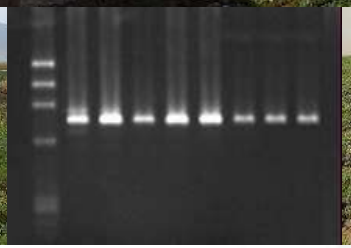
The Importance of Germplasm Health in Preventing Transboundary Spread of Plant Pests and Diseases

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ICARDA
Science for resilient livelihoods in dry areas

CGIAR

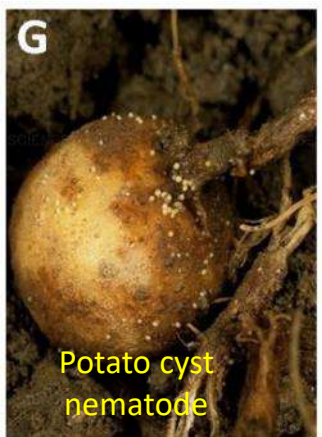
Outline

- Impact of Pathogens & Insect Pests
- Importance of Transboundary Plant Pests and Pathogens
- Germplasm Movement & CGIAR Germplasm Health Units (GHUs)
- Monitoring, Clearance and Documentation of Safe Germplasm Movement
- Challenges and Conclusions

Crop Diseases: Outbreaks, Epidemics & Pandemics

- ✓ >1,300 known pests and pathogens infect agricultural crops globally
- ✓ Estimated economic impact of around US$ 540 billion, annually
- ✓ Most severe damage inflicted by introduced pests & pathogens

SERIOUS THREAT TO FOOD SYSTEMS AND BIODIVERSITY



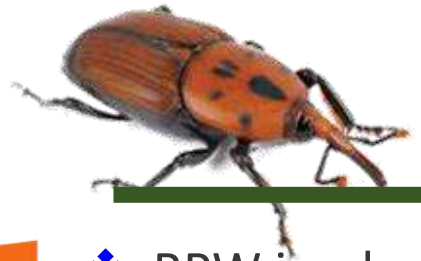
Importance of Transboundary Plant Pests

- Transboundary pests (insect pests, diseases, nematodes, weeds) cause significant economic losses worldwide.
- They cause serious negative impacts on livelihoods, food security and global markets.
- In a recent study (Eschen *et al*., 2021), the total estimated annual cost of Transboundary pests in Africa was US$65.58 billion.
- Fall armyworm (*Spodoptera frugiperda*) causes the highest yield losses (US$9.4 billion), in Africa.
- Unfortunately, there are no studies on the economic impacts of Transboundary pests in our region.

Losses of transboundary pests

Country	Estimated losses in Euro/year
Worldwide	Trillion
USA	90 billion
Europe	12 billion
China	11 billion
New Zealand	2 billion
UK	2 billion
Source: European Union, 2013	

Eschen *et al.* (2021). *CABI Agriculture and Bioscience,* https://doi.org/10.1186/s43170-021-00038-7



Red Palm Weevil (*Rhynchophorus ferrugineus*)

- RPW is a key pest of palms – Introduced from India and East Asian countries to Saudi Arabia, Gulf countries, Iraq, the Middle East, North Africa, Southern Europe, ……
- RPW causes devastating damage to date palm trees, affecting production, and livelihoods of around 50 million farmers.
- The main challenges of RPW are effective and sustainable management, detection of infection at an early stage and weak agricultural quarantine regulations.
- FAO is working with international and national stakeholders to promote a national, regional insect management program in the Near East and North Africa region.
- ICARDA, in collaboration with national programs in the Gulf Cooperation Council, is developing a mobile application to monitor and collect data on infections and agricultural systems to understand infection mechanisms and more effective and participatory control.

Fall armyworm (*Spodoptera frugiperda*)

"from a transboundary insect to an endemic insect"

- FAW was introduced from Americas to Africa (2016), Indian continent (2018), various countries in Asia (2019), Australia (2020), ... and it continues to spread.
- It infects about 350 hosts, most of which are grasses (corn, rice, sugarcane, wheat), which are considered the food basket and guarantee food security for humanity.
- FAO and other organizations have been concerned with this pest since the time of its emergence, providing advice and assistance in curbing its spread and reducing losses.
- ICARDA in Lebanon is training farmers on the management of FAW (using male pheromone trap and other management options).
- FAO was published a book in Arabic on the FAW (by Drs. I. Jboory, Th. Yassin and M. Al-Kahki) https://doi.org/10.4060/cb7104ar







Olive quick decline syndrome (*Xylella fastidiosa*)

"Poses a serious threat to olive cultivation in the Mediterranean region"

- *Xylella* was introduced from Americas to southern Italy (2013).
- It has cost European economies 22 billions of dollars, and the infestation has so far been estimated at about 240 thousand hectares.
- This bacteria infects more than 350 different plant species belonging to 70 plant families (including grapes, olives, citrus fruits, almonds, peaches, coffee, avocados, and oleanders).
- Many wild plants and herbs can carry the bacteria without symptoms.
- It is transmitted by many insects, especially sucking insects (Cicadellidae).
- **Immediate measures must be taken to protect olive trees in the Mediterranean region, and funds must be allocated to develop research and strong information campaigns directed at civil society.**

Cochineal insect (*Dactylopius opuntiae*) on Cactus

"It destroys the fruits of the poor"

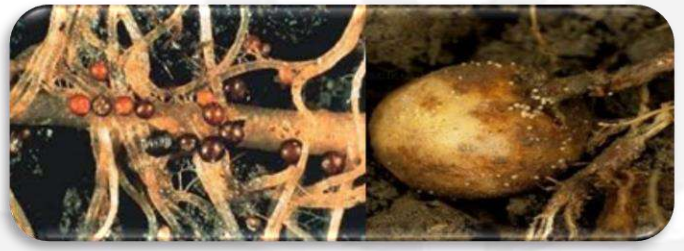
- Cochineal insect introduced from South America to Morocco (2015), then it invaded Jordan, Syria, Palestine... and it continues to spread and kill cactus.
- Cactus is an important food resource both for humans and livestock.
- ICARDA, in collaboration with INRA-Morocco, is implementing a research program to combat the cochineal cactus by evaluating a range of genetic accessions from the cactus. Of these, 8 resistant ecotypes were identified.

Other examples of important transboundary pests

- **Banana wilt caused by the *Fusarium oxysporym* (TR4)** – Introduced from East Asia to Southern Africa and Latin America (the main source of bananas in the world).

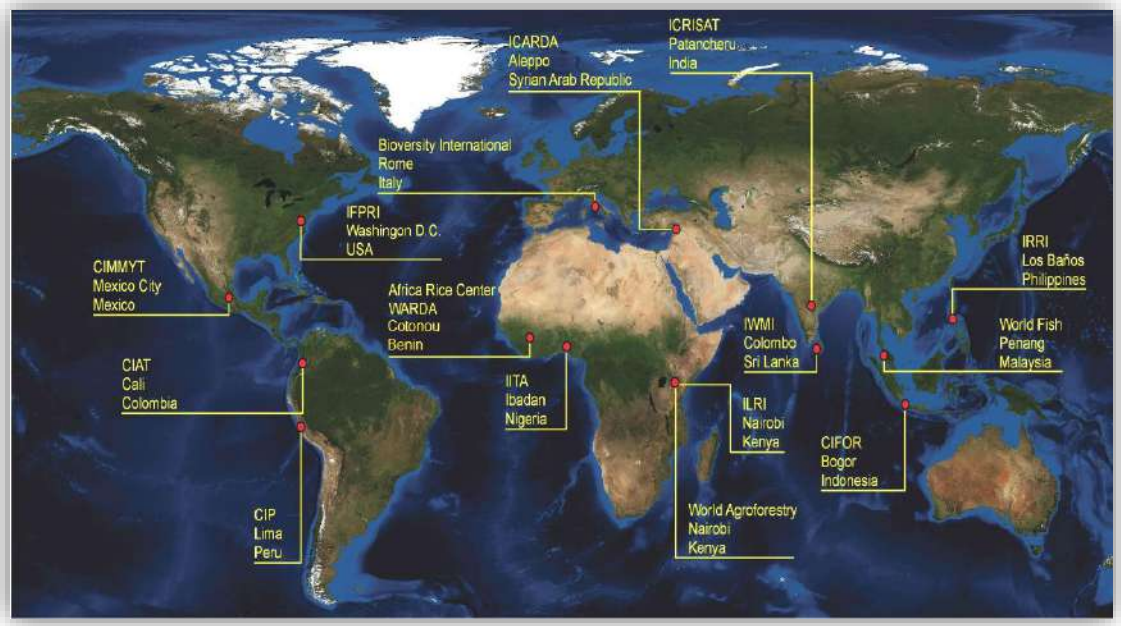
- **Tomato leaf miner (*Tuta absoluta*)** – Introduced from South America to Europe and from there it moved to North Africa, the Middle East, Asia and South Africa.

- **Potato cyst nematode** – Introduced from South America to Europe with potato shipment and spread widely in Europe, then moved to most countries of the word.



- **Fruit fly (*Bactrocera dorsalis*)** – Origin is Asia and is currently found in about 65 countries (including America & African continent). Its life cycle is short (10 generations/year). It is one of the most destructive and widespread types of fruit flies. Its losses were estimated at 320 million euros in the Near East.

CGIAR Genebanks



Seeds Genebank
(ICARDA-Syria)

Collection of banana accessions at the
Bioversity International

11 CGIAR Genebanks

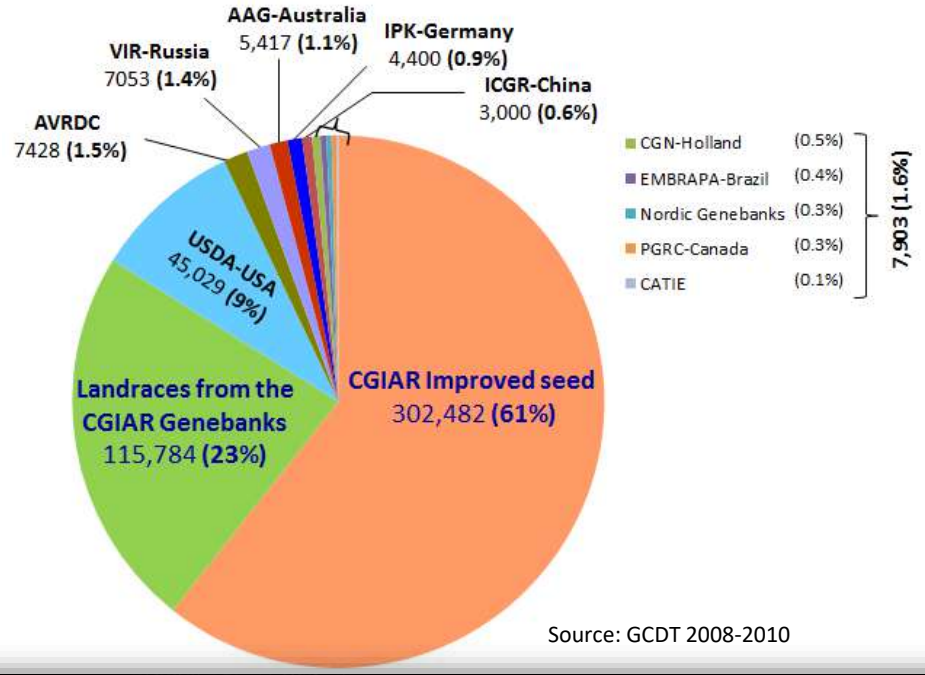
Conserve 760,467 accessions

- Cereals
- Grain legumes
- Forages
- Tree species
- Root & tuber crops
- Bananas

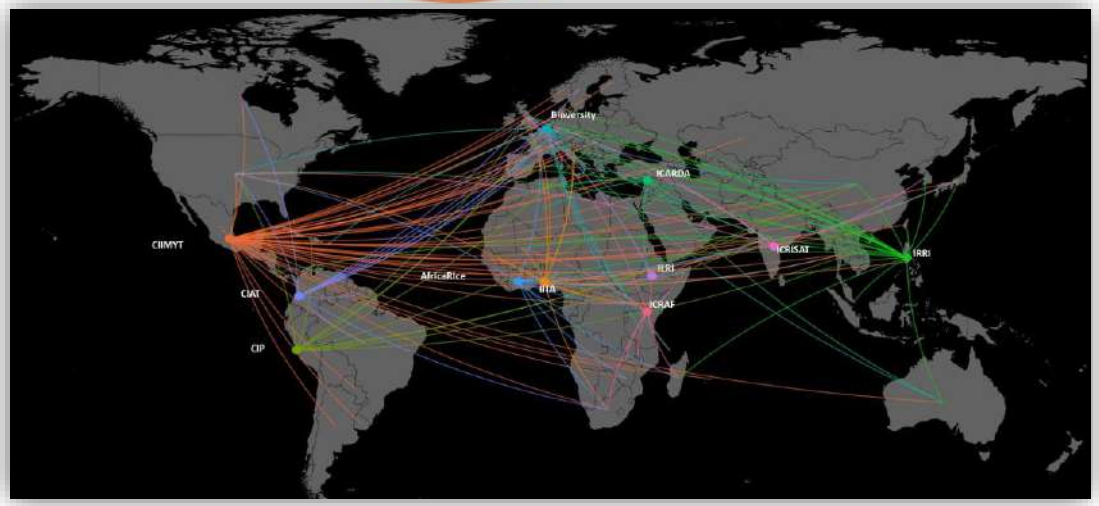
ICARDA Genebank Holdings

Crop	No. of accessions in 2009	No. of accessions in 2022
Barley	26,856	32,487
Wheat	39,762	44,243
Faba bean	9,181	9,654
Chickpea	13,462	15,385
Lentil	11,008	14,377
Grass pea	3,210	4,412
Pea	6,075	4,594
Forage and range plants	24,606	26,869
Total	**134,160**	**152,021**

Germplasm as a Carrier of Pests and Pathogens



Source: GCDT 2008-2010



- **Highest per cent of international germplasm distribution from CGIAR programs (about 85%)**
- Seeds/germplasm have been recognized as an important pathway for spread of pests and pathogens through human activities of collection and distribution.
- The spread of pests has increased dramatically in recent years, through:
  - ✓ International trade
  - ✓ Environmental forces
  - ✓ Insect or other vectors
  - ✓ Seed and agricultural trade

Germplasm Health Units (GHUs) as CGIAR Gateway for Safe Germplasm Exchange

CGIAR centers have established GHUs to ensure the safety of exchanged plant materials, and compliance with the IPPC procedures and ISPMs used by NPPOs.

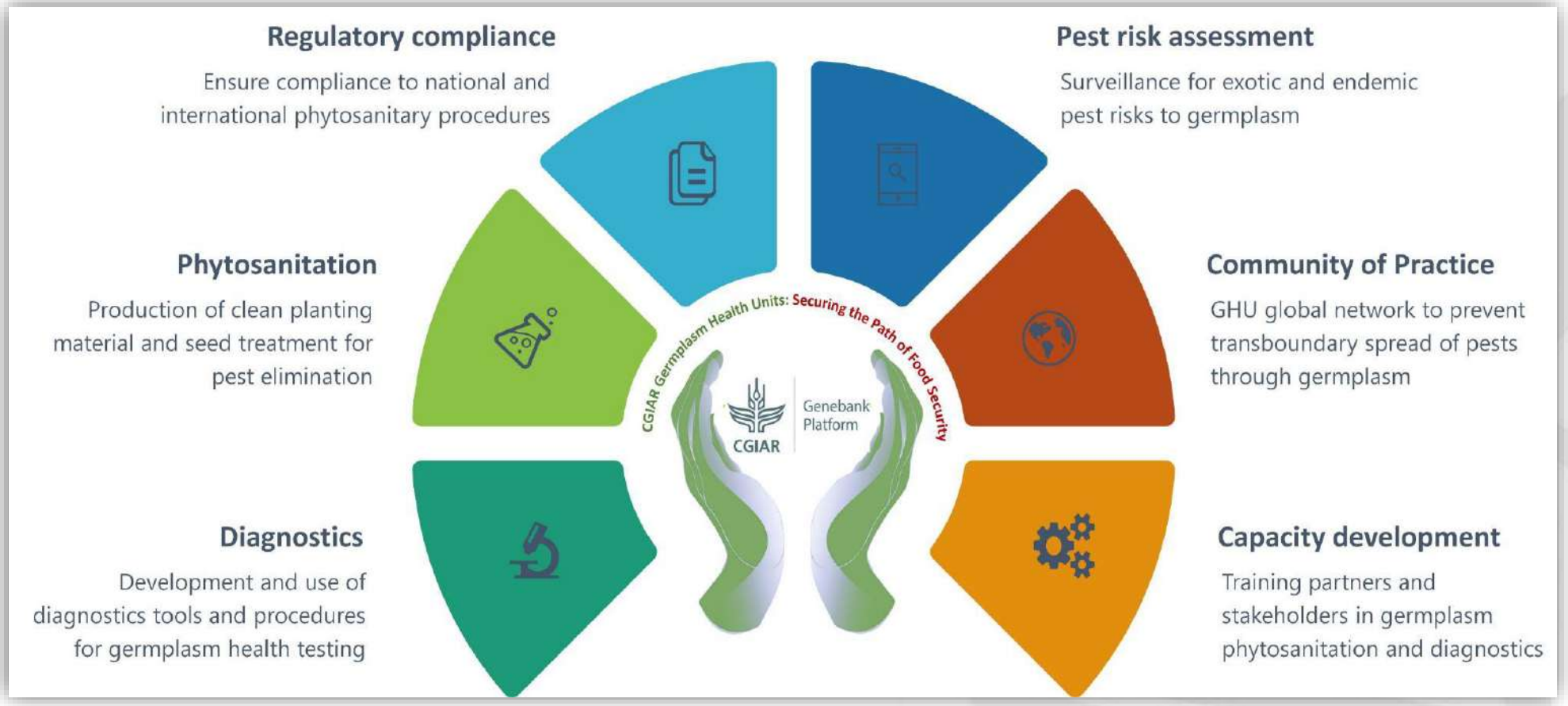
Objectives of GHUs are:

1. Avert the spread of quarantine pests in all CGIAR germplasm transfers;
2. Prevent pest outbreaks;
3. Safeguard biodiversity.

11 GHUs

Alliance

The Role of CGIAR Germplasm Health Units (GHUs)



11 GHUs

Alliance

Control of Transboundary Pests and Pathogens

Control measures are aimed either at decreasing the pest source or at preventing pest spread within the crop, usually by a vector. Management of transboundary pests can be done through:

1. Seed health testing

2. Crop production practices

3. Chemical control (It is very well targeted application placed directly on the seed)
   - ✓ Seed fumigation
   - ✓ Seed treatment
   - ✓ Seed washing

4. Phytosanitary measures (Preventive measures)
   - ✓ Seed certification
   - ✓ Plant quarantine

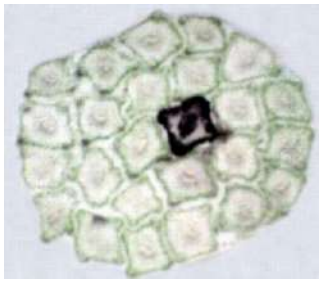
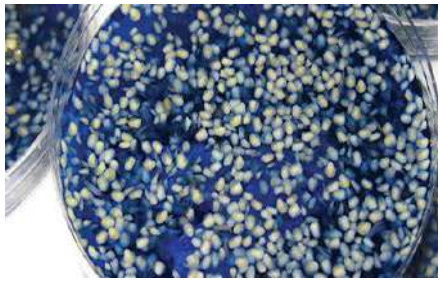
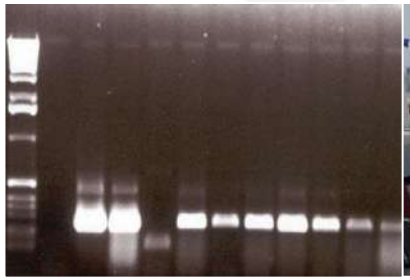
Seed Health Testing

Seed health testing for incoming and outgoing shipments using up-to-date diagnostic methods at ICARDA is a primary component of crop management program particularly with an international germplasm distribution dimension. Through this process infected seeds are spotted and replaced with health stocks.

- ✓ Dry seed inspection/ Visual examination
- ✓ Growing-on test (seed germination)
- ✓ Indicator-inoculation test
- ✓ Centrifuge Washing Test (CWT)
- ✓ Agar Plate Test (APT)
- ✓ Freezing Blotter Test (FBT)
- ✓ Embryo Test (ET)
- ✓ Nematode Extraction Test
- ✓ Serological tests (ELISA, TBIA, Slide agglutination test)
- ✓ Molecular tests (PCR)





Recommended Practices to Produce High-Quality & Healthy Seeds

Management practices to be considered at different crop stages are :

1. Before planting

- ✓ Planting in regions with minimum disease pressure.
- ✓ Crop rotation – It helps to reduce the buildup of root-rotting organisms.
- ✓ Using certified seeds, avoiding local or unknown seed sources.

2. During crop establishment

- ✓ Field inspection (rouging): Removal & destruction of diseased plants as soon as disease symptoms are observed.
- ✓ Apply pesticides at the most appropriate timing to prevent pest emergence.
- ✓ Weed control.

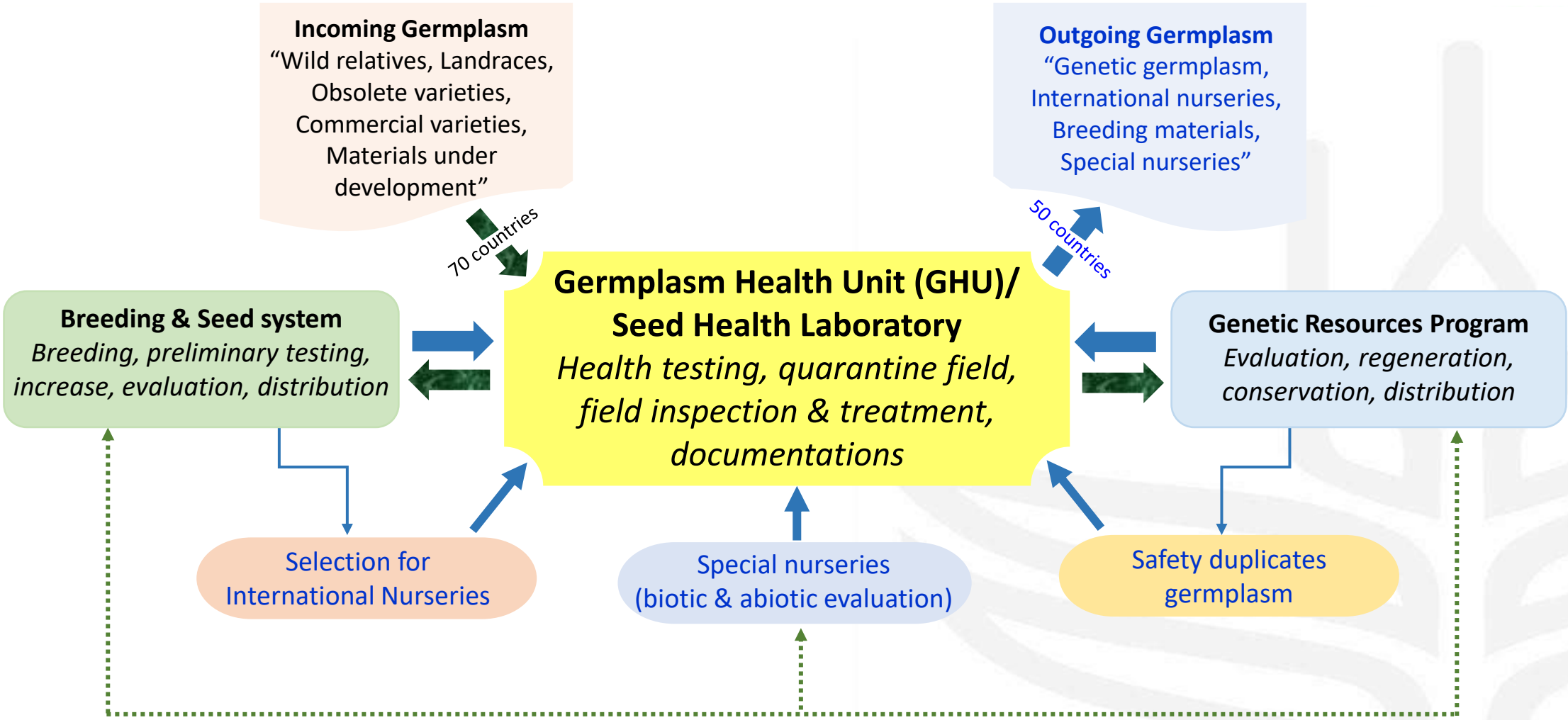
3. During harvesting, threshing & processing

- ✓ Use good harvesting machines and seed cleaning techniques.

4. During storage

- ✓ Adjusted storage conditions to avoid development of storage pests.
- ✓ Fumigation, chemical application

ICARDA Germplasm Health Unit (GHU) role in relation to movement of genetic resources and breeding germplasm



Protocol of incoming (imported) seeds applied by ICARDA in collaboration with the NPPO of the host country

Check the germplasm health of all incoming materials and apply the quarantine regulations of the host country, through:

- ✓ Import permit request to NPPO,
- ✓ Process germplasm as per the NPPO approved procedure,
- ✓ Seed health testing,
- ✓ Fumigation & Seed treatments,
- ✓ Growing only of acceptable materials at Post-Entry Quarantine Fields, followed by field inspection, health testing, …..


IP issued by NPPO

الجمهورية اللبنانية
وزارة الزراعة
مديرية الثروة الزراعية

إذن مسبق لاستيراد بذور

الملاحق: - القانون رقم 778 تاريخ 2006/11/28 (الحجر النباتي بتدابير الصحة النباتية)
- قرارات شروط الاستيراد رقم 1/780، 1/781، 1/782، 1/783 تاريخ 2011/8/26، والقرار رقم 1/1038 تاريخ 2011/11/23، والقرار رقم 1/1272 تاريخ 2012/12/18

أذن للمستدعي:
شركة أو مؤسسة ....
باستيراد المواد النباتية المحددة بالطلب المقدم منه رقمه ....
تاريخه .... (المرفق ربطاً)
والتي ستصل الى لبنان عبر .... مطار رفيق الحريري الدولي
خلال شهر ....
شرط التقيد بالقرار رقم 1/781 تاريخ 2011/8/26 المعدل بالقرار رقم 1/1038 تاريخ 2011/11/23 والقرار رقم 1/1272 تاريخ 2012/12/18.

يعمل بهذا الإذن لمدة ثلاثة أشهر من تاريخه

بيروت في
مدير الثروة الزراعية بالتكليف
م. محمد ابو زيد

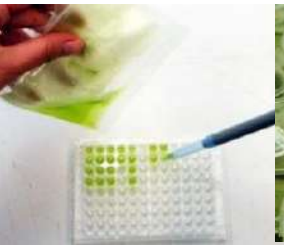
Protocol of outgoing (exported) seeds applied by ICARDA in collaboration with the NPPO of the host country

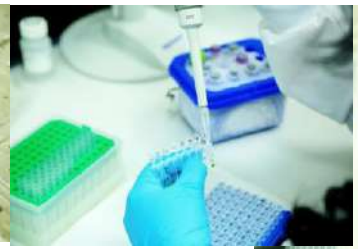
Test all materials before dispatching from ICARDA against the quarantine regulations of recipient country, through:

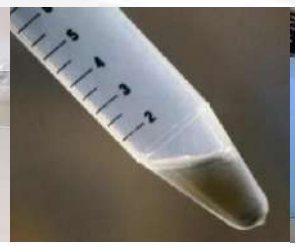
- ✓ Field inspection,
- ✓ Seed health testing,
- ✓ Issue the Phytosanitary Certificate by NNPO of host country,
- ✓ Fumigation & Seed treatment,
- ✓ Dispatch along with required quarantine documents (Phytosanitary Certificate issued by the NPPO, Certificate of Origin, GMOs,…..) fulfilling the international phytosanitary requirements and Standard Material Transfer Agreement (SMTA).


LEBANESE REPUBLIC
Ministry of Agriculture
Plant Resources Directorate
Import, Export & Plant Quarantine Department
ICARDA- LEBANON
Phytosanitary certificate
246472
Original
To Plant Protection Organization of
AUSTERIA
Vienna International Airport
Country of origin: Lebanon | Weight kg: 2.7 kg | Number & description of packages: 1 box | Botanical name: Vicia faba | Name of product: Faba bean
Disinfestations and / or Fumigation treatment
Chemical (active ingredient)
Treatment
Date
Duration and Temperature
Concentration
Additional information
Place & date of issue
Name & signature of authorized office
Stamp of service
No financial liability with respect to this certificate shall attach to the Ministry of Agriculture or to any of it is officers or representatives.

PC issued by NPPO



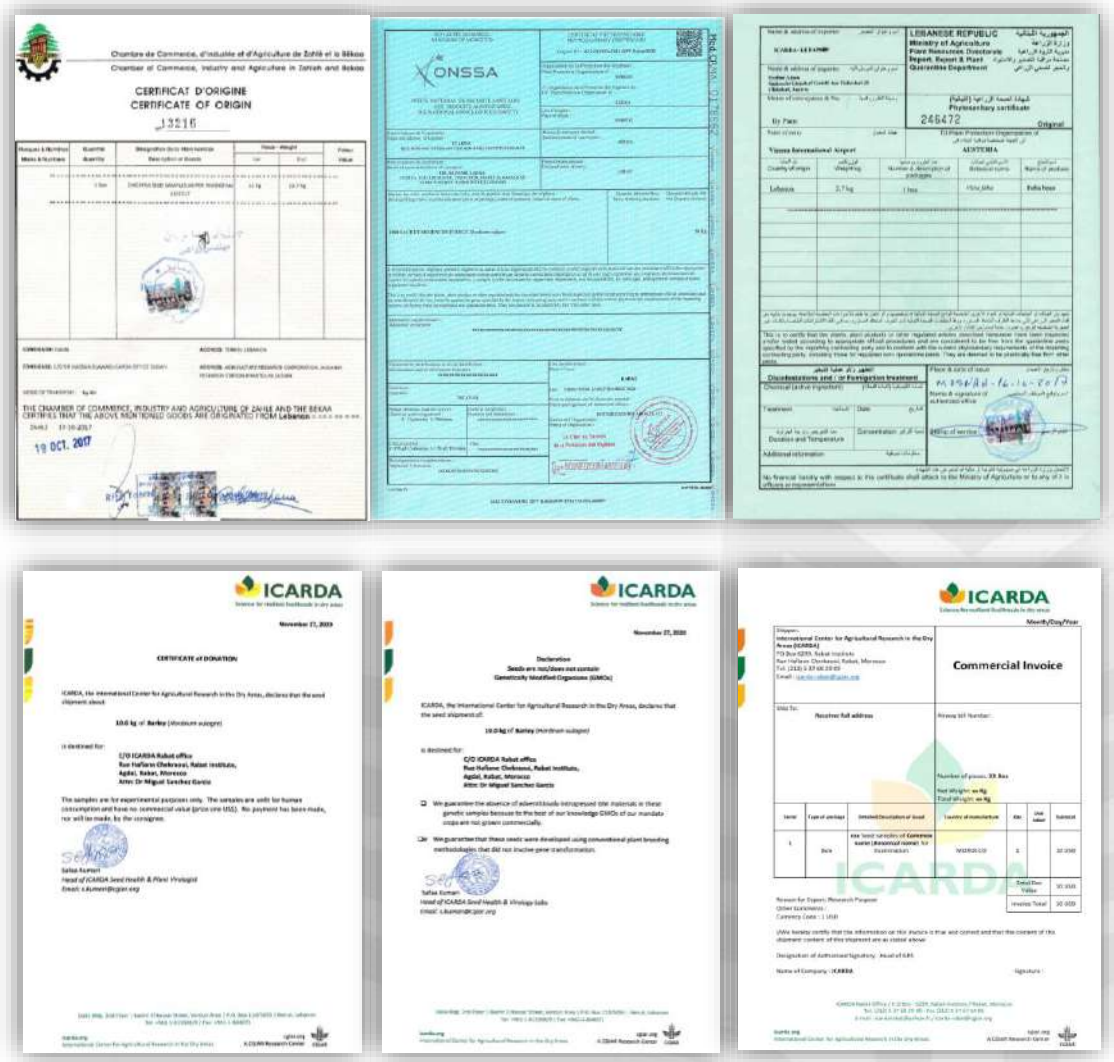


Required documents for seeds (incoming/outgoing) shipments based on the regulations of host county

Document
Import permit (host country) *
Phytosanitary Certificate*
Commercial Invoice
GMO free declaration
Certificate of donation
Certificate of origin*
List of materials

* Issue by Ministry of Agriculture of the host country based on ICARDA SHL's request



ICARDA's GHU Linkages with NPPOs

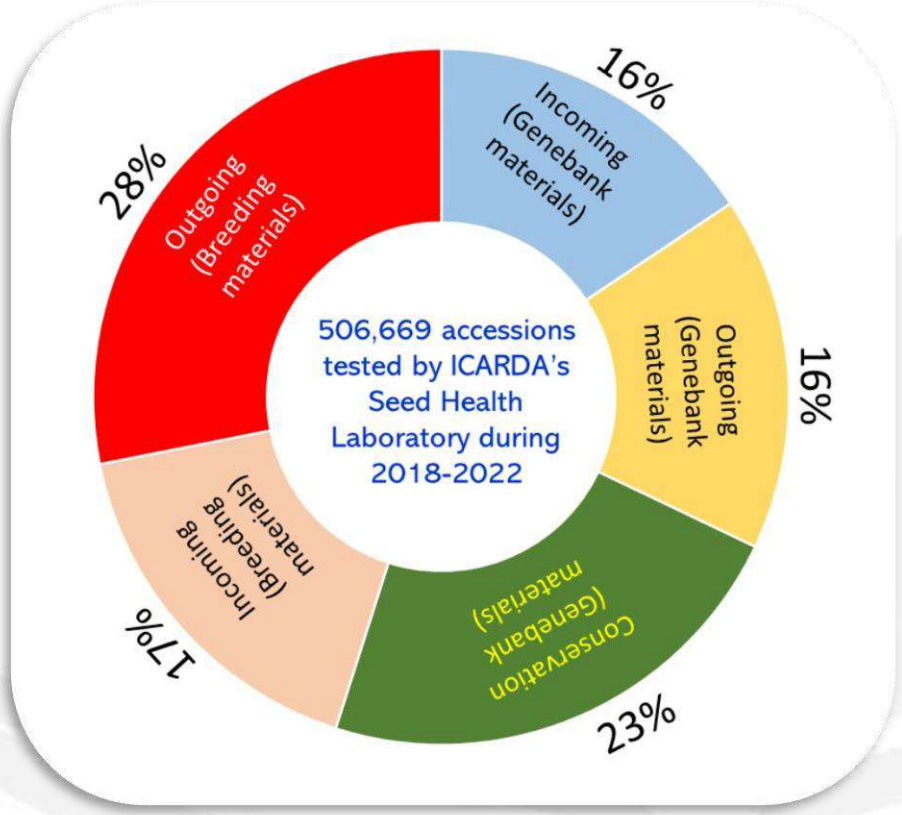
NPPOs in ICARDA's Host Countries

Lebanon	Import, Export & Plant Quarantine Department, Ministry of Agriculture Beirut, Lebanon
Morocco	ONSSA (The National Office of Food Safety) Ministry of Agriculture and Fisheries Rabat, Morocco

Seeds are ready for mailing with all needed documents

Germplasm Health Testing and Pest Elimination

- GHUs checks for about 320 pests and pathogens.
- 453,972 samples tested during 2018–2019; 6% samples removed due to quarantine pests and pathogens infestation (2.47 million diagnostic reactions were employed).
- >65,000 samples distributed to >100 countries per year.
- 10-12 million US$ is spent annually on the generation of clean germplasm to prevent the transboundary spread of pests and pathogens.



Challenges of Germplasm Exchange

- Emerging new diseases and insect pests.
- Minor pests and diseases are becoming important due to the climate change.
- Variable standards and different phytosanitary demands.
- Limited funding for preventive measures.

Conclusions

- GHU efforts averted the inadvertent spread of quarantine insect pests and pathogens through CGIAR globally coordinated R4D.
- GHUs enabled germplasm access to global crop productivity improvement leading to broad social, economic, and environmental impact.
- The plant quarantine measures acts as an important tool in providing effective implementation for management of pests, which in turn helps in maintaining crops productivity.
- Using procedures of transboundary management as a full package is a corner stone for safe exchange of germplasm.
- To avoid the scenario of COVID-19 pandemic in agricultural crops, we should pay attention on the safe and efficient transfer of germplasm.
- This requires enhanced collaboration with phytosanitary organizations and research institutions to obtain the most advanced information on pest detection and epidemiology.

plants

MDPI

Review

Phytosanitary Interventions for Safe Global Germplasm Exchange and the Prevention of Transboundary Pest Spread: The Role of CGIAR Germplasm Health Units

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Rabat, Morocco

ICARDA's GHU Staff

Thank you