Shipment costs	30 000	0
	Workshop	35 000	39 242
	Travel (Seed summit, Hurtigruten, IPK Leibniz)	0	0
	Meeting costs (Huset febr 2020)	0	0
	<b>Sub-total</b>	<b>383 753</b>	<b>224 030</b>
<b>Conserving data on long-term storage medium</b>	Administration	0	0
Project no 709523	Compiling data	54 320	0
	Contracted services	130 000	0
	<b>Sub-total</b>	<b>184 320</b>	<b>0</b>
<b>Upgrade of the Seed Portal database and interface</b>	Coordination and compiling data	208 640	191 446
Project no 709526	Assistance	0	0
	Contracted services	1 060 000	1 115 614
	<b>Sub-total</b>	<b>1 268 640</b>	<b>1 307 060</b>
<b>Arrangement Svalbard february 2020</b>	See separate budget	192 548	230 461
Project no 709528	<b>Sub-total</b>	<b>192 548</b>	<b>230 461</b>
	<b>Total SEK budget and result</b>	<b>5 073 150</b>	<b>4 449 633</b>
	<b>Total SEK funding</b>		<b>5 049 741</b>
	<b>Result actual to funding</b>		<b>600 108</b>

exchange rate Dec 2019 1 EURO=10,5565 SEK  
exchange rate 24.jan2020 1 EURO=10,5388 SEK

## Annex 3. Key figures - deposits and depositors

Seed deposits, depositors, seed boxes in the Seed Vault and seed deposit events for 2017-2020, actual numbers for each year and accumulated figures.

	Year	2017	2018	2019	2020
<b>Seed accessions</b> <sup>1) 2)</sup>					
Accessions deposited		64403	92638	32572	82501
Deposited accessions in total, by 31.12		983316	1075954	1108526	1191027
Withdrawals		54354		24064	
Withdrawals in total by 31.12.		92430	92430	116494	116494
Seed Vault collection by 31.12		890886	983524	992032	1074533
<b>Depositors</b>					
Depositors		15	30	7	42
New depositors		3	3	3	8
Depositors in total by 31.12		74	77	80	87
New signatories		2	6	6	5
Signatories in total by 31.12		79	85	91	96
Number of deposit events		4	3	4	3
<b>Seed boxes</b> <sup>1)</sup>					
Number of deposited boxes		173	277	113	256
Deposited boxes in total		2704	2981	3094	3350
Number of retrieved boxes		161		36	
Retrieved boxes in total		289	289	325	325
Boxes in Seed Vault by 31.12		2415	2692	2769	3025

<sup>1)</sup> *Test seed samples and test boxes are not included.*

<sup>2)</sup> *Deposited seeds samples not registered in the Seed Portal database are not included. These are seeds from Svalbard native flora, orchid seeds from Myanmar and pasture seed mixtures deposited by Royal Botanical Gardens, Kew in the UK.*

## Annex 4. Lectures and presentations 2020

Åsmund Asdal:

- 12.2. Svalbard Global Seed Vault: 10000 years of crop evolution conserved in the Arctic. Darwin Day 2020. Museo di Storia Naturale di Milano. Italy.
- 25.2. Long-term seed storage experiments at Svalbard: what do we hope to learn? The 2020 Svalbard Seed Summit. Svalbard Cultural Centre. Longyearbyen, Norway
- 26.2. Seed longevity experiments in Svalbard: Results from the ongoing investigations in the coal mine and plans for a new experiment in the Seed Vault. Presentation for Seed Summit participants during visit to Coal Mine #3, Longyearbyen, Norway.
- 28.2. Svalbard globale frøhvelv. Orientering for personalet ved BioBank AS. UNIS, Longyearbyen, Norway. (Information to Biobank staff visiting Longyearbyen)
- 28.2. Svalbard Global Seed Vault. Conserving plant genetic resources in the Arctic. Presentation for Chief Executives Organization, Washington DC, USA in Svalbard Museum, Longyearbyen, Norway
- 28.8. Svalbard Global Seed Vault. Conserving plant genetic resources in the Arctic. Presentation for the Ambassador and Permanent Representative for U.S. Mission to the U.N. Agencies in Rome and U.S. Embassy in Oslo. Seed Vault maintenance building, Longyearbyen, Norway.

## Annex 5. Publications 2020

Asdal, Å. 2020. Seed Capital. Journal of a seed Bank co-ordinator. *World of Interiors*, November 2020.

Solberg, S.Ø., G. Brodal, R.v. Bothmer, E. Meen, F. Yndgaard, C. Andreasen and Å. Asdal. 2020. Seed Germination after 30 Years Storage in Permafrost. *Plants MDPI* 2020.

Solberg, S.Ø., F. Yndgaard, C. Andreasen R.v. Bothmer, I.G. Loskutov and Å. Asdal. 2020. Long-Term Storage and Longevity of Orthodox Seeds: A Systematic Review. *Frontiers in Plant Science*

Westengen, O.T., C. Lusty, M. Yazbec, A. Amri and Å. Asdal. 2020. Safeguarding a global seed heritage from Syria to Svalbard. *Nature Plants*. [www.nature.com/natureplants](http://www.nature.com/natureplants)

