

# THE ROLE OF THE SVALBARD GLOBAL SEED VAULT FOR SECURE AND EFFECTIVE LONG TERM CONSERVATION OF PLANT GENETIC RESOURCES



***Roland von Bothmer  
The Global Seed Vault  
NordGen***

# ***What is the background for agricultural diversity?***

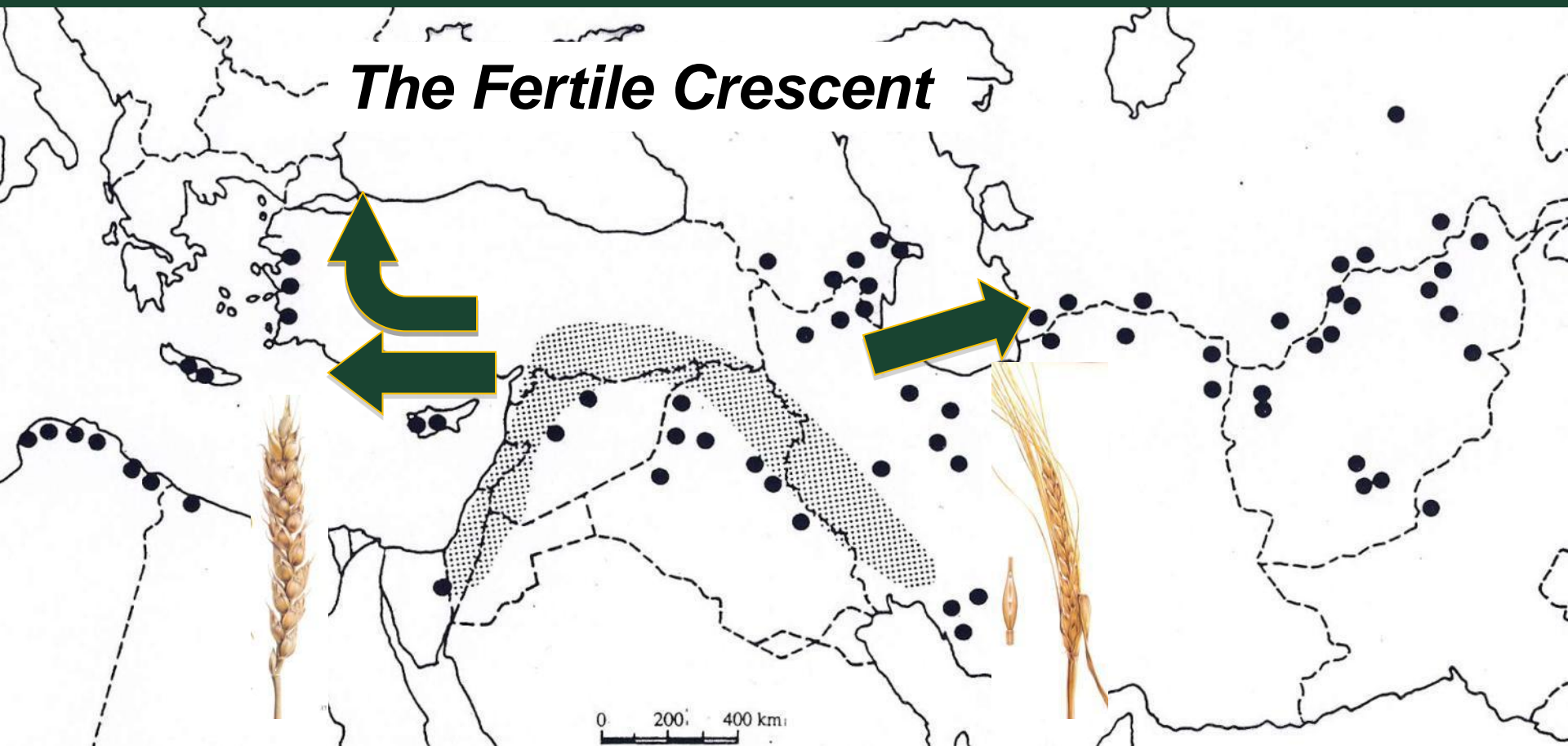


# ***What is the background for agricultural diversity?***

- **Domestication**
- **Migration and adaptation**
- **Conscious selection by farmers**
- **Modern plant breeding**



# MIGRATION and ADAPTATION



**After the first domestication followed  
a rapid migration**



# Locally adapted landraces were developed over the world

Barley from Northern Pakistan...



*...and from Bhutan*







**Landraces were the base for  
modern plant breeding**



**Many species show  
an extreme  
adaptation...**

***Wheat field in northern  
Pakistan, 4000 m***



**... but old land races  
disappear at an  
alarming speed**





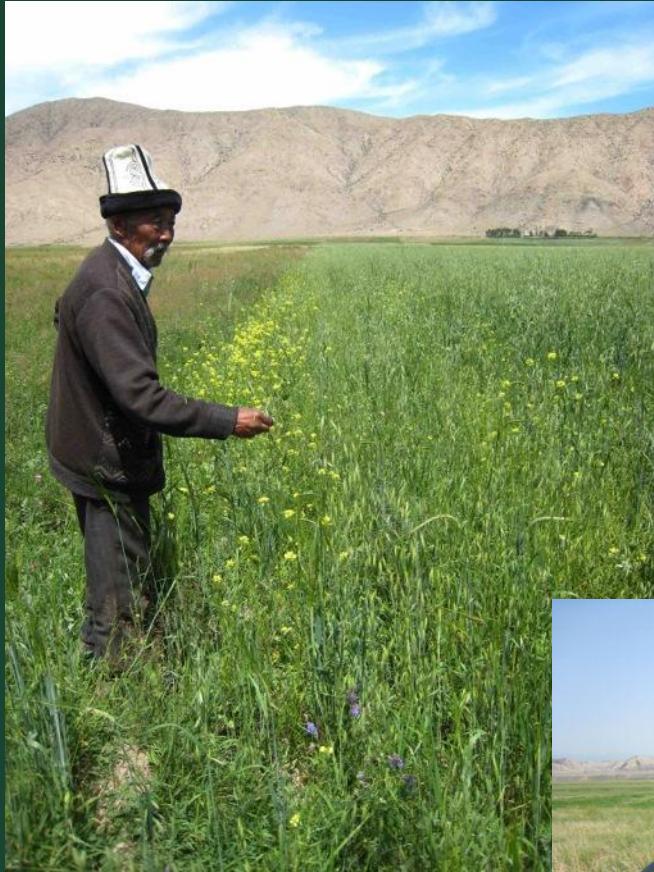
**... and genetic erosion is a reality!**



**....sometimes it is too late!**



# Can "new diversity" be created?? *example from Kyrgyzstan*



*Birjan Usubaliev*

# Background

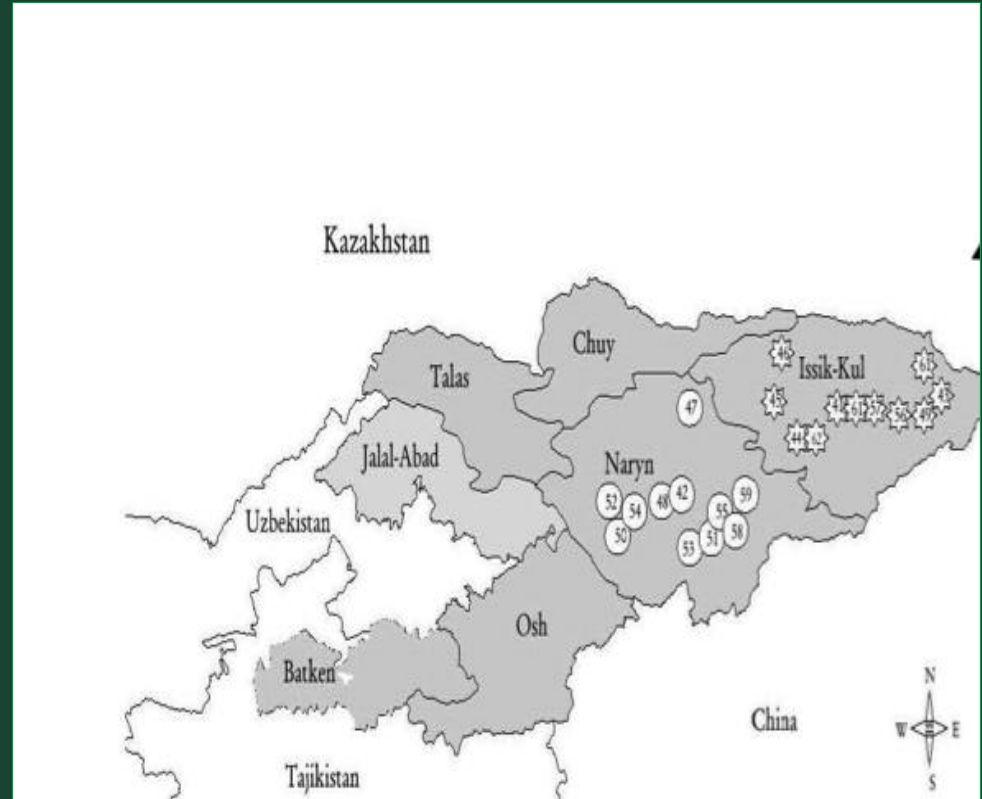
## Country information



Land Area: 198,500 sq km



# Collection mission in Kyrgyzstan





**The variation is very large  
– is it a landrace?**







Tortkyol

Kapacy Ka

Image © 2011 TerraMetrics

© 2011 Google

Image © 2011 GeoEye

© 2011 Mapabc.com

© 2010 Google



**We came in the  
middle of  
the harvest**



**We came in the  
middle of  
the harvest**





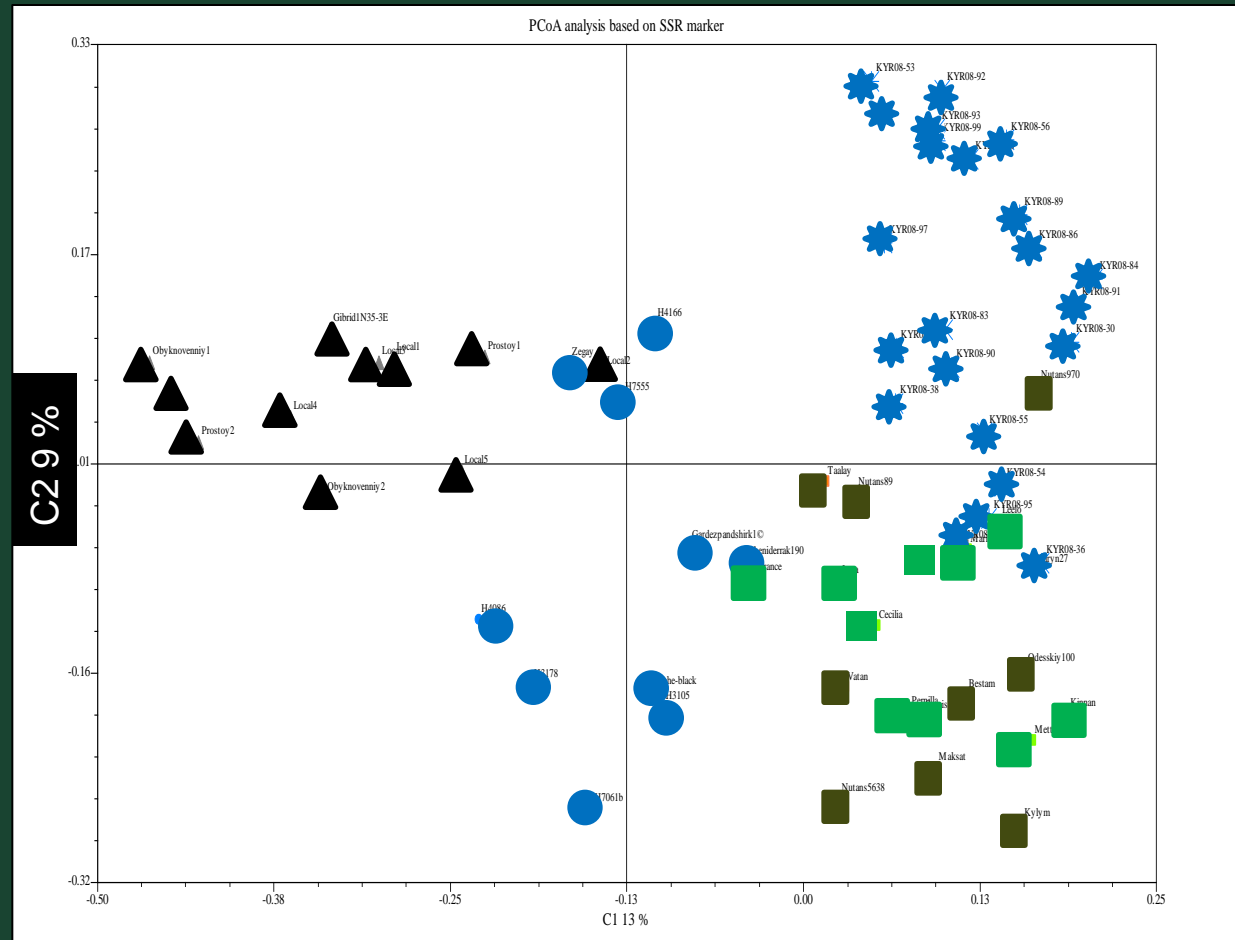


**What was the harvest?**



**0.5 t/ha!**

## PCoA analysis



\* FMPs, ■ Kyrgyz cultivars, ■ Nordic and Baltic cultivars,  
▲ Russian accessions, ● accessions from Afghanistan, China and Pakistan

# Conclusion

## Allele richness and genetic diversity of spring barley

Accession	Average number of alleles within accession	Average number of polymorphic loci within accession	Average genetic diversity within accession (H)	Genetic diversity among the accessions (h)	Average number of alleles
Russian landraces	1.5	3.6	0.131	0.569	5.0
Kyrgyz cultivars	1.1	1.7	0.066	0.594	3.9
Nordic and Baltic cultivars	1.1	0.7	0.034	0.551	3.8
Asian landraces	1.5	4.6	0.116	0.595	6.2
FMPs (Kyrgyzstan)	2.8	11.0	0.426	0.686	8.4





Reason: ***POVERTY!!!***

# HOW DOES THE FUTURE LOOK LIKE??



- Climate change
- Overpopulation
- Environmental issues
- Hunger and poverty

*How can we  
possibly increase  
food production??*



# How many plant species are used?

*Totally  
ca 300 000  
species of  
higher plants*

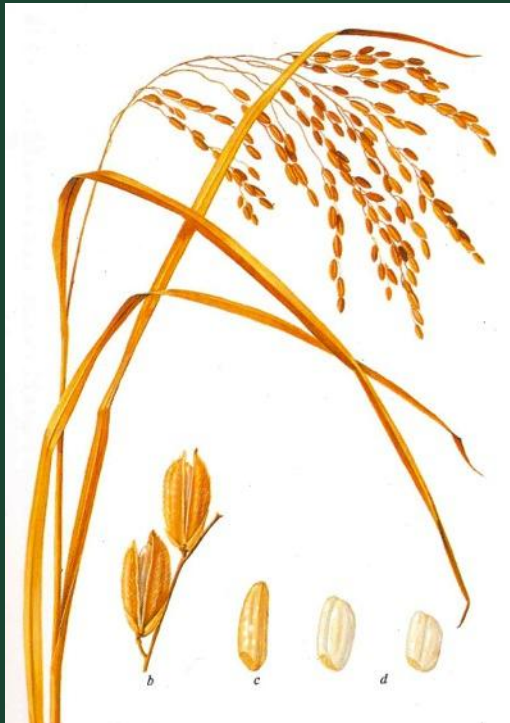
Ca 7 000 species can be used

120 species of  
national importance

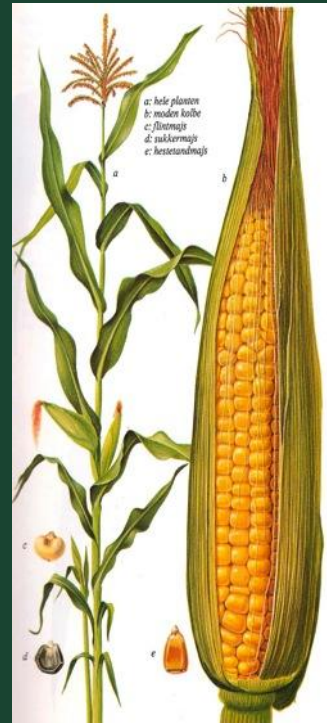
30 species stands  
for 90 % of  
calories



# Three species provide 60 % of the global calory uptake!!



*Rice*



*Maize*



*Wheat*

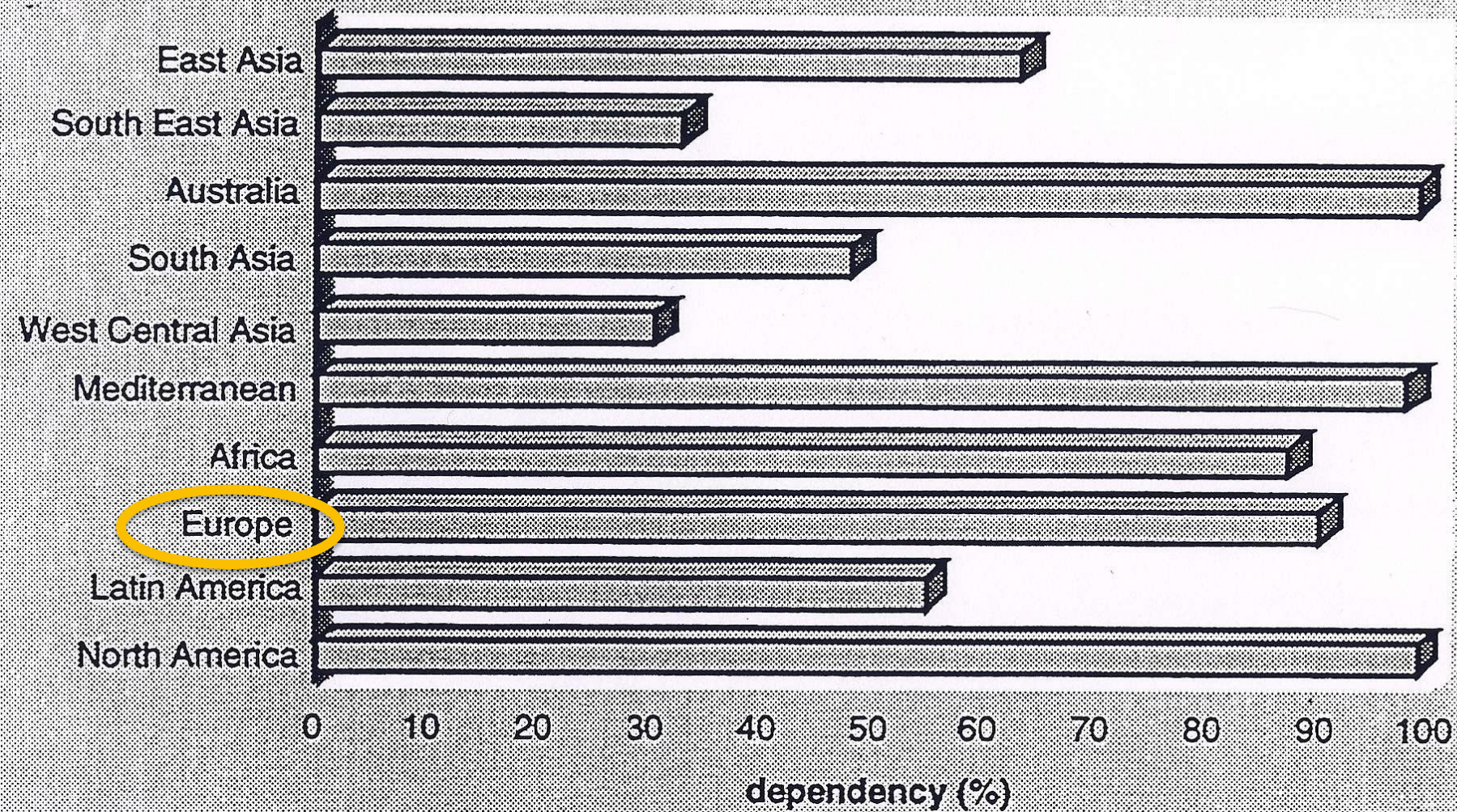
**A vulnerable system!**



# GLOBAL DEVELOPMENT and INTERNATIONAL UNDERTAKINGS





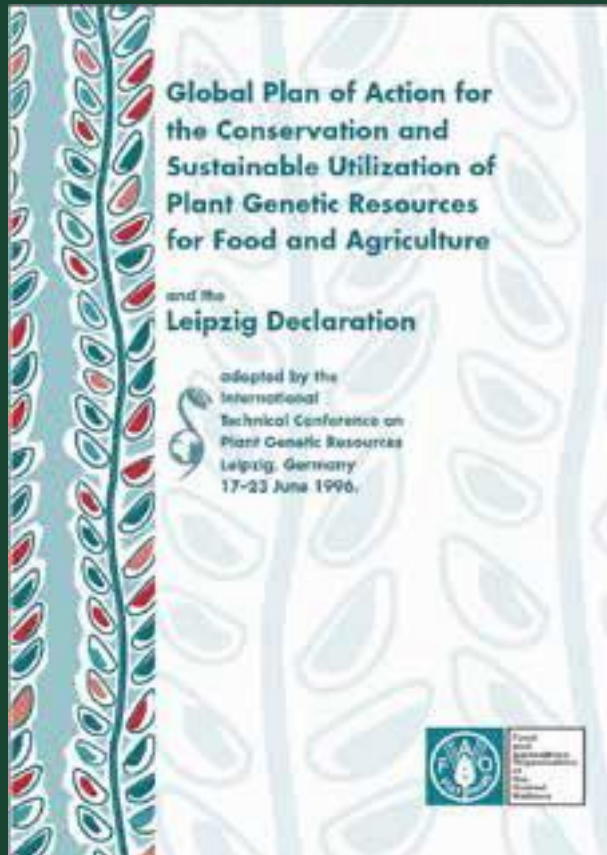


*Source: adapted from Kloppenburg & Kleinmann (1987)*

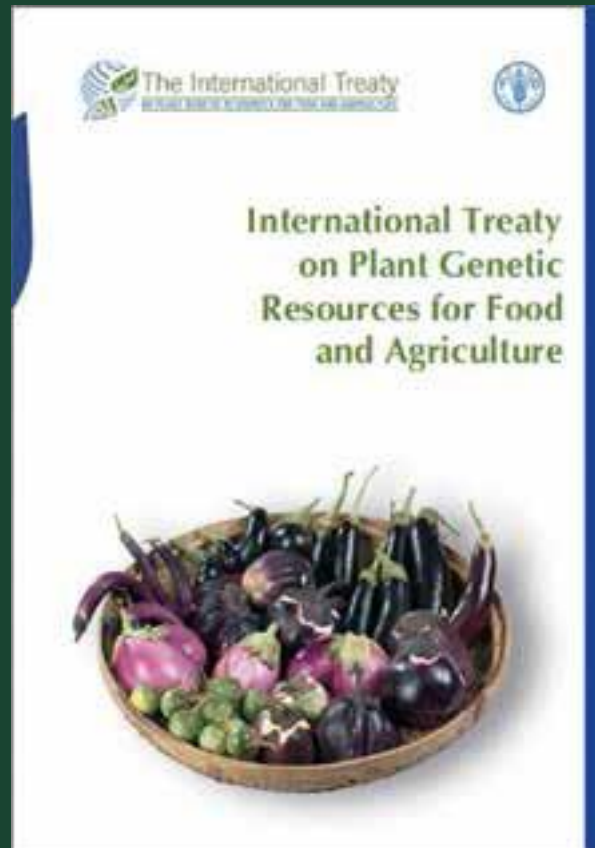
# Dependency of imported gene sources



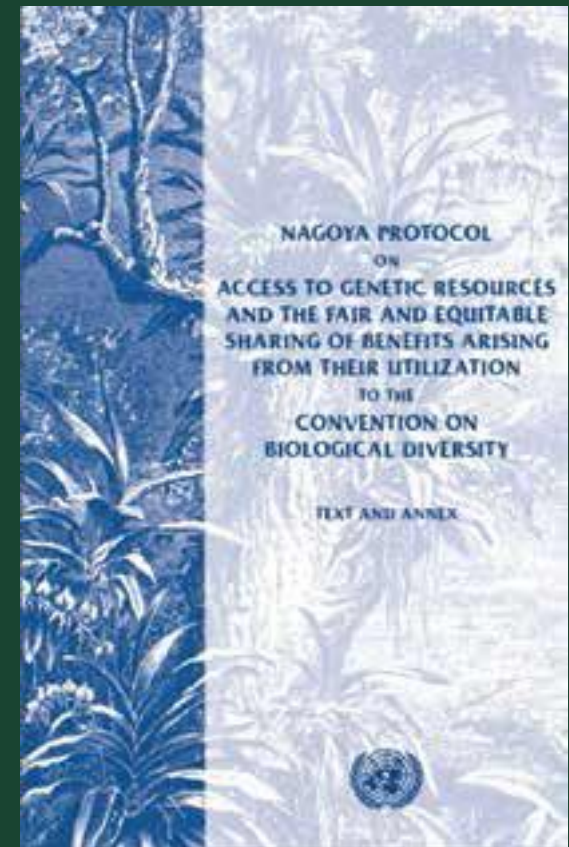
# POLICY and INTERNATIONAL TREATIES



***CBD  
Global Plan of Action***



***The International Treaty***



***The Nagoya  
Protocol***

# INTERNATIONAL DEVELOPMENT

- 1982 FAO, Commission of Plant Genetic Resources
- ***1992 Convention on Biodiversity (CBD/COP)***
- 1992-2004 FAO, The International Undertaking
- 1994 TRIPS Agreement (GATT, WTO)
- 1996 The Leipzig Declaration
- ***2004 The International Treaty on PGR***
- ***2010 The Nagoya Protocol***

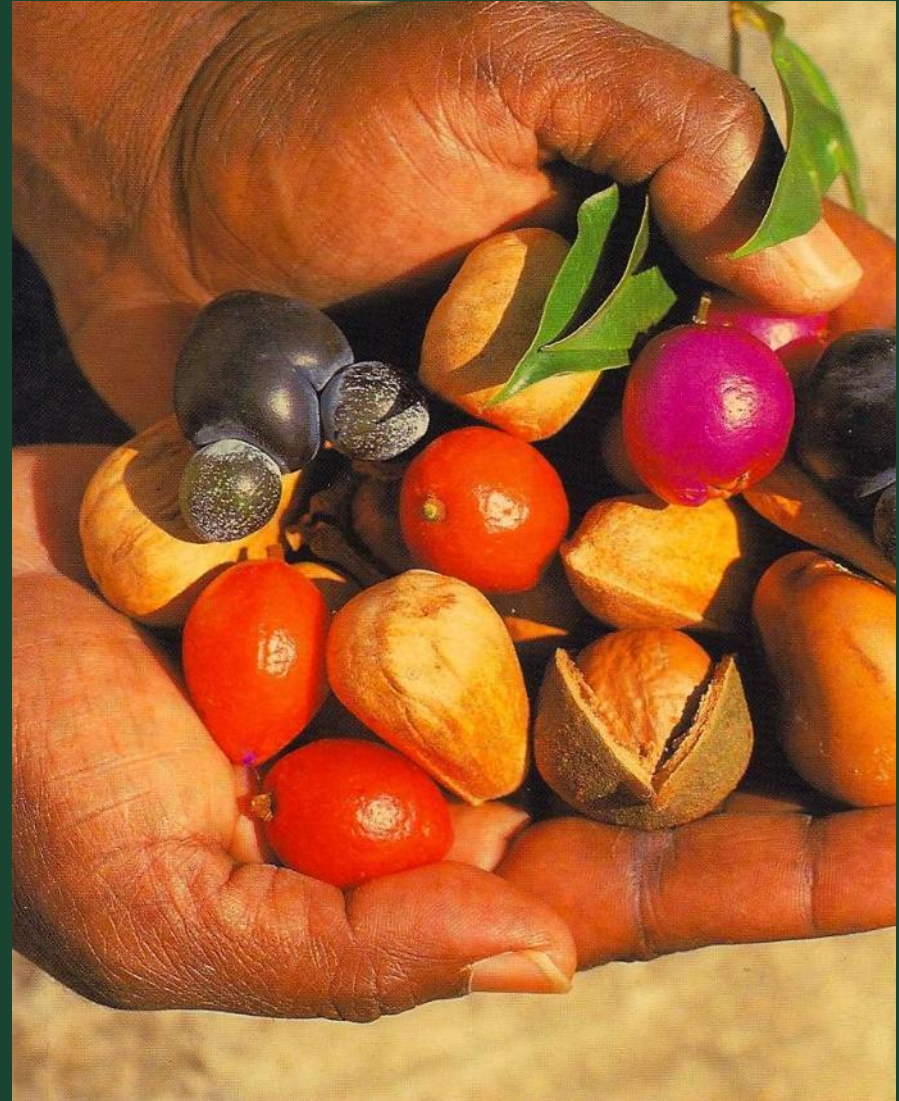


# What does the Rio Declaration say?

AGENDA 21, 15:3:

*"..countries have*

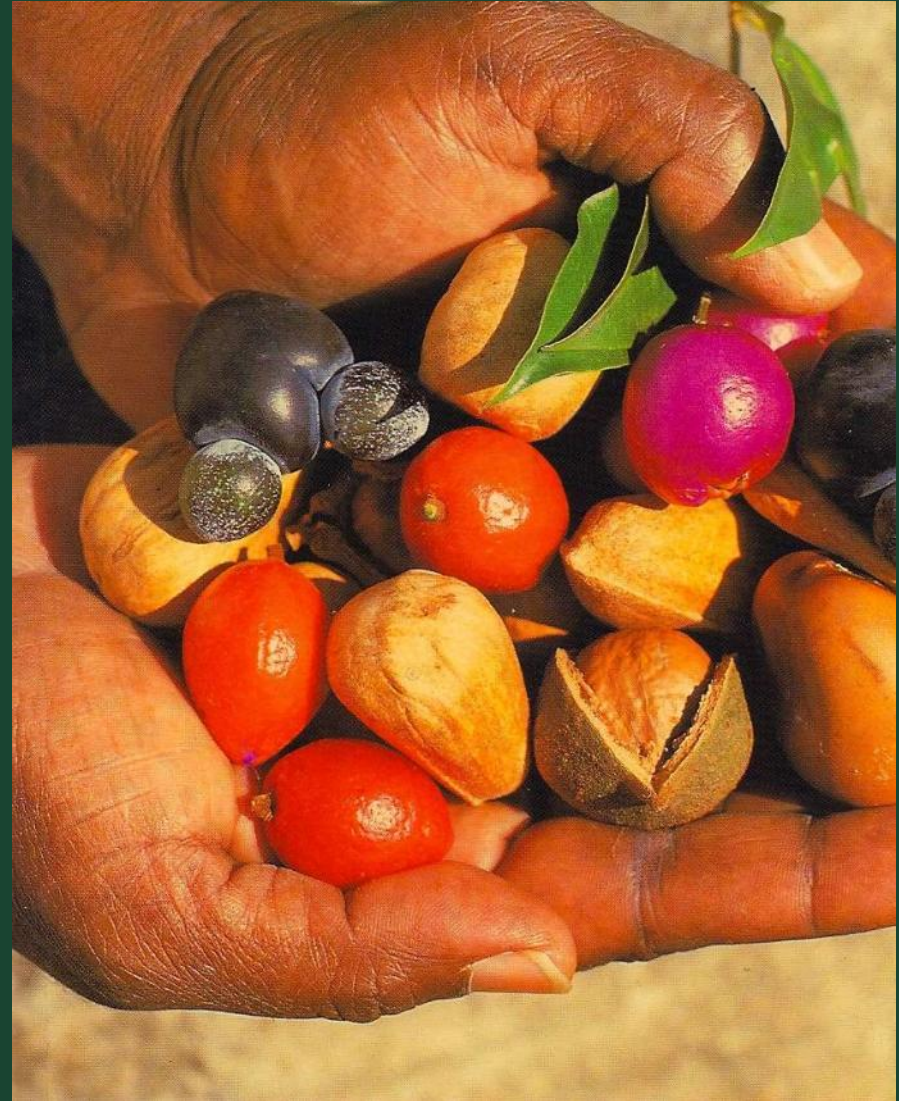
***souvereign rights** ..to their  
own genetic resources"*



# What does the Rio Declaration say?

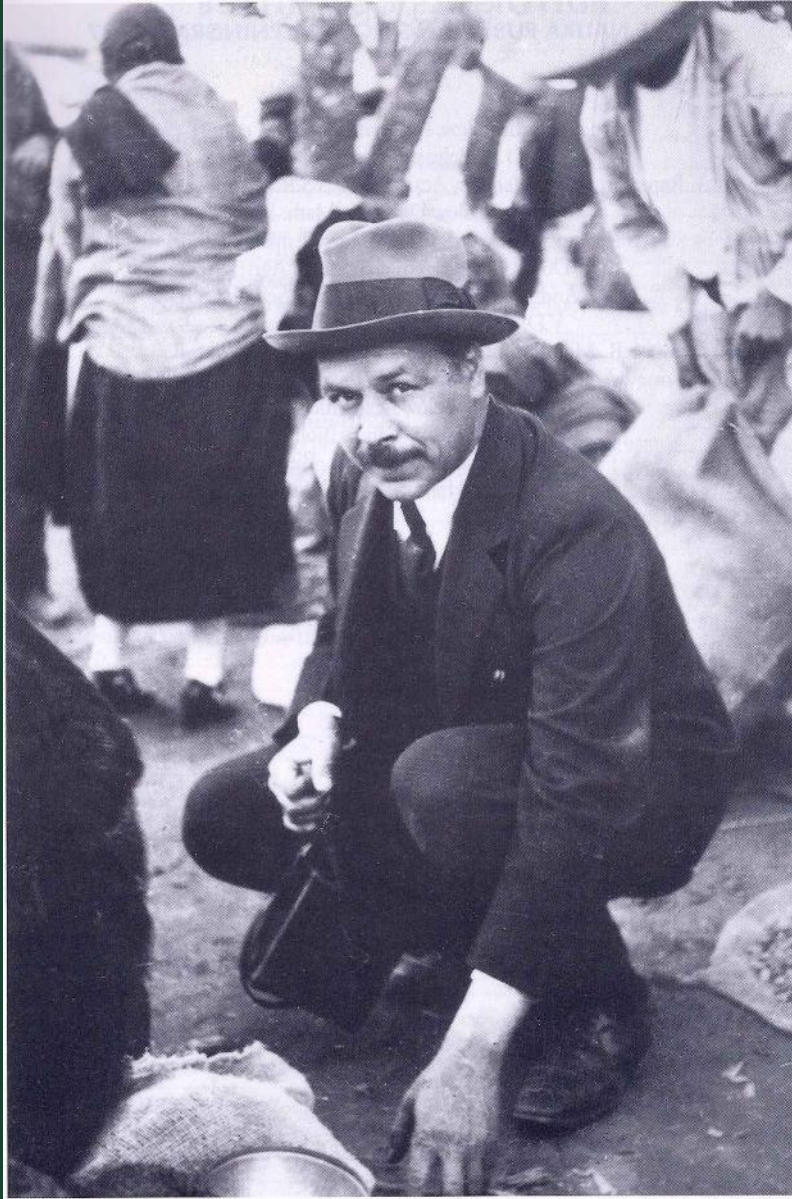
AGENDA 21, 14:57:

*“.. **sharing of benefits** of the results of research and development in plant breeding...”*





# THE GENE BANK CONCEPT DEVELOPS



***N. I. Vavilov***  
**– a pioneer**

# WHAT IS A GENE BANK?

Gene bank activity is "low tech"

- dry seed in a freezer!!

The value lies in the information.





# WHAT IS A GENE BANK?

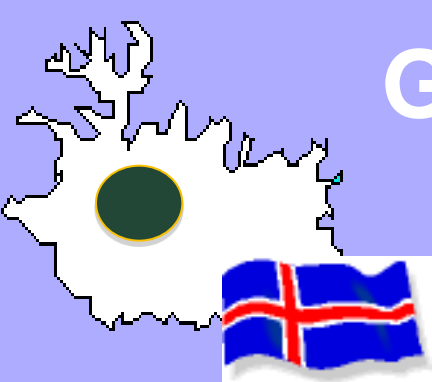
Gene bank activity is "low tech"  
- dry seed in a freezer!!

The value lies in the information.

**Ca 1750 GENE BANKS  
IN THE WORLD**



# GENETIC RESOURCES in the Nordic area



● = national programs



**NordGen**





# Agriculture and climate gradients:

- West– East, maritime – continental, precipitation
- North – South, var growth period, temperature



# NORDIC GENETIC RESOURCES

Seed multiplied material





# "ARCTIC CABBAGE" from Tromsø

- Has a special quality



*Arctic cabbage stands  
long time storage*



*Modern, compact Dutch  
variety, rottens quickly!*

# NORDIC GENETIC RESOURCES

Vegetatively multiplied material in clone archives



*cherries*



*apple*



*horse radish*



*black currants*



*potatoe*



# NordGen Plants

- Active collection:  
*Alnarp, Sweden*
- Base collection:  
*Årslev, Denmark*
- Security collection:  
*Svalbard, Norway*



# **International collaboration**



- **Future food security depends on the diversity in our food crops**
- **The gene banks are vulnerable for a great number of threats: war, civil strides , catastrophies in nature, lack of money, failure in equipments etc**
- **The time is ripe for international collaboration to secure the future of genetic resources**



# **There are immediate threats for genebanks!!!**

- **lack of money,**
- **failure in equipments**
- **war**
- **civil strides**
- **catastrophies in nature like  
landslides, tsunamis, flooding,  
earth quakes**

# There are immediate threats!!!

## Central Asia 2008



***Failure of  
electricity!!***



# There are immediate threats!!!

*Flooding !!*

The Thai Genebank





**90 % of ICARDA's material is saved in the Vault!**

**Civil war!**







Svalbard, Norway 74-  
81° North, 10-35°  
East

# SVALBARD





**NordGen had its safety  
duplicate set in an  
abandoned coal mine  
at Svalbard in the  
middle of the 1980s**



***Mine No 3  
March 2012***

# Vision

A global security net

**The Svalbard Global Seed Vault shall be the most secure back-up storage for a **global system** of *ex situ* collections of diversity in crops**

**The Svalbard Global Seed Vault shall have the capacity to store all unique plant genetic resources in conventional genebanks of the world**



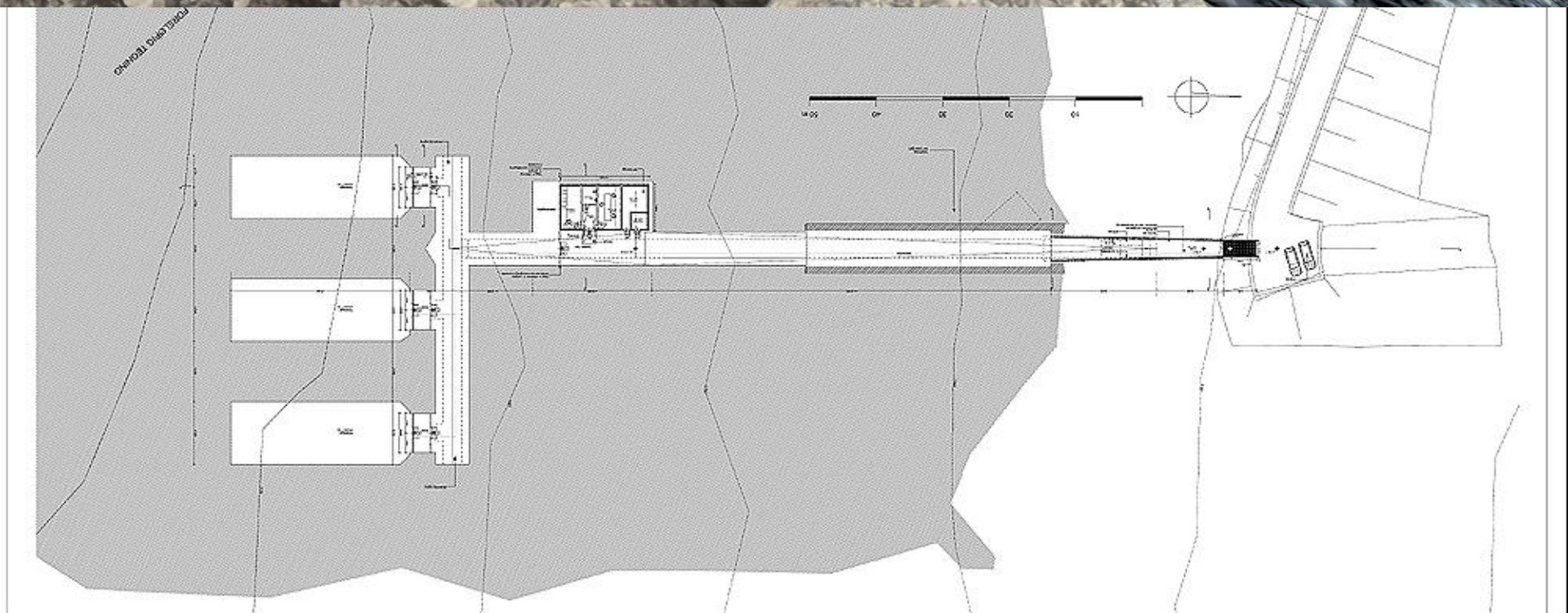
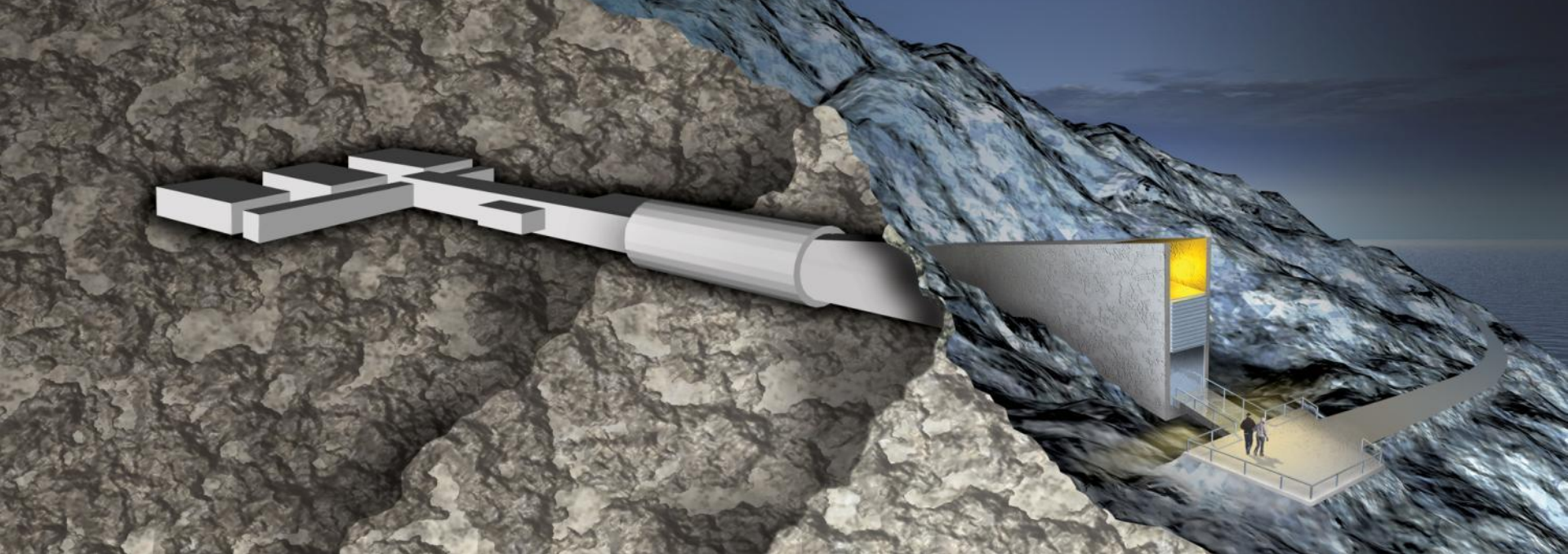


# The Vault lies in the mountain



*August*

*February*





# The structure

- The Vault is embedded 120 m into the mountain
- 130 m above sea level; above the worst scenario for climate change
- Geologically (and politically?) stable area
- Temperature at  $-18^{\circ}\text{C}$
- The permafrost is a guarantee for cooling at  $-4^{\circ}\text{C}$  if the technology fails
- Monitoring and control with gas-, temperature- and motion detectors

# Organisation

- **Norwegian Government:** owner, responsible authority.
- **NordGen:** responsible for management and operations.
- **The Global Crop Diversity Trust:** is partly funding the operations by granting the participation by developing countries
- **International Advisory Council:** monitors the operation at the Vault

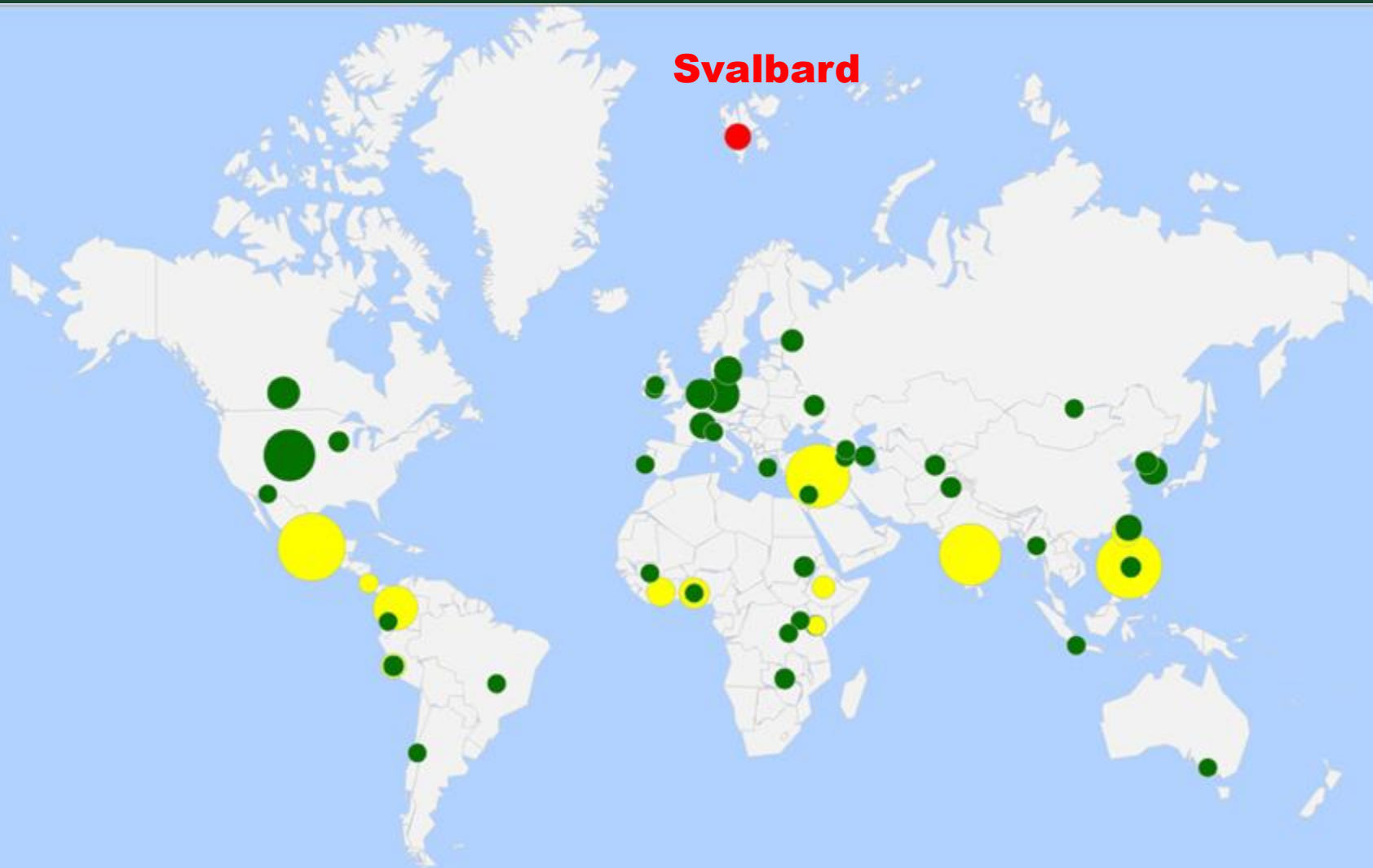




# **Conditions**

- **Deposit and storage is free of charge for public and private collections**
- **Ownership stays with the depositor**
- **“Black box – system”; material will not be opened**
- **Responsibility for tests of germinability and multiplication remains by the depositor**
- **Information is available via an open, online, data portal**
- **Resending after request**

# Depositors in The Seed Vault



● International Agricultural Centres e.g. IRRI, CIMMYT and ICARDA




[Home](#) [Depositor Guidelines](#) [Information sharing](#)
 [Search!](#)

## Welcome to the Seed Portal of the Svalbard Global Seed Vault

### Search the Seed Portal by:

- Seed samples [320 549]
- Species [2 939]
- Genus [645]
- Depositor Institutes [22]
- Seed deposit events [26]
- Country of origin [220]
- Continent of origin [8]

### This data portal serves two main users

**For depositors:** The seed portal provides a way to submit inventories of the material they wish to deposit in the Seed Vault - see the [Depositor Guidelines](#) tab in the menu above.

**For the general public:** The seed portal is a way to find basic information about the seed samples conserved in the Seed Vault - see the [Information Sharing](#) tab in the menu above.

### SGSV Seed Portal

The data in the Svalbard Global Seed Vault (SGSV) Seed Portal will build on, and be fully compatible with, the new global accession level data portal for access to PGRFA data under development by Bioversity International with contribution from NordGen, and supported by the Global Crop Diversity Trust.



The Svalbard Global Seed Vault (SGSV) is now open, February 26, 2008, 10:30 Photo by Simon Jeppson

# Current figures in *The Global Seed Vault*

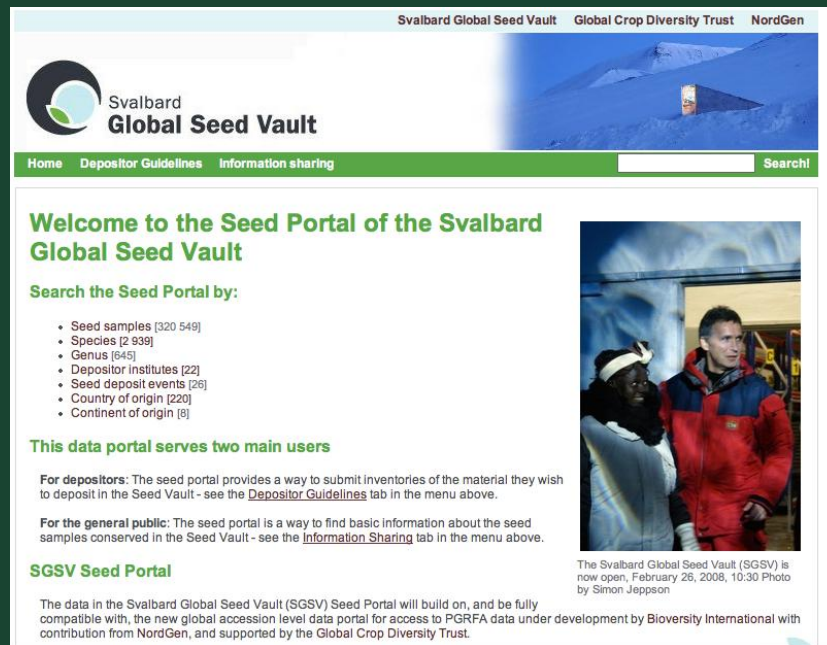
## June 25, 2015

Countries of origin: 232

Number of plant genera: 943

Number of plant species: 5 103

Number of accessions: 864 309



The screenshot shows the homepage of the Svalbard Global Seed Vault website. At the top, there is a navigation bar with links to "Svalbard Global Seed Vault", "Global Crop Diversity Trust", and "NordGen". Below this is a header section with the Svalbard Global Seed Vault logo on the left and a photograph of the vault's entrance on the right. A green navigation bar contains links for "Home", "Depositor Guidelines", "Information sharing", and a "Search" box. The main content area features a "Welcome to the Seed Portal of the Svalbard Global Seed Vault" message, followed by a "Search the Seed Portal by:" section with a bulleted list of search criteria: Seed samples [320 549], Species [2 939], Genus [645], Depositor institutes [22], Seed deposit events [26], Country of origin [220], and Continent of origin [8]. Below this, a section titled "This data portal serves two main users" provides information for depositors and the general public. A photograph of two people in winter gear is shown on the right. At the bottom, there is a section for the "SGSV Seed Portal" and a small caption about the vault's opening.

Svalbard Global Seed Vault Global Crop Diversity Trust NordGen

Svalbard Global Seed Vault

Home Depositor Guidelines Information sharing Search

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**SGSV Seed Portal**

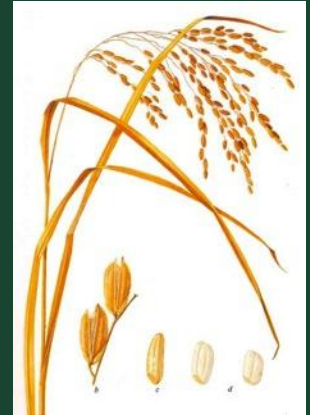
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# Major crops in the Global Seed Vault (*accessions*)

<b><i>TRITICUM</i></b>	<b>156 223</b>
<b><i>ORYZA</i></b>	<b>148 667</b>
<b><i>HORDEUM</i></b>	<b>74 294</b>
<b><i>SORGHUM</i></b>	<b>48 208</b>
<b><i>PHASEOLUS</i></b>	<b>38 816</b>
<b><i>ZEA</i></b>	<b>35 454</b>
<b><i>CICER</i></b>	<b>28 836</b>
<b><i>.....</i></b>	
<b><i>BRASSICA</i></b>	<b>10 531</b>



# ***MATERIAL IN GENE BANKS***

- **What is preserved and what is available??**



Collecting *Hordeum roshevitzii* in China



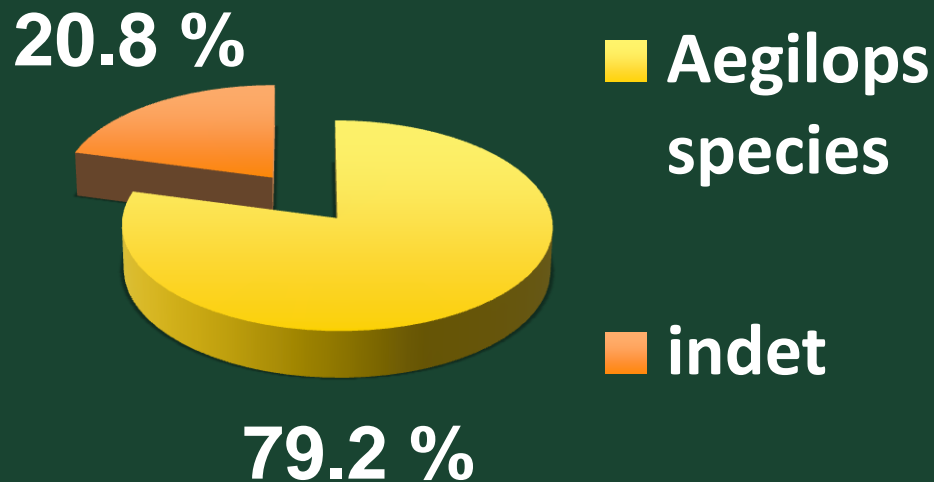
# *Aegilops* in gene banks



**Goatgrasses**

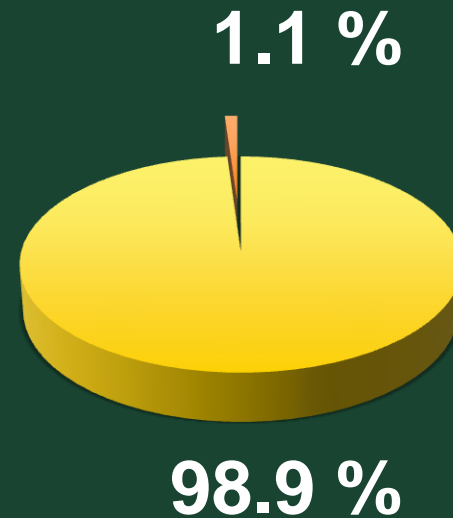
# *Aegilops* in gene banks

## WIEWS



41 species  
42 273 accessions

## SGSV



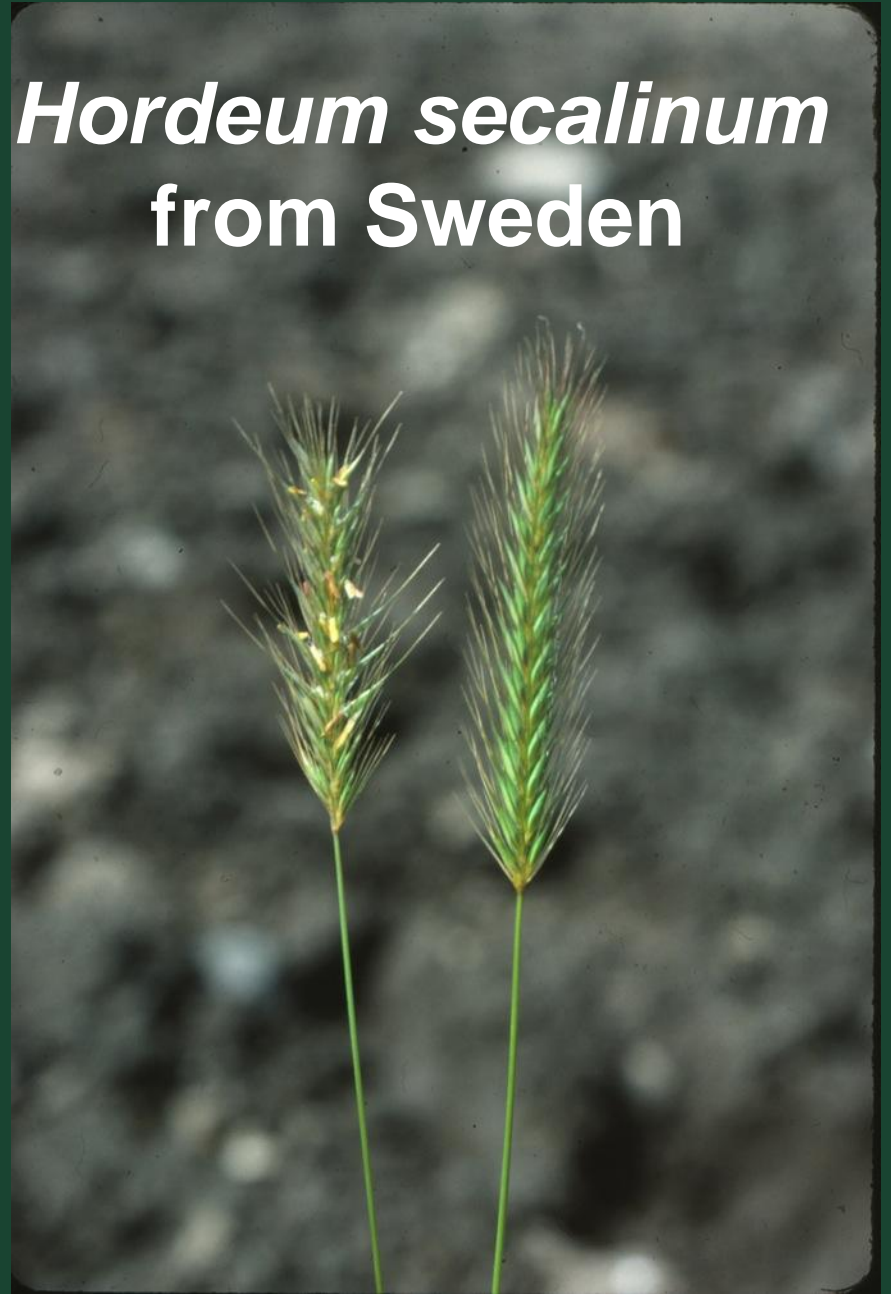
26 species  
3 855 accessions (8.3 %)

# ***HORDEUM*** in gene banks

***Barley landrace  
in China***



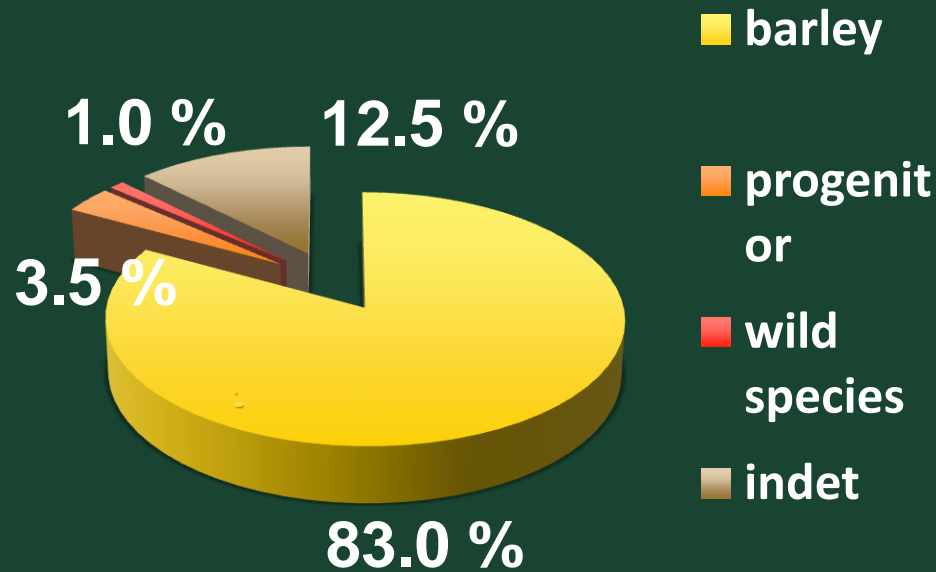
***Hordeum secalinum  
from Sweden***





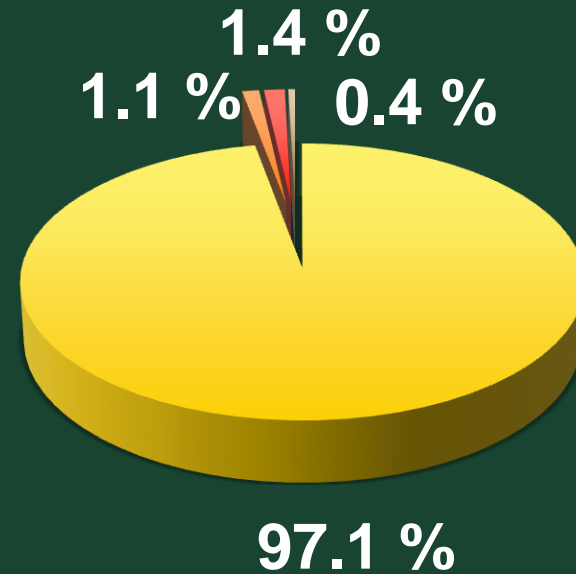
# ***HORDEUM*** in Gene Banks

## **WIEWS**



**469 590 acc**

## **SGSV**



**74 613 acc (15.9 %)**

# Status of material in SGSV

*“We estimate that 1/3 of the globally distinct accessions of 156 crop genera stored in genebanks ... are conserved in the Seed Vault”*

*Westengen et al. 2013*



# WILD *BRASSICA* (n=9) IN GENEbanks

## *Collected material:*

IBPGR missions in 5 countries in 1982 – 1988:

- ESP, FRA, ITA, GRC, GBR
- ~ 185 accessions of 9 species
- Available: 19 accessions of 2 species (16 GBR and 3 GRC)
- No information on other accessions



*From Noortje Bas, CGN*



# WILD SPECIES (CWR) IN GENE BANKS

## CONCLUSIONS

- **Several collecting missions; availability is limited or badly known**
- **Number of collected/available samples is limited** - *often seed collected from very few plants*
- **Material made available under different conditions**

*In some collections: “not to be used for breeding”*

# Handling of material in SGSV

## *Harvest*



# Seed handling





# Package





# Transport



# The seed shipment arrives at Svalbard





# Interior of The Vault



*Ola Westengen*

## The Tunnel

## Preparation for storage



# Interior of The Vault

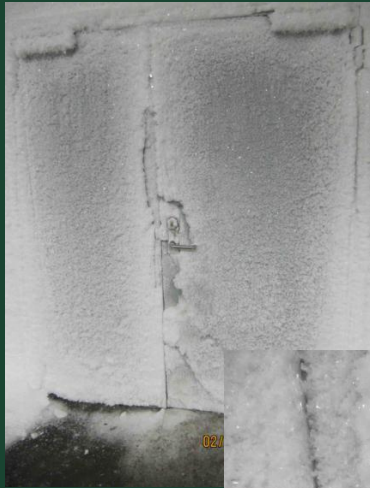
Seed boxes from  
ICARDA



Old and new packages



# The inner Vault – We try to keep it safe for the future



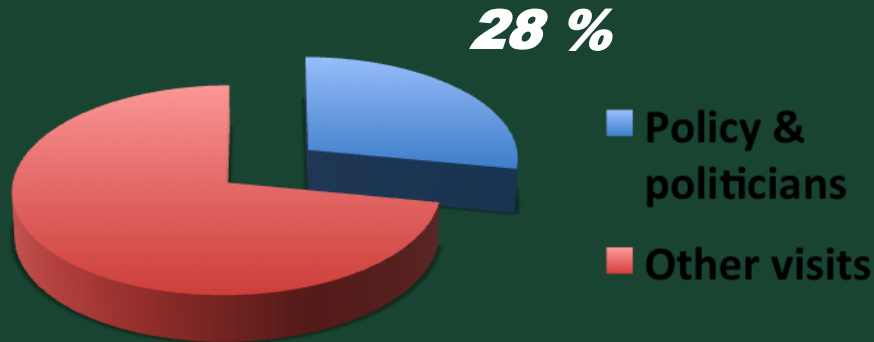


**Visits to the Vault are important – but we have a very restrictive visiting policy**



***Indian Minister for Science and Education  
and Norwegian Minister of Education***

# Visits: policy makers and politicians

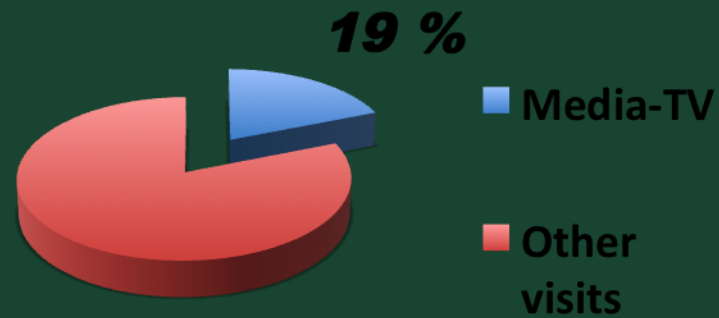


***Ban Ki Moon, UN***



***Dr. Swaminathan, India***

# Visits: Media-TV

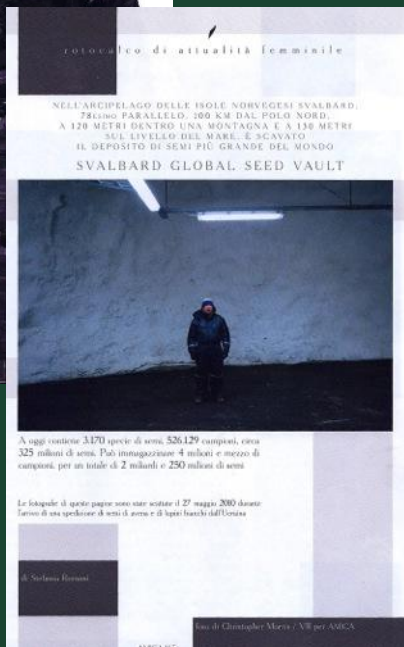




# Visits: Media-magazines

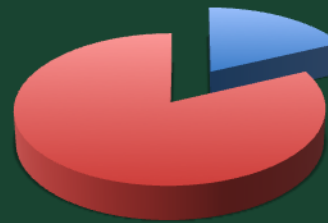


**AMICA**



**Fashion magazine**

**18 %**



**Media-magazine**  
**Other visits**



**Topolino**



**Kids magazine**

# A special visit to The Vault

**March 13, 2013:**  
**Her Royal Highness**  
***Princess Maha Chakri***  
***Sirindhorn, Thailand***



# ART PROJECTS

*The Japanese artist  
Mitsuaki Tanabe  
donates his  
sculpture "The Seed"  
to The Vault*





# **CONSERVATION**

## **- TAKE HOME MESSAGES**

- **Availability of genebank material often uncertain**
- **Genetic status of material rel. unknown**
- **Much material is not determined**
- **Safety back-up needs improvement**
- **Complementary collecting necessary (CWR)**
- **Different taxonomies used**
- **Databases are not fully compatible**
- **How many duplicates are there?**

# The Global Seed Vault is a part of the efforts!

## We try to keep it safe for the future



[www.seedvault.no](http://www.seedvault.no)

Seed Portal: [www.nordgen.org/sgsv](http://www.nordgen.org/sgsv)



**Thank you!!**

