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Svalbard's Doomsday Vault

The Global Seed Vault Raises Political/Conservation Debate

Issue: The opening of the Global Seed Vault in Norway's high Arctic February 26 closes a 30-year campaign for a World Gene Bank – and opens an overdue debate on the State of the World's Plant Genetic Resources and the need to support on-farm conservation strategies.

Stakes: Less than a third of the 6 1/2 million seed samples now in storage are probably unique. Of these, perhaps two-thirds are in urgent need of regeneration. While the Global Seed Vault is a step in the right direction, many vital *ex situ* gene banks are in desperate straits. As much as half of the world's crop diversity may still be in farmers' fields protected only by the family and the community – who are up against industrial agriculture, plant patenting, global trade rules, corporate concentration and climate change. Global food security depends upon a coherent *in situ* (on-farm) and *ex situ* (gene bank) strategy.

Policies: Serious work is needed on the implementation of the rolling plan of action for the conservation of plant genetic resources. The next meeting of the Governing Body for the FAO Treaty should devote special attention to the issue of *in situ* conservation and the urgent need for a financial facility to support this conservation. The Governing Body must also address the issue of accession duplication as it relates to the Global Seed Vault. Later this year, ETC Group will release additional studies that examine the relationship between the Global Crop Diversity Trust and the International Seed Treaty.

Forum: Agriculture is on the agenda of the UN Commission on Sustainable Development in May and at the UN Convention on Biological Diversity in meetings in Bonn in May. Although the Governing Body of the FAO Treaty won't meet until early 2009, the opening of the Global Seed Vault affords an opportunity for governments and farmers' organizations to commit to establishing a long-term strategy for the conservation and utilization of plant genetic resources on the farm. Importantly, the government of Norway is leading the way by demonstrating that even a secure *ex situ* seed collection is not the ultimate solution. On 25 February the Norwegian government pledged to give 0.1% of money spent on commercial seed sales to support Farmers' Rights, and challenged other governments to do the same.

On putting our eggs in one basket

Driftnet: In the last days of January, two undersea cables were cut just outside the Port of Alexandria on Egypt's Mediterranean. One hundred million Internet users throughout the Mideast and South Asia were dumped down the digital divide. Conspiracy theorists still clinging to the tattered Internet assured one another that it was sabotage.[1] Others took the lesson that too much of the world's information was being funnelled through Alexandria's too narrow portal as everyone attempts to circumnavigate the tumultuous Middle East by routing their cables through comparatively tranquil Egypt. A case of too many electronic eggs in one basket?

Egyptian tomes: As a species, we're slow learners. When Caesar sailed to Cleopatra's rescue, he set fire to Alexandria's harbour and – oops – burnt down its famous library. This was just the first of a succession of fires that ultimately destroyed 700,000 scrolls.[2] A thousand years later, the 1.5 million books in the Cairo library were destroyed by invading Turks who ripped off the leather covers to make sandals. For information wonks, the solution might seem to be to give Egypt a pass.

Imperial immolations: Saving anything until "doomsday" is a tough ask. History shows that large data centers (i.e. libraries) make big targets. Rome's Palatine library burned with the rest of the city as Nero (presumably) fiddled. A century after the burning of the Alexandria Library, China's first Qin emperor presided over the world's greatest book burning when he tried to erase all written knowledge produced before his dynasty. The Aztec's first emperor had the same idea when he consolidated his conquests by burning all the documents he could lay his hands on. Spanish conquistadors kept up the practice when they had the opportunity. Back in Spain, Christian conquerors destroyed libraries containing about a half-million books when they captured Córdoba. When England's Protestants sacked Catholic monasteries, the Papal books were scrubbed clean to make Protestant paper. More recently, Nazis ransacked libraries across Europe destroying more than 100 million books and the 30,000 tablets thought to have been in the Nineveh library (now in Iraq) are AWOL – some, doubtlessly, lost over the millennia and the rest cluster bombed "out of print" in this decade. If you build it they will burn it, it seems.

Is there a lesson here for the Doomsday Vault – the global seed library? According to library historians, most of the ancient tablets, scrolls, and books that have weathered the ages have come from modest little libraries and family bookshelves.[3] Are crop geneticists focusing on the Doomsday Vault when they should be looking to secure smaller gene banks and on-farm seed stocks? Is the vault yet another example of technological hubris?

Saving eggs

Pole vault: The $8 million Global Seed Vault – dubbed the Doomsday Vault – has been tunnelled into solid rock on a mountainside high enough above climatologists' projections for sea level rise and so deep in the polar permafrost that it would take extreme global warming decades or centuries to reach its contents. Partly because of its location but mostly because it will be a minimalist gene bank of last resort for the world's crop genetic diversity (seeds) maintenance costs at the Vault are expected to be no more than $125,000 per year. That's about six cents per seed sample if all of the world's 1.5 - 2 million unique seed accessions eventually end up in the bank. Since the world is continuing to collect vanishing seed varieties, the bank is roomy enough to accommodate up to 4.5 million samples.

The Law of the Seed: The opening of the Seed Vault comes as a sequel to the 2004 Treaty governing the exchange of plant genetic resources for food and agriculture adopted at FAO in Rome. Since the 1970s, governments, farming communities, and indigenous peoples as well as global seed companies have been nervous about the ownership and control of seed stocks. Corporations have been patenting them and governments have been hoarding them. That governments and scientists agreed to the Arctic vault is partly a credit to the Treaty and partly to Norway – arguably one of the world's most trusted countries. Not only is the government respected – and expected to treat the "black box" seed samples as the sovereign property of those who deposit them – but most observers expect the Norwegian island to be as free of wars, civil unrest, and industrial accidents as any place on Earth. In recent decades, other national and university gene banks have often been damaged or destroyed due to a variety of natural or human-made disasters. If you had to bet on a safe place to store the world's endangered seeds, Norway's Svalbard is a pretty good bet. That

doesn't mean the Doomsday Vault isn't surrounded in controversy. (And, it must be noted that an earthquake of 6.2 magnitude – the biggest in Norway's history – hit the Svalbard archipelago on February 20, a week and a day before the opening of the Vault. The vault survived without damage.) Some of the issues are primarily scientific and technical and some are understandably political.

Storehouses or Tombs? The first gene bank was built in St. Petersburg almost a century ago by the renowned Russian geneticist, N.I. Vavilov. Vavilov and his disciples scoured the planet searching for crop seeds that might be used to give Russian agriculture a boost. Only heroic efforts protected Vavilov's collections during the Siege of Leningrad in World War II but even this heroism was not enough to withstand Stalin and the collapsing economy of the Soviet Union afterward. Vavilov himself died in prison (apparently, of hunger) – the victim of scientific jealousy and political ideology during the war. His meticulously collected seeds were allowed to deteriorate under warehouse conditions stored in old Pepsi or vodka bottles without temperature or humidity control.

In the mid-1970s, plant geneticists became alarmed that a combination of the Green Revolution's high yielding varieties and industrial agriculture was leading to the genetic erosion of the world's crop diversity. This led to the formation of the International Board for Plant Genetic Resources in Rome. The IBPGR – under the flag of the United Nations – aggressively supported seed collection expeditions in the various centres of crop diversity (where crops were first domesticated). Literally hundreds of thousands of samples were gathered during the 70s and 80s. For a time, the building of gene banks lagged well behind the collecting of seeds and many collections were stored under perilous conditions. Successful long-term seed storage is widely thought to be a combination of low temperatures and low humidity. Although it remains a theory, most scientists agree that for every 5°C temperature drop, seed longevity in banks doubles; and, that the optimum long-term storage temperature is -18°C – the temperature set for the Doomsday Vault. Humidity within the seed sample is equally or even more important. For every 1% seeds are dried, their life expectancy also doubles. Since the seeds coming to Svalbard are already sealed, and (presumably) dried, the actual humidity inside the vault is not a factor. The combination of cooling and drying means that many seed species can remain in storage at least several decades and perhaps several hundred years before they should be replaced by rejuvenated (grown out) samples and their progeny (the next generation of seed) is returned to the vault.
In the 70s and 80s it was not uncommon to walk into gene banks and find the refrigeration defunct or the bank generator out of gas and the room wet and balmy. A major international gene bank in Hyderabad, for example, was found with its door wide open and puddles of water on the floor as the outside temperature hit the plus forties. Another bank, outside Bangkok, cooled more beer than seeds. At different times, scientists have had to don "wellies" or hip-waders to inspect national seed collections in Brazil and the Philippines. In the 1980s, even Canada's national bank – which accepted global responsibility for some of the world's most important cereal collections – left the seeds in boxes in office corridors where a television crew filmed mice gambolling amid the grains. The bank's backup generator was a farm tractor that could be backed up to the building in the not-unlikely event of power failure.

Exacerbating the increasingly political environment, as IBPGR and national governments intensified collection efforts, thousands of (mostly family-owned) seed companies were being snapped up by multinational pesticide companies like Monsanto, DuPont and Syngenta and patent offices were besieged by corporate applications to monopolize first plant varieties and then the genes inside the plant varieties. Concerned for national sovereignty and potential profits, governments began to make it harder to exchange germplasm (seeds) among the world's breeders.

Governments also began to build more gene banks. Whereas, at the beginning of the 70s, there were fewer than 10 banks, today, FAO estimates that there are close to 1500 (spread over 150 countries) holding roughly 6.5 million seed samples. However, of these 1500 collections only 400 have medium or long-term storage potential and probably only 35 or so can be considered to meet scientific standards. Of the millions of seeds in storage, only 1.5 to 2 million are thought to be unique. Still, the duplication of samples in more than one bank is agreed to be a good thing since the failure in one bank doesn't mean the absolute loss of genetic diversity if the seeds can be found in another.

Despite this, many geneticists would agree that the world has far too many gene banks and, probably, too much replication of too few samples. There is still much out there that has yet to be collected and is endangered.

This is especially true in the context of global warming. Changing temperatures will force crop migration to cooler climes either up the mountainside or toward the poles. Temperature and precipitation changes will also cause pests and diseases to migrate creating new risks for the crops. Crop genetic diversity has never been more important – more economically valuable – and, therefore, more political.

The scramble – a quarter of a century ago – to collect and store seeds also ran well ahead of our technical understanding of the complexities of long-term seed conservation. Even our understanding of crop genetic erosion is pretty sketchy. In the early 1980s, for example, RAFI (ETC Group by an earlier name) looked at IBPGR gene bank collection data; a series of five-year snapshots of the global seed situation published by FAO; and, maps of the Vavilov centers of genetic diversity and very loosely surmised that genetic erosion was taking place at about 2% per annum. Canada's International Development Research Centre adopted and cited RAFI's guesstimate and FAO quoted IDRC with authority. The figure is still used today – with about the same scientific credibility. And, it might even be correct.

Gene banks were being built on low budgets and limited knowledge. Advice on cooling equipment and storage facilities – refrigerators, freezers, or specially built units – varied. How to cool seeds and how to dry seeds was also uncertain. Once cooled and dried, should seeds be stored in glass containers, zip-loc baggies, laminated aluminium foil envelopes, tin cans, or the kitchen cookie jar? In the 1980s, the prevailing wisdom was to use commercially-available, laminated aluminium wraps. The wraps were cheap, light, and easy to transport. But, they had the disadvantage of not being see-through unlike glass jars. It was necessary to open the envelope and expose the seed to see how it was doing. Crop specialists debated how often different species needed to be rejuvenated and how low the germination level could drop before an expensive grow out was necessary. Then, too, where should bank seeds be grown out? If you collect a sorghum sample in the Sudan but grow it out in Colorado will the harvested seeds put back in the bank have the same genetic characteristics as the original sample? Or, will they have adapted to Colorado and only the seeds that do well in Colorado survive while the traits important to Sudanese farmers disappear? Over time, will seeds grown out around foreign gene banks take on the necessary characteristics to survive in the foreign environment? Since the biggest and best gene banks were in industrialized countries did this also mean that gene bank accessions would, over time, become economically more important to industrial agriculture and big seed companies than to the farmers who donated seeds in the first place?

Decades later, all of these debates continue. Following an international conference on plant genetic resources in Leipzig Germany in 1996, farmers and scientists realized that much (possibly most) of the seeds collected over the last 30 or 40 years were being held in highly dubious gene banks. The laminated aluminium foil envelopes of the 1980s were not airtight after all. At least two later generations of envelopes have struggled to solve the problem. The Norwegians insist that the aluminium foil envelopes they recommend for the Vault are "state of the art" and will admit neither air nor moisture. Others say they've heard that before. What is becoming clear is that we don't know as much about the 6.5 million seed samples in gene banks as we should.

Fort Knox or for farmers? The political debates of the 70s and 80s have not gone away. The entry into force of the International Treaty on Plant Genetic Resources for Food and Agriculture of 2004 was more than seven years in the making and still has many unresolved tensions. Back in the mid-1970s, of the thousands of small family seed companies around the world not one had even a fraction of 1% of the commercial seed market. As the Doomsday Vault prepares to open its doors, the world's 10 largest multinational seed companies control 57% of the commercial seed market and four multinationals monopolize almost 100% of the land sown to genetically modified seeds. Access to plant genetic resources is of paramount commercial interest.

Counting on Farmers? As long ago as 1983, RAFI speculated that it would be both cheaper and safer to pay for farmers to save seeds in their fields. A system of farmer-curators, we supposed, could set aside small plots of land on which to maintain heirloom varieties that might otherwise disappear. Since many seeds can be stored under ambient conditions for two or three years, not all the seed would have to be grown all the time. Since the seeds to be grown out were in the ecosystem in which they were born, the danger of genetic drift – the seeds adapting to foreign climates or even to the inhospitable confines of dark and damp gene banks – would be gone. Many geneticists thought this a good idea. The notion that *ex situ* gene bank

collections could be supplemented by *in situ* or on-farm collections was born.

Twenty-five years later, ETC Group (the inheritor of RAFI's myopia and insights) and others blush to admit that on-farm conservation is – by far – the best way to save seeds and that *ex situ* collections should be the backup for farmers. More embarrassingly, we all now realize that farmers have been saving seed for 10,000 years and do it rather well. More importantly, everyone now recognizes that farmers not only save seeds but also are plant breeders. Since the 1980s, for example, institutional breeders have produced about 75,000 new plant varieties mostly for a handful of crops in major growing areas. During that same period, small farmers have created millions of varieties covering a much wider range of crops and growing conditions. It is this diversity that is needed to get the world through climate chaos in the decades ahead.

Eggs on Faces

Saving seeds or saving face? The continuing problems of national and international gene banks are an embarrassment for governments. Officials at FAO and at Bioversity International (IBPGR morphed into the International Plant Genetic Resources Institute, IPGRI, in the 1990s and then changed again recently to BI – next, BI-Polar?) are well aware that much of the material collected under their auspices is probably dead in the banks. At the 1996 Leipzig Conference, FAO reported that at least a million seed samples were in urgent need of grow-out and that a majority of the world's gene banks were in bad shape. A 2002 survey by Imperial College advised that two-thirds of the South's banks have still more urgent regeneration problems and that the same percentage are muddling along with static or declining budgets.

Global harming: Both cold storage gene banks and field gene banks are vulnerable to sudden losses. A weekend power failure ended Cameroon's root and tuber collection. Peru and Guatemala's beans, Colombia and Costa Rica's chili peppers and tomatoes all died of old age in their banks. Viral disease carried off a critical banana collection in Philippines and Togo's yams blackened from a brush fire.

War and civil unrest also pose major problems for seed security. War destroyed Afghanistan's national collection in 1992. In 1993, in the midst of fighting, the regional genebank at Gitega in Burundi was ransacked and the seed bags destroyed. During the 2003 invasion, the Iraqi seed collection at Abu Ghraib was wiped out.

Geneticists know that many of the problems arise from a lack of money, a lack of training, failures in political commitment of national governments, and a series of technical mis-judgments related to storage conditions, containers, humidity, germination testing, and seed multiplication. For all the merits of decentralized systems, they also know there are too many banks and that national pride and institutional inertia will make it very hard to bring rationality to the system. It's been 12 years since the Leipzig Conference on genetic resources adopted its tome – the so-called "rolling" plan of action. To date, however, the rolling tome has gathered no money. In this context, the high-visibility that has accrued to the Doomsday Vault – yet another gene bank – has rubbed salt into the wounds of national gene bank directors.

The South's farmers are also unhappy. Almost all of the world's crops were domesticated in the tropics and subtropics of Asia, Africa, and Latin America. Most of the remaining crop genetic diversity lies in farmers' fields in these regions. Most of the genetic diversity in gene banks – including the biggest banks in the United States, Europe and Japan – comes from farmers. Initiatives that would store more seed still further away are not likely to draw praise.

Quite rightly, farmers also distrust the way scientists have collected genetic diversity in their fields. Farmers' varieties are not like commercial seed varieties that have been bred for maximum genetic uniformity -- primarily to meet the requirements of patent offices and, secondarily, to allow for machine harvesting. Farmers' varieties are more like "populations" less like identical twins than like kissing cousins that welcome genetic variation in the family. The greater the diversity in the field the more likely seed is to withstand pests and diseases and for the family to have something to eat at harvest time. When geneticists come calling to sample a farmer's field, 'best practice' dictates that the collector grid the land and sample from each section in order to gather up the full range of diversity in the populations. This is hard, time-consuming work that means getting off the highway and foregoing 'Happy Hour' at the Hilton. As a result, most farmers believe that the genetic diversity in gene banks substantially under-represents the diversity in their fields. The whole idea of gene banks is biased toward the

conservation of genetically-uniform commercial varieties least in need of protection and least of value in the future.

Chickens or eggs? Farmers can be especially frustrated that their approach to on-farm conservation is demonstrably less expensive and scientifically more sound than *ex situ* gene banks. Local conservation means that genetic diversity isn't kept on ice but kept in the field where it can evolve and adapt to changing climatic conditions and where farmers can select the best adaptations to withstand new pests and diseases. Quite simply, the system of high-tech gene bank storage has not only been shown to have major technical problems but it also plays to the interests of northern plant breeders and international seed companies who can access the computerized databases and receive the FedEx-ed samples. Although some are sympathetic, few scientists are working with farmers to improve local conservation technologies, strengthen local breeding strategies, or to access far away seed accessions. In this unhappy environment, the Doomsday Vault becomes a lightning rod for everybody's discontent. That's precisely why the Norwegian government's pledge, on the day before the official opening of Svalbard – is critically important. By pledging to commit 0.1% of commercial seed sales to support Farmers' Rights initiatives (presumably on-farm conservation and breeding initiatives – though details were not given) – and by challenging other governments to do the same – Norway is acknowledging that money for gene banks is not the ultimate solution.

So, many farmers' organizations and CSOs – including ETC Group – don't see the seeds at the end of the tunnel in Svalbard as the solution to long-term food security and are anxious that governments and scientific institutions now move on to put their money and energy into more on-farm conservation and breeding. For some, the Doomsday Vault is a diversion that could breed governmental complacency much the way the Green Revolution of the 1960s and 70s let governments abandon agriculture and rural development in the 1980s and 90s. Genetic erosion is real, CSOs insist, and the need to support farmers in their conservation work is desperately urgent.

Fault at the vault? Still, the acrimony around the Doomsday Vault is hard to understand. The Norwegians – long and passionate supporters of plant genetic resources and especially of Farmers' Rights to those resources – are the first to agree that their Vault is only one small piece in the botanical chess game needed to protect genetic resources. But, the Norwegian government spent $8 million of its own money – not from foreign aid funds – to build the Vault partly because of the international prestige of having it on its soil. That money would not have gone to on-farm conservation. At $125,000 per year to maintain the vault, even some well-funded CSOs could afford to pony up the money.

Da Vinci's Cold (store): The conservation and use of crop genetic diversity is complicated – politically and scientifically – and it needs more hard work and a little less conspiracy.

Given the fate of big libraries, does this mean that the new seed vault is doomed? After all, the U.S. Library of Congress has been around quite some time and has more than 100 million items on 530 miles of shelves. Harvard's Widener Library holds a more modest 57 miles of books and is doing just fine. But even here there is a cautionary tale: Harvard's library was the endowment of a grieving mother who lost her son on the Titanic – one of the world's finest examples of technological hubris.

The Bottom Line: The Global Seed Vault is a constructive contribution to the conservation and sustainable use of plant genetic resources. It is unfair to compare the Doomsday Vault to a library. Libraries – and gene banks – are in the business of collecting, saving, and exchanging books or seeds. The Vault is not in that business – it's just holding onto collections that have been duplicated elsewhere. If the list of burned-out libraries is long, the list of lost seed collections in just the past half-century is at least as impressive. Over 40 national gene banks have lost some or all of their collections.[4] There should be no complacency that the Arctic vault will last forever. Until the end of the Cold War, after all, Svalbard was on the sea lane for the Soviet Union's nuclear submarine fleet. Those times might not be entirely over. We need to get on with the work of on-farm conservation. But, since the world isn't getting any safer, a backup vault to the backup gene banks – not a library – is a good idea.[5]

Questions being asked about The Global Seed Vault

The opening of the Vault concludes a process that began in the 1970s when plant geneticists meeting through the auspices of FAO in Rome began to discuss the feasibility of a "world gene bank" as a backup to the handful of existing *ex situ* collections available at that time. Over the years, many locations – from the Pampas in the far south of Argentina to international space stations – have been proposed. At least since an international scientific conference held at FAO in 1981, the possibility of storing a duplicate sample of the world's seed diversity deep in a mountain in the high Arctic of Norway has been discussed. When the FAO International Treaty on Plant Genetic Resources for Food and Agriculture came into force in 2004, the Norwegian government offered to build and make this facility available to the international community. The Governing Body to the Seeds Treaty accepted this offer unanimously.

The creation of a world gene bank has always been controversial. Rumours surrounding the development of the Vault include justifiable concern that it could be financed or otherwise controlled by multinational seed companies like Monsanto, Syngenta and DuPont and/or that the Vault will become a one-stop shop for the multinationals to pirate and patent the world's seed supply. There are also less-justifiable rumours that the Vault is the latest manifestation of some eugenics grand plan conceived by the Rockefeller Foundation and funded by the Gates Foundation that will give the world's elite exclusive hegemony over genomics. While there's no denying the Rockefeller Foundation's enthusiasm for eugenics a half-century ago, nor Bill Gates's enthusiasm for technological monopoly, these rumours are essentially malicious. Many of us in civil society have been concerned that attention drawn to the Vault will make governments sanguine about the need to conserve national genetic diversity and maintain their existing gene banks or – even worse – suck limited resources away from *in situ* (on farm) seed conservation and plant breeding. Do we really need a vault, many ask? Couldn't the money have been better spent elsewhere? A healthy debate over the role of – balance between – funding for *ex situ* and *in situ* conservation is overdue. This important debate should begin with some basic information about the Global Seed Vault. Although the information below is as complete and accurate as possible, this doesn't mean there aren't more questions to be asked or other aspects of the existing questions to be addressed.

1. Does the world really need a Doomsday Vault?
According to the UN Food and Agriculture Organization (FAO), the world already has nearly 1500 *ex situ* gene bank facilities holding an estimated 6.5 million seed samples. However, only about 1.5-2 million of the samples are unique accessions and almost all of the world's gene banks are poorly and erratically funded and managed. The Seed Vault is intended as a backup seed source of last resort to be accessed only if the original collections in other gene banks are lost. In recent years, wars and natural disasters have destroyed national collections in gene banks in several countries including Vietnam and the Philippines.

2. Why a Vault on Svalbard?
Long-term seed storage on Svalbard is especially inexpensive (at the recommended -18°C) because of its Arctic permafrost condition. Scientific investigation indicates that Svalbard is about as safe from global warming (including sea-level rise) as almost any place on Earth. Although history shows that nothing can be guaranteed, the Vault's location in Norway's Arctic currently makes it an unlikely target for wars, industrial disasters, or civil disturbances. The Nordic Gene Bank has held its own back-up seed collection in an abandoned coal mine in Svalbard for over 20 years.

3. Why Now? The idea of a world gene bank was first proposed in 1981, but Norway couldn't act until FAO's International Seed Treaty came into force in 2004.

4. Who owns and controls the Doomsday Vault?
The Government of Norway. However, the government has proceeded with the unanimous support of the Governing Body of the International Treaty on Plant Genetic Resources for Food and Agriculture. The government is also establishing an International Advisory Council that will include representatives of FAO, CGIAR, the Treaty's Governing Body, and civil society.

5. How much did it cost to build and who paid for it?
It cost around $8 million to build the Seed Vault and the money came from three Norwegian government ministries: Ministry of Foreign Affairs, Ministry of Agriculture and Food, and the Ministry of Environment. No outside funding was solicited or received from any public or private party. If the Vault eventually holds a sample of each of the world's known unique seed accessions, this backup facility will have been constructed at a cost of $4 (or less) per accession. The Vault has the capacity to maintain 4.5 million seed samples. Given that there are, at most, about 2 million unique samples in collections today, this gives the Vault considerable room to expand as necessary.

6. Are multinational seed companies involved?
Contrary to widespread rumours, no corporation or trade association (including Monsanto) has been involved in the planning or funding of the Seed Vault.

7. What will it cost to maintain the Vault annually and who will pay?
It will cost about $125,000 a year (about $0.06 per sample) to operate the facility. It is expected that the Global Crop Diversity Trust will furnish most of this through its endowment. The Trust itself has received a small grant from the Gates Foundation that will make it possible for some South and CGIAR gene banks to package and ship seeds to Svalbard. (Note, however, that the Trust has received grants from DuPont and Syngenta for activities not related to the Svalbard Vault.) See below for further information.

8. Could this money have gone to *in situ* conservation?
No. The Norwegian government is making this unique contribution because the collection will be held in Norway and because Norway has broadly supported plant genetic resources conservation worldwide for many years. However, media and donor attention stimulated by the Seed Vault should lead to substantially increased financial support for both *in situ* and *ex situ* conservation around the world.

9. What about the crop germplasm that can't be stored in the Vault?
That's a real ongoing concern. Only so-called "orthodox" seeds are amenable to long-term storage. Many important food plants including cassava, breadfruit, sweet potato, taro, etc. don't do well in gene banks. The international community must address this issue. However, crops like rice, maize, wheat, sorghum, millets, pulses, beans, oats, rye, and many vegetables and forages – comprising well over three-quarters of humanity's caloric intake – can be stored in the Vault.

10. Will multinationals have easier access to the Vault than to other gene banks?
No, materials will only leave the Vault at the request of the depositor. Unlike regular gene banks, samples are not made available to breeders (and others). In fact, samples will only be released if the depositor's original sample is lost and no other sources of the seed are available. Because the seeds must be duplicated in another gene bank, it will be up to the depositor to agree with the other banks on the availability of the duplicates.

11. Could multinationals send their seeds for free storage in the Vault?
Yes, under the same conditions as national governments. But, companies, too, must have their samples duplicated in another gene bank.

12. Could farmers' organizations store seeds in the Vault?
Yes – but not easily. Again, their seeds must be duplicated elsewhere. Unless they receive a grant, it is unlikely that many farmers' organizations will do this.

13. Will national governments that put seeds in the Vault relinquish sovereignty over this germplasm? Do seeds stored in the Vault automatically become part of the public domain?
No, the seeds continue to be the property of the depositor. Article 10 of the Seed Treaty recognizes the sovereign rights of States over their own plant genetic resources. The depositors must have the original seed samples and a duplicate collection in another gene bank. However, Norway is leaving it up to the depositor to decide how much they want to divulge about the seeds being deposited in the Vault. And, it is up to the depositor to decide whether or not the location of duplicated samples is disclosed. The first shipment of seeds deposited in the Vault include collections that are held by both national governments and CGIAR gene banks. Duplicate samples held in a CGIAR gene bank may also be deposited in black boxes.

14. Who will know what seed samples are being stored at the Seed Vault?

Seeds in the Vault will be stored in sealed packages and will not be opened without the written permission of the depositor. The Nordic Gene Bank (Norway's national gene bank) maintains a public on-line database of deposited materials deposited in the Vault, giving the "passport" information (species, sample size, original country of collection, etc.) customary in gene banks. However, it is up to the depositor to divulge what materials are being deposited and whether or not to disclose the location of duplicated samples. The responsibility for sample regeneration remains with the depositor. The Governing Body must address the issue of accession duplication as it relates to the Global Seed Vault.

15. Could samples in the Vault be contaminated by GM seeds?

It's hard to imagine how, but nothing can be assumed to be impossible. However, under current Norwegian law, GM seeds cannot be brought into Norway unless an exemption license is granted for research purposes by the Norwegian government. Anyway, each seed sample is stored in a sealed airtight container at -18°C inside a mountain, behind locked doors in an Arctic environment in which no crop can currently survive – making it a poor venue for either germination or deterioration. Because GM seeds are prohibited in Norway, depositors might be able to use the collection as a scientific reference point for comparison to contaminated seeds in their country or community. However, because seeds in the Vault are not to be returned unless the duplicates have been lost, this research possibility may not materialize.

16. Is Bill Gates or his foundation paying for the Vault; paying for stocking the Vault; or paying for rejuvenating seeds for the Vault?

The Bill and Melinda Gates Foundation gave the Global Crop Diversity Trust approximately $5.8 million to give as grants to South countries that wish to regenerate threatened accessions in their genebanks (including money for equipment, labour, etc). The money from Gates came with no assumption or obligation on anybody's part to send samples to Svalbard. But, Gates has also given the Trust about $750,000 to give to South countries and CGIAR centres to pack and ship seeds to Svalbard. The cost of getting a seed sample to Svalbard (packaged and shipped) is estimated at roughly one dollar, making the cost of placing a duplicate of every unique sample collected to date into the vault about $2 million. OECD countries, of course, will have to pay their own costs.

17. Is the Vault cost-efficient compared to other forms of conservation?

The Seed Vault is an extremely cheap insurance policy. But, insurance policies are only cost-effective if you need them. The annual maintenance cost of seed samples in the Vault – largely because of its location in the high Arctic – is significantly lower than elsewhere. In sum, the Vault cost Norway $8 million to build and could cost as much as another $2 million to fill. After that, annual operating costs will be $125,000. Put another way, per unique sample: the costs are five dollars for constructing/shipping and six cents per annum afterward.

18. Does the opening of the Seed Vault signal that we no longer need to be concerned about *in situ* conservation?

No, *in situ* conservation combines the conservation of important traits with continuous plant breeding at the local level. This is not only irreplaceable but it is absolutely essential if agricultural biodiversity is to meet the challenge of chaotic climate change. The opening of the Seed Vault has captured enormous public interest and attention. We must take advantage of the increased awareness and importance given to genetic diversity to strengthen and multiply our work for *in situ* (on-farm) conservation.

Sources of additional information:

Background on plant genetic resources (FAO):
http://www.fao.org/ag/cgrfa/PGR.htm

Norwegian Government's website on Svalbard Vault:
http://www.nordgen.org/sgsv/

Global Crop Diversity Trust:
http://www.croptrust.org/main/arctic.php?itemid=216

Global Crop Diversity Trust – Source of Funds Raised to Date:
http://www.croptrust.org/documents/web/Funding%20Status%2017-12-07.pdf

[1] Associated Press, "Internet provider in UAE confirms undersea cable cut between Dubai, Oman, cause unknown," *International Herald Tribune*, February 2, 2008, and *The Economist* online print edition, "The internet: Of cables and conspiracies," February 7, 2008.

[2] The Egyptians not only lost their library – they've lost Cleopatra as well. Her mummified remains – not well-preserved and in serious need of a Botox treatment – are on display in the Vatican Museum in Rome.

[3] According to historian Matthew Battles, "…great libraries are problematic in times of war, disaster, or decay, for their fate becomes the fate of the literatures they contain. Much of what comes down to us from antiquity survived because it was held in small private libraries tucked away in obscure backwaters of the ancient world, where it was more likely to escape the notice of zealots as well as princes." From: *Battles, Matthew, Library: An Unquiet History*, W.W. Norton & Co., 2003.

[4] Afghanistan, Argentina, Bolivia, Botswana, Brazil, Burma, Cambodia, Cameroon, Chile, Dominican Republic, Ecuador, Eritrea, Ethiopia, Gambia, Guatemala, Guinea, Guinea-Bissau, Honduras, India, Iran, Iraq, Kenya, Liberia, Mali, Mexico, Nepal, Nigeria, Pakistan, Panama, Paraguay, Peru, Philippines, Rwanda, Senegal, Sri Lanka, Sudan, Tanzania, Turkey, Uruguay, Vietnam and Zambia.

[5] In the spirit of full disclosure, Pat Mooney accepted an invitation to speak at a seminar at the opening of the Vault on Svalbard where he spoke about the importance of on-farm conservation.