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Svalbard Global Seed Vault: Global central seed bank

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Abstract

Svalbard Global Seed Vault is not a gene bank, it is a facility for maintaining crop diversity in the form of seeds, stored and conserved in a frozen state. The ideal temperature is between minus 10 and minus 20 degrees Celsius. The Seeds in the Seed Vault shall only be accessed when the original seed collections have been lost for any reason. The depositors will retain their rights over the seeds. There will be no way that Svalbard Global Seed Vault, or Norway can give access to the seeds without consent from the depositors. The Seed Vault has the capacity to store 4,5 million different seed samples. Each sample will contain on average 500 seeds, so a maximum of 2,25 billion seeds may be stored in the Seed Vault. The Seed Vault will therefore have the capacity to hold all the unique seed samples that are conserved today by all the approximately 1400 gene banks that are found in more than 100 countries all over the world.

The low temperature and the limited access to oxygen will ensure low metabolic activity and cause a delay in the aging of the seeds. Svalbard is a unique location for such a facility in multiple ways. Svalbard has perfect climate and geology for underground cold storage. Because of the permafrost, the temperature will never rise above minus 3,5 Celsius. The sandstone at Svalbard is stable to build in and low in radiation.

Approximately 6,5 million seeds sample are stored in gene banks today. Only about 1-2 million of these are estimated to be distinct. Plant breeders and researchers are the major users of gene banks. The biggest threat comes from lack of resources and funding. Poor management can be a major problem. Gene banks have been subject to natural disasters, war and civil strife. Many gene banks are situated in developing countries and many have been faced with different challenges over time. Extinction is forever. Different varieties of wheat and potato can disappear as permanently as the dinosaurs.

Key words: Gene bank, Seed samples, Global Seed Vault, Low temperature

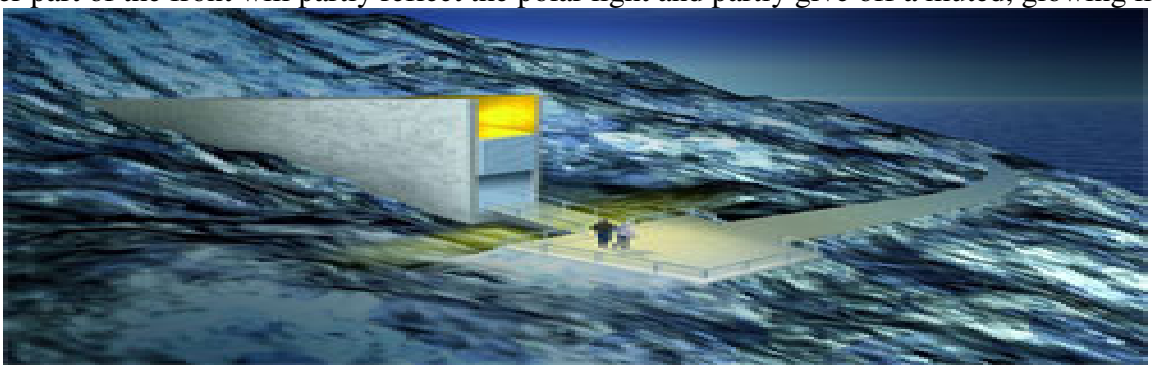
I. Introduction

General public is well aware of the threat of extinction to animal species, far fewer are aware of the risk of crop extinction. With whales or tigers or polar bears," you can look at them in the eye and you can be very empathetic. But you can't do that with a wheat variety or carrot variety"[1]. The history of Svalbard seed vault starts as early as 1983. Like other big projects, it's been a long and not very easy journey. Preserving seed from food plants is an absolutely essential part of the work of preserving the world's biodiversity, adapting to climate change and global warming and thereby ensuring food for the world's population for the foreseeable future. There are hundreds of gene banks (globally there number

is around 1400). But some of them are highly vulnerable to natural disasters, war or the lack of management or finance and security. The foundation of a "global central seed bank" for the world's seeds (primarily of food plants) has therefore long been an issue and Svalbard Global Seed Vault was a step in this direction. In 1989, IBPGR started surveying the relevant alternative sites in Svalbard. Norway offered to take care of the actual construction of the vault, while FAO and IBPGR would take care of the administrative operating costs through the creation of a fund based on capital from external donors.

II. Description of the facility

This Seed Vault lies about 1 kilometre from Longyearbyen Airport, at about 130 metres above sea level and consists entirely of an underground facility, blasted out of the permafrost (at about minus 3-4 degrees Celsius). The facility is designed to have an almost **"endless" lifetime.** The location takes into account all known scenarios for rising sea level caused by global climate changes. The facility has also been located so deep inside the mountain that any possible changes to Svalbard's climate, which we know about today, will not affect the efficacy of the permafrost. This will be a temporary temperature back up in the event of technical failure, such as loss of power supplies for a period. The facility consists of three separate underground chambers. Each chamber has the capacity to store 1,5 million different seed samples. With the aid of its own electric machinery, powered by electricity from the local power station, it will maintain a constant interior temperature of minus 18 degrees Celsius. The chambers will have storage shelving for pre packed examples of food seeds from the depositors. The storage chambers themselves are reached via an access tunnel about 100 metres long, with an entrance portal on its outside. The entrance portal will be the only visible part of the facility. It is in the form of a long, narrow concrete "fin", with an entrance of brushed steel. An artistic decoration on the outer roof surface and on the upper part of the front will partly reflect the polar light and partly give off a muted, glowing light [2].



The outer half of the entrance tunnel is constructed as a steel pipe with a diameter of about 5 metres. This will pass through the layer of snow and ice and the loose rocks, into solid mountain. The innermost part and the storage chambers will be blasted out of the mountain using tunnel drilling and rock blasting techniques. The mountain is secured with bolts and spray concrete. The permafrost will also contribute to stability. The interior floor is of asphalt. There is electric lighting throughout and the facility will be secured against forced entry and will have TV surveillance. Areas for filing and other administrative work of a temporary nature will be located beside the entrance tunnel. These will be heated to normal room temperature whilst work is going on.
The total floor area of the facility is just less than 1,000 square meters.

Who owns the world's heritage?

In the early 90s there was heated debate between the various member countries of the FAO about patenting and access to genetic resources. Developing countries wished to receive part of the proceeds

from the commercial seed industry, since the diversity mainly came from their areas, whilst the commercial seed industry wanted free access to such resources and the opportunity to patent the seeds. This led to a polarised atmosphere with little mutual trust regarding the administration of seed. The lack of international agreements to regulate this area eventually became an obstacle to realizing the plans and IBPGR and FAO eventually had to give up looking for donors. Together with the Norwegian authorities they decided to shelve the plans for an international safety deposit for seeds in Svalbard.

The turning point came when FAO's International Treaty for Plant Genetic Resources for Food and Agriculture came into force in 2004. This created a new basis for taking the plans up again. The Norwegian Ministry of Foreign Affairs and the Ministry of Agriculture and Food took up the challenge. A group of Nordic and international experts under the direction of Noragric at the Norwegian University of Life Scientists (UMB) were appointed to carry out a preliminary study. In September 2004 the group put forward an unambiguously positive report, which concluded that suitable locations were to be found in Svalbard. The report recommended that a chamber should be built inside the mountain. It was also stressed that the storage of seeds should be done in accordance with international gene bank standards, at minus 18 degrees, and that the seeds should be stored by the **"black box" method**, that is that only the institution which deposits seeds has right of ownership and disposition over them[3].

In November 2004 the report was presented at FAO's Commission for Genetic Resources for Food and Agriculture. The Norwegian idea received a positive response and was perceived by many countries as a most welcome contribution to the international work of preserving the world's plant genetic resources. Some developing countries also pointed to the earlier positive experience of development collaborations with Nordic countries and the Nordic Genetic Resource Centre in Svalbard [4].

Following the FAO meeting Norway began work on financing the construction project. Since the purpose of the seed vault was multilateral, it was natural to pave the way for making this a joint initiative between three ministries, the Ministry of Foreign Affairs, the Ministry of the Environment and the Ministry of Agriculture and Food. The government backed the initiative and in 2005 an inter-departmental steering group was set up for the project, consisting of the Ministry of Agriculture and Food, the Ministry of the Environment, the Ministry of Foreign Affairs, the Ministry of Justice and the Consumer and Administration Ministry. Under the chairmanship of the Ministry of Agriculture and Food, the steering group discussed various alternatives for the location, organization, agreement format and operation of the seed vault, as well as working in close cooperation with international experts in relevant fields. Statsbygg was given responsibility for building and running the technical plant. Planning commenced in autumn 2005 and building commenced in May 2007.

The project consists of three chambers, each of which has the capacity to store 1.5 million seed samples. Even though the facility is owned by Norway, it is important to underline that the seed samples which are stored in the vault are indisputably the property of the depositor (whether country, gene bank or institution), which has right of ownership and disposition over them. Building work will be completed in November 2007. Then the cooling process begins and the temperature should be down to minus 18 degrees during the course of January. The facility will be officially opened on 26th February 2008.

Owned by Norway

It is Norway which formally owns the seed vault, with Ministry of Agriculture and Food as the responsible authority for Svalbard Global Seed Vault. Nordic Genetic Resource Centre is responsible for scientific operation, whilst Statsbygg operates the technical plant. Construction has cost almost 9 million

US dollar and has been entirely financed by the Government of Norway. The Global Crop Diversity Trust (GCDT) has also been brought in as an active partner and will finance a substantial amount of the annual operating costs of the vault. The other operating costs will be financed by the he primary funding of the Trust came from the Bill & Melinda Gates Foundation, United Kingdom, Norway, Australia, Switzerland, and Sweden, though funding has been received from a wide variety of sources including four developing countries: Brazil, Colombia, Ethiopia, and India. GCDT is also helping to secure operations by assisting developing countries in the packing and dispatch of seed samples to Svalbard [5].

Why Svalbard

1) Svalbard, as Norwegian territory, enjoys security and political and social stability. Norway understands the importance of preserving Svalbard as an area of undisturbed nature, which is now an important research and reference area. The seed vault fits ideally into this concept.
2) Svalbard has an isolated position far out in the ocean, between 74° and 81° N and only 1000 kilometers from the North Pole. The archipelago is characterized by an undisturbed nature. Permafrost provides stable storage conditions for seeds. Besides which there is little risk of local dispersion of seed.
3) The seed vault, which consists of three chambers, is located right outside Longyearbyen and directly opposite Longyear Airport. The facility is about 130 metres above sea level and has been tunneled 120 metres into the mountain, in a stable sandstone situation. Each of the three underground chambers is about 1,200 cubic metres (20 metres deep, 10 metres wide and 6 metres high). The location so far below ground guarantees stable permafrost for the foreseeable future and is high enough above sea level to secure the facility against any rise in sea level as a result of global warming.
4) The facility's open location near the town makes monitoring and security easier. Security is the responsibility of the Governor of Svalbard in cooperation with the University of Svalbard (UNIS).

Since Svalbard was a natural choice for physical and security reasons, the Norwegian government decided that Norwegian ownership, operating responsibility and financing of the facility was equally natural. The seed vault is also in line with Norwegian policy with regard to biodiversity, preservation of genetic resources, north-south policy, and development policy and food safety, as displayed in the following points:

In establishing the international seed vault, Norway is making a unique contribution to the preservation of the planet's most important biodiversity. This will help to fulfill the main objectives of the Biodiversity Convention and the FAO treaty, priority issues for Norway for many years. The seed vault could come to have a special significance for a number of regions in developing countries where the storage conditions in regular gene banks are a constant challenge [6].

For many years it has been Norway's aim to play a bridge-building role in the north-south debate about genetic resources and biological diversity. This doesn't mean that we necessarily always take the middle line, but rather that we try to see new elements in the positions of all sides with the aim of finding solutions which actually lead to the sensible management of genetic resources. We believe that Svalbard Global Seed Vault can be a unifying initiative, which offers much to countries both north and south and which will hopefully also promote global collaboration in taking care of our most important genetic resources.

Securing food supplies is one of the most basic issues in any strategy for eliminating poverty. In a time of climate change, this is equally a global issue. The establishment of a global seed vault is therefore very much in line with the principle of informed self-interest.

Partners

The Svalbard Global Seed Vault is financed by three Norwegian Ministries: The Ministry of Foreign Affairs, the Ministry of Environment and the Ministry of Agriculture and Food [7].

- The Nordic Genetic Resource Centre is responsible for the management and operations of the Seed Vault.
- The Global Crop Diversity Trust provides scientifically guidance and assistance in organizing shipments of seeds. The Trust will also finance a large part of the management and operation of the Seed Vault.
- The Governor of Svalbard is responsible for the overall security of the Seed Vault.
- FAO Commission on Genetic Resources for Food and Agriculture (CGRFA) and the Governing Body of the International Treaty for Plant Genetic Resources for Food and Agriculture (ITPGRFA) provide the Global Framework for the Seed Vault. The seed Vault will contribute to the FAO Global System for Plant Genetic Resources

III. Management and operations

Free of cost
The Svalbard Global Seed Vault will provide facilities free of cost for safety deposits under "black box conditions" on request from public or private holders of seeds of distinct genetic resources that are important to humanity. Priority will be given to the safety deposit of plant genetic resources of importance for food security and sustainable agriculture.

Packaging and shipment
Costs pertaining to the packaging and shipping of the deposited seeds will be borne by the depositors. However, in the case of developing countries and international gene banks, the Global Crop Diversity Trust is funding the costs of preparing, packing and shipping their seeds to Svalbard.

18°C
The material deposited will be maintained in permafrost conditions supplemented by refrigeration in accordance with internationally agreed standards.

International regulations
The depositors who will deposit material will do so consistently with relevant national and international law. The Seed Vault will only agree to receive seeds that are shared under the Multilateral System or under Article 15 of the International Treaty on Plant Genetic resources for Food and Agriculture (ITPGRFA) or seeds that have originated in the country of the depositor [4].

Replacement policy
The Seed Vault will not have the opportunity to test the viability of the seeds, but will accept new shipments of seeds when the duplicate samples at the depositor's possession have lost fertility. Import and storage of GMO seeds according to Norwegian legislation will require advance approval. Certain

other criteria will apply to "sealed internal use" for research purposes and indoor storage of GMO, for example with regard to the risk of spreading GMO. Norwegian gene technology legislation was formulated before the Svalbard Global Seed Vault (SGSV) was set up, and therefore fails to take into account the vault's special status, or the low risk related to handling seeds in sealed packaging. Until changes can be made to the rules or exemptions can be provided from them, long-term storage of GMO seeds in the SGSV will not be approved

Black boxes
"Black box arrangements" mean;

- that the deposit of the seeds will not affect any property or other rights pertaining to the material;
- that the deposited seeds will remain in sealed envelopes, unless otherwise agreed with the Depositor;
- That the Svalbard Global Seed Vault will take no action to further transfer the material except back to the original Depositor or the Depositor's successor in title, or in accordance with the Depositor's instructions [5].

IV. Conclusion

Svalbard Global Seed Vault is not a gene bank, it is a facility for maintaining crop diversity in the form of seeds, stored and conserved in a frozen state. The ideal temperature is between minus 10 and minus 20 degrees Celsius. Gene banks may also contain living plants and parts of plants in those cases where it is difficult to store the crop in the form of seeds), but a safety-storage for preservation of duplicate collections of seeds on behalf of gene banks. The Seeds in the Seed Vault shall only be accessed when the original seed collections have been lost for any reason. The depositors will retain their rights over the seeds. There will be no way that Svalbard Global Seed Vault, or Norway can give access to the seeds without consent from the depositors. The seeds will be returned to the depositors on request. The Seed Vault has the capacity to store 4,5 million different seed samples. Each sample will contain on average 500 seeds, so a maximum of 2,25 billion seeds may be stored in the Seed Vault. The Seed Vault will therefore have the capacity to hold all the unique seed samples that are conserved today by all the approximately 1400 gene banks that are found in more than 100 countries all over the world. In addition the Seed Vault will have capacity to also store many new seed samples that may be collected in the future. When in full use, the Svalbard Global Seed Vault will represent the world's largest collection of seeds. Priority will be given to crops that are important for food production and sustainable agriculture, which is of the utmost importance for developing countries where food security is a challenge. More than 7,000 plant species have historically been used in human diets; however, less than 150 species are today used in modern agriculture. Only 12 plant species today represent the major vegetable source in today's menu. Within each plant species a high number of varieties and great genetic diversity may be found. For example, there are more than 100,000 varieties of rice. The seeds will be stored in minus 18 degrees Celsius, that is, long term storage condition. The seeds will be placed in sealed packages that again will be placed in sealed boxes that will be stored on high shelves inside the vault. The low temperature and the limited access to oxygen will ensure low metabolic activity and cause a delay in the aging of the seeds. The permafrost will still ensure the continued viability of the seeds if the electricity supply should fail [8].

Each country or institution will still own and control access to the seeds they have deposited. Svalbard is a unique location for such a facility in multiple ways. Svalbard has perfect climate and geology for underground cold storage. Because of the permafrost, the temperature will never rise above

minus 3,5 Celsius. The sandstone at Svalbard is stable to build in and low in radiation. In terms of security, Svalbard scores high compared to the locations of many other gene banks in the world. The infrastructure is good with daily flights and with a reliable source of energy. The prospects of climate change have been given consideration when searching for the optimal location for the Seed Vault. The Seed Vault will be located at such an altitude and so deep into the mountains that neither the potential rise in sea level nor the melting of the permafrost is considered as a potential threat in the foreseeable future. Approximately 6,5 million seeds sample are stored in gene banks today. Only about 1-2 million of these are estimated to be distinct. Plant breeders and researchers are the major users of gene banks. The diversity stored in the gene banks is the raw material for plant breeding and for basic biological research. Several thousand samples are distributed annually for such purposes.

Different crops varieties have different characteristics and not all the differences may be visible to the eye. Genetic traits may provide differences in disease resistance, adaptability to various soils and climates, different tastes and nutritional qualities. If we ever need to use the potentially unique and sometimes hidden traits found in a particular crop variety, then we must ensure that the variety is available. The biggest threat comes from lack of resources and funding. Poor management can be a major problem. Gene banks have been subject to natural disasters, war and civil strife. Many gene banks are situated in developing countries and many have been faced with different challenges over time. It is impossible to know, as there is no way of ascertaining how many different types have existed in the past. But, surely, much diversity has already been lost. The number of plant varieties used during the last 30 years of intensification of agriculture has been dramatically reduced. Extinction is forever. Different varieties of wheat and potato can disappear as permanently as the dinosaurs [9].

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