How to directly valorize best performing disease tolerant and more robust cultivars from fruit tree genetic resources collections? ‘A Belgian example’

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First International Training Course, Online

Content

- Reminder of the importance of long term evaluating genetic resources in unsprayed orchards
- Disease tolerance >< resistance
- Examples of direct uses of fruit tree genetic resources
  Public-Private-People Partnership is a key element to meet the user's demand

Reminder of the importance of long term evaluating genetic resources in unsprayed orchards

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- **Long term non-sprayed evaluation orchards as basic principle which allow dynamic co-evolutionary interactions between climate/pest & diseases/genetic resources**

Characterization descriptors: These enable a quick and easy discrimination between phenotypes. They are generally **highly heritable**, can be seen easily by the eye and **are equally expressed in all environments**.

Evaluation descriptors: Many of the descriptors in this category **are susceptible to environmental difference** and **are very useful to crop production and improvement**. They include yield, agronomic performance, biotic and abiotic stress susceptibilities,…

Adapted from *Plant Genetic Resources: Characterization and Evaluation New Approaches for Improved Use of Plant Genetic Resources, 1996*

=> Need long term evaluation process to take into account years variability

Reminder of the importance of long term evaluating genetic resources in unsprayed orchards

- **Long term non-sprayed evaluation orchards as basic principle which allow dynamic co-evolutionary interactions between climate/pest & diseases/genetic resources**

>> diversity of strains

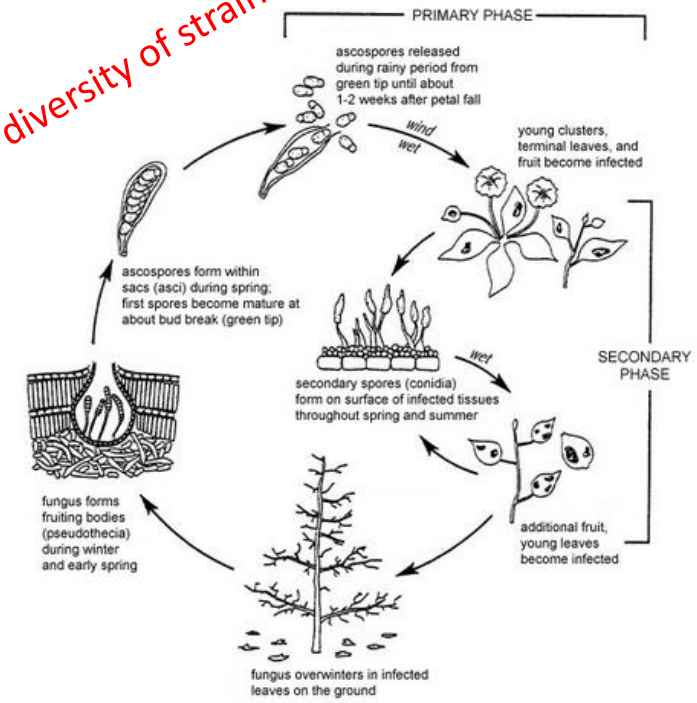

Figure 13. Disease cycle of apple scab.

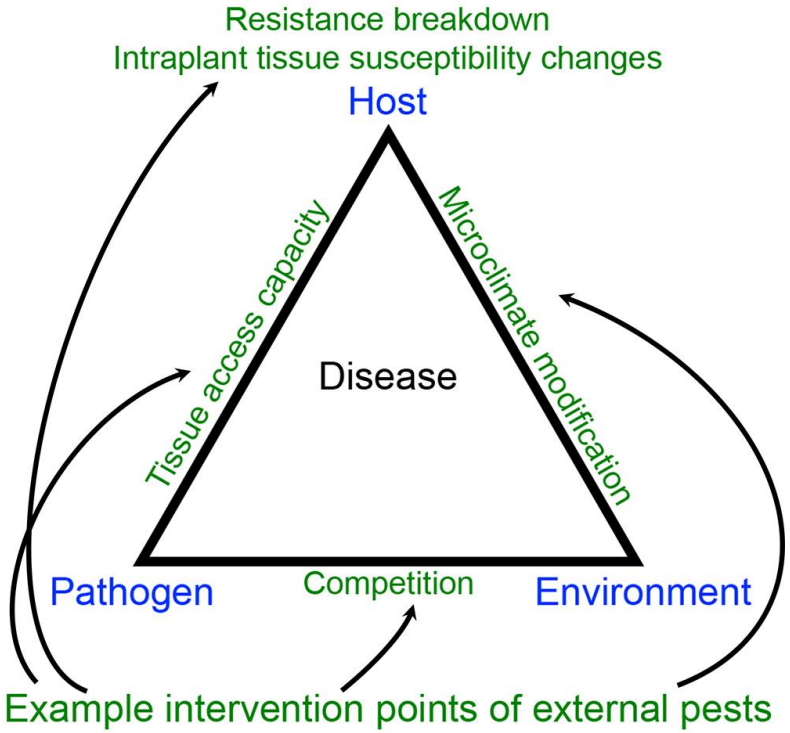

Figure 2. Disease triangle incorporating example points in which pests external to a considered pathosystem, or situational synergistic agents (SSAs), might influence eventual disease levels.

Gauthier, Nicole. 2018. Apple scab. *The Plant Health Instructor*. DOI: 10.1094/PHI-I-2000-1005-01

Anco, D. J. 2018. Continuing consideration of co-infection and multiple pests. APS Features. doi:10.1094/APSFeature-2018-4.

Reminder of the importance of long term evaluating genetic resources in unsprayed orchards

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- **Long term non-sprayed evaluation orchards as basic principle which allow dynamic co-evolutionary interactions between climate/pest & diseases/genetic resources**

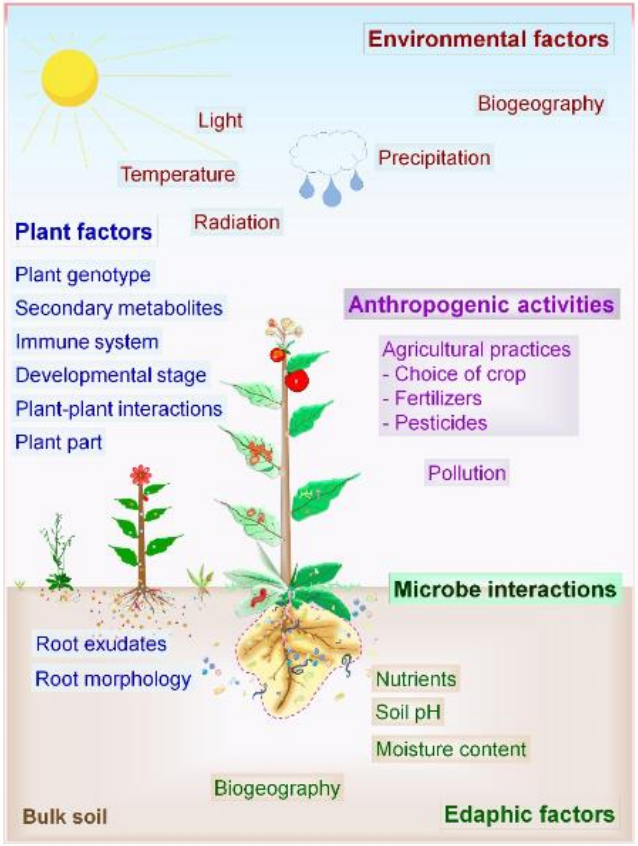


Figure 2. Driving factors of plant–microbe interactions. Environment-, soil- and plant-mediated factors determine the composition and structure of host microbiota. Furthermore, plant–plant, microbe–microbe, and plant–microbe interactions also impact the plant and soil microbiome.

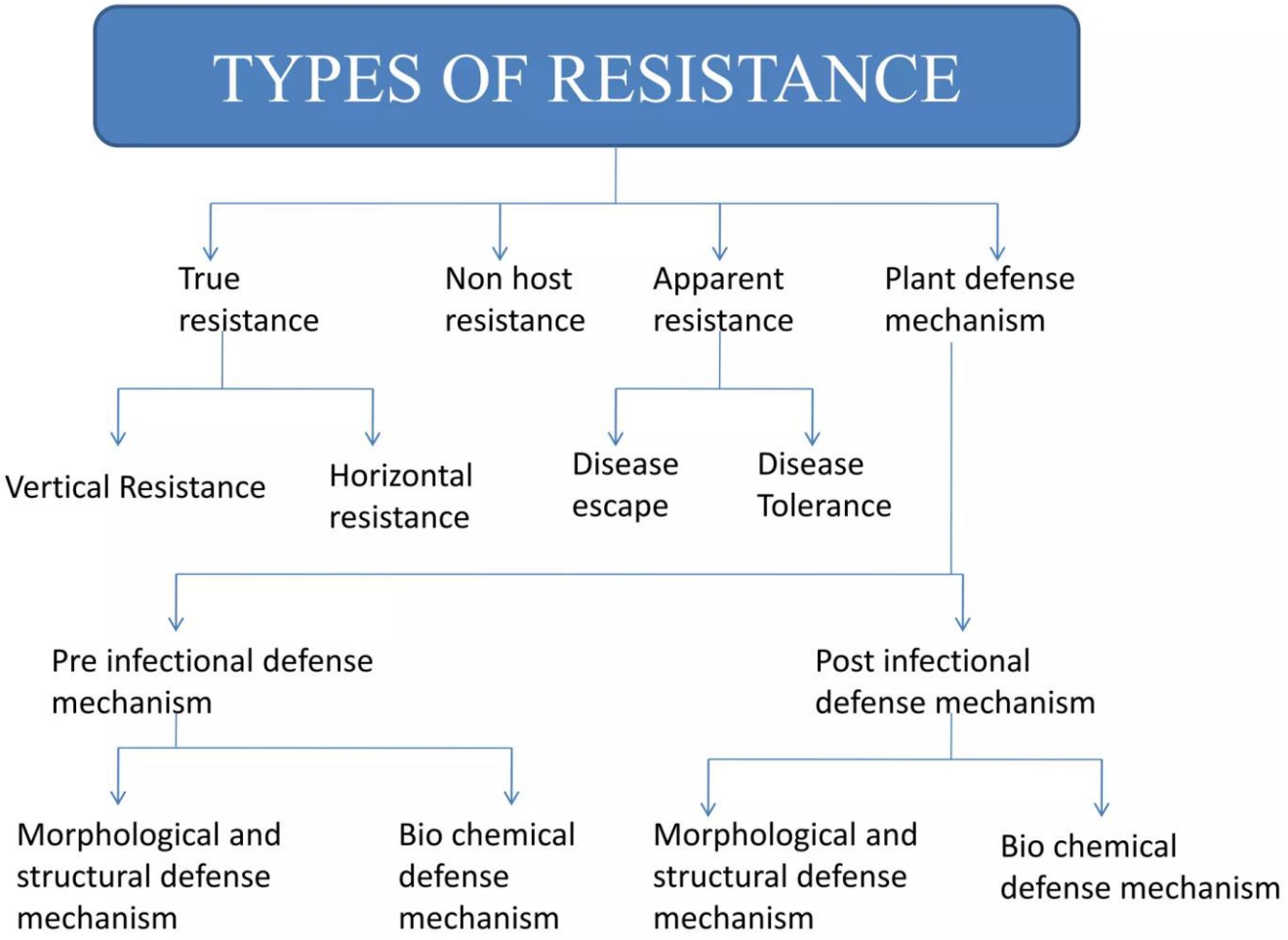
- Dynamic evolution of pests and diseases + microbiome

⇒ Qualitatively & quantitatively
⇒ Resurgent and/or new pests & diseases
⇒ Very large diversity of combinaison of biotic & abiotic stress

= the right way for fruit tree genetic resources evaluation process

Shelake *et al*. Microorganisms 2019, 7, 269; doi:10.3390/microorganisms7080269

Disease tolerance >< resistance



https://fr.slideshare.net/slideshow/karuppi-final/189859591

Disease tolerance >< resistance

The two major mechanisms of plant defense against pathogens are

- **resistance** = the host's ability to **limit pathogen** multiplication and

- **tolerance** = the host's ability to **reduce the effect** of infection on its fitness **regardless** of the level of pathogen multiplication

Israel Pagán* and Fernando García-Arenal*
Tolerance to Plant Pathogens: Theory and Experimental Evidence
Int J Mol Sci. 2018 Mar; 19(3): 810.
Published online 2018 Mar 11. doi: 10.3390/ijms19030810
PMCID: PMC5877671; PMID: 29534493

Disease tolerance >< resistance: a dynamic process

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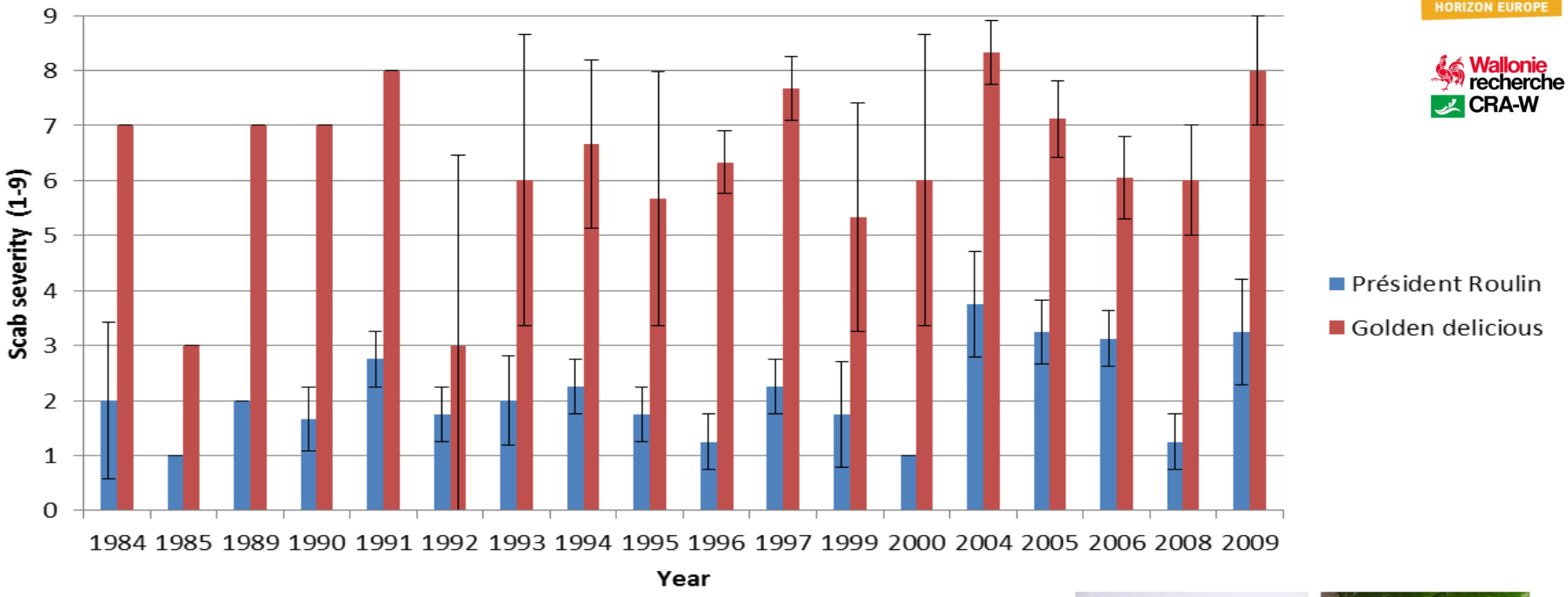
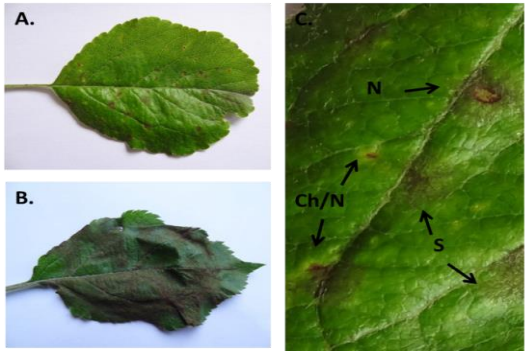
Example of low scab susceptible old Belgian cv. 'Président Roulin' RFG-Gblx



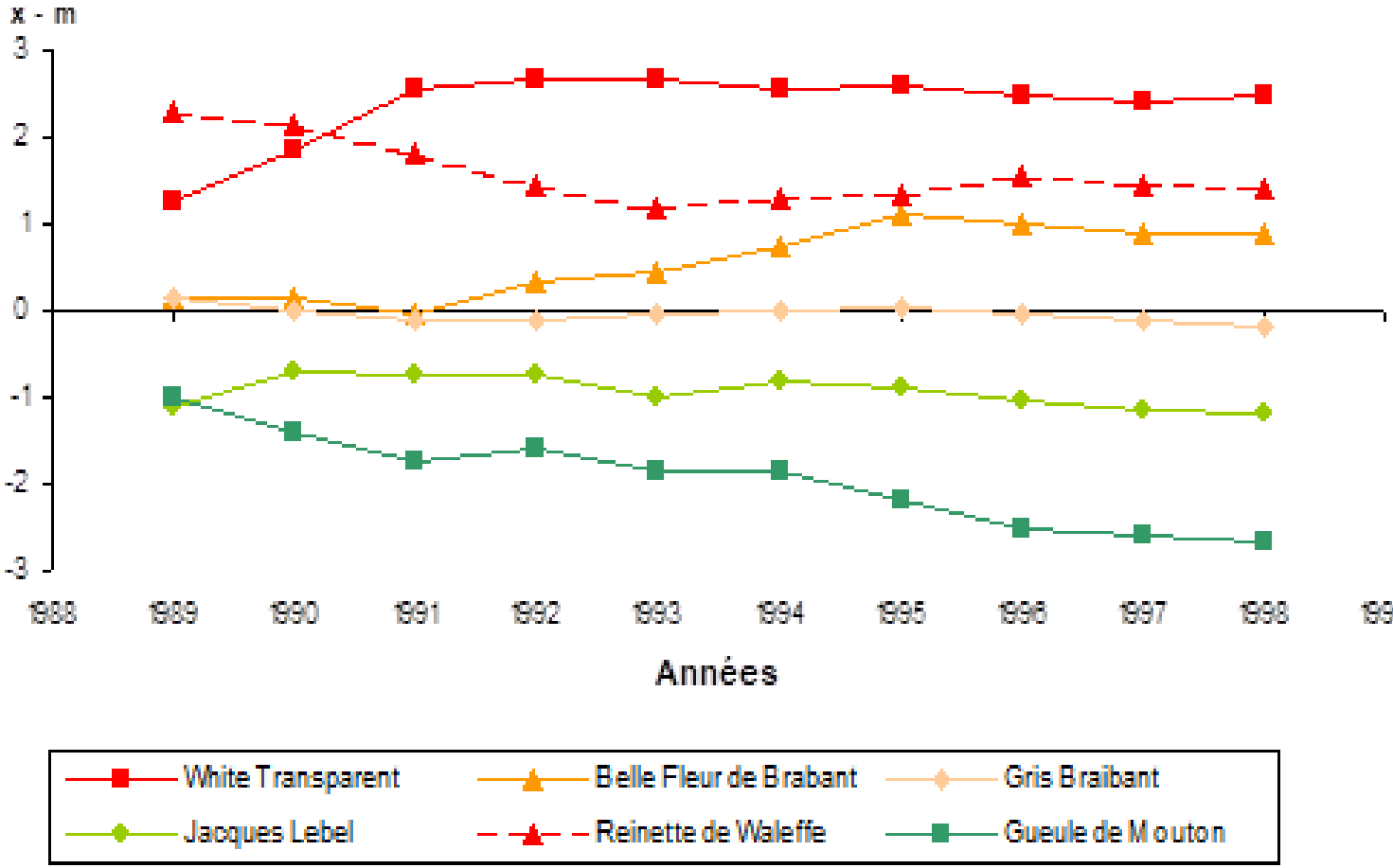
'Président Roulin'

'Gala'



Disease tolerance >< resistance

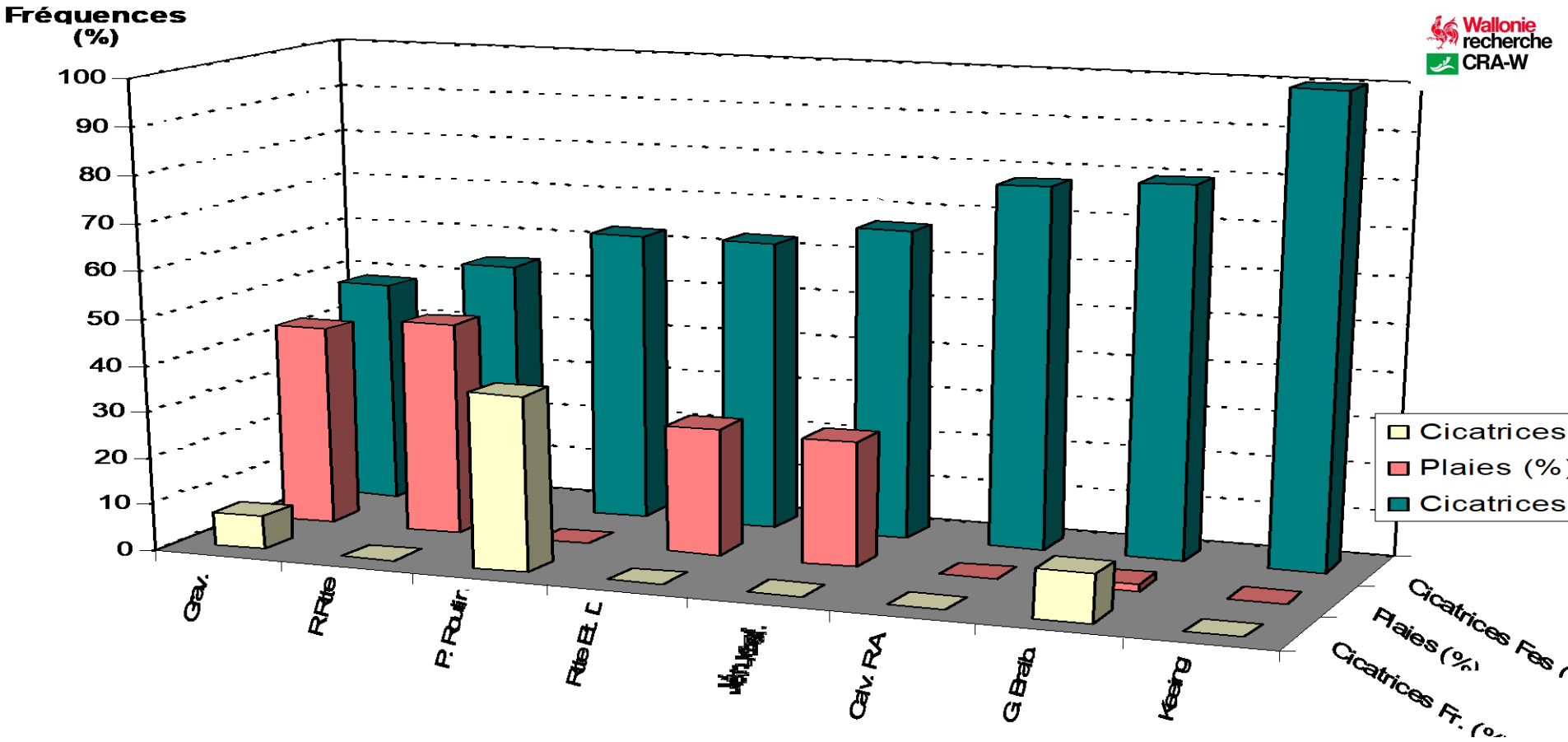
Example of European canker evolution (Lateur, 1999)



Orchard mean infection

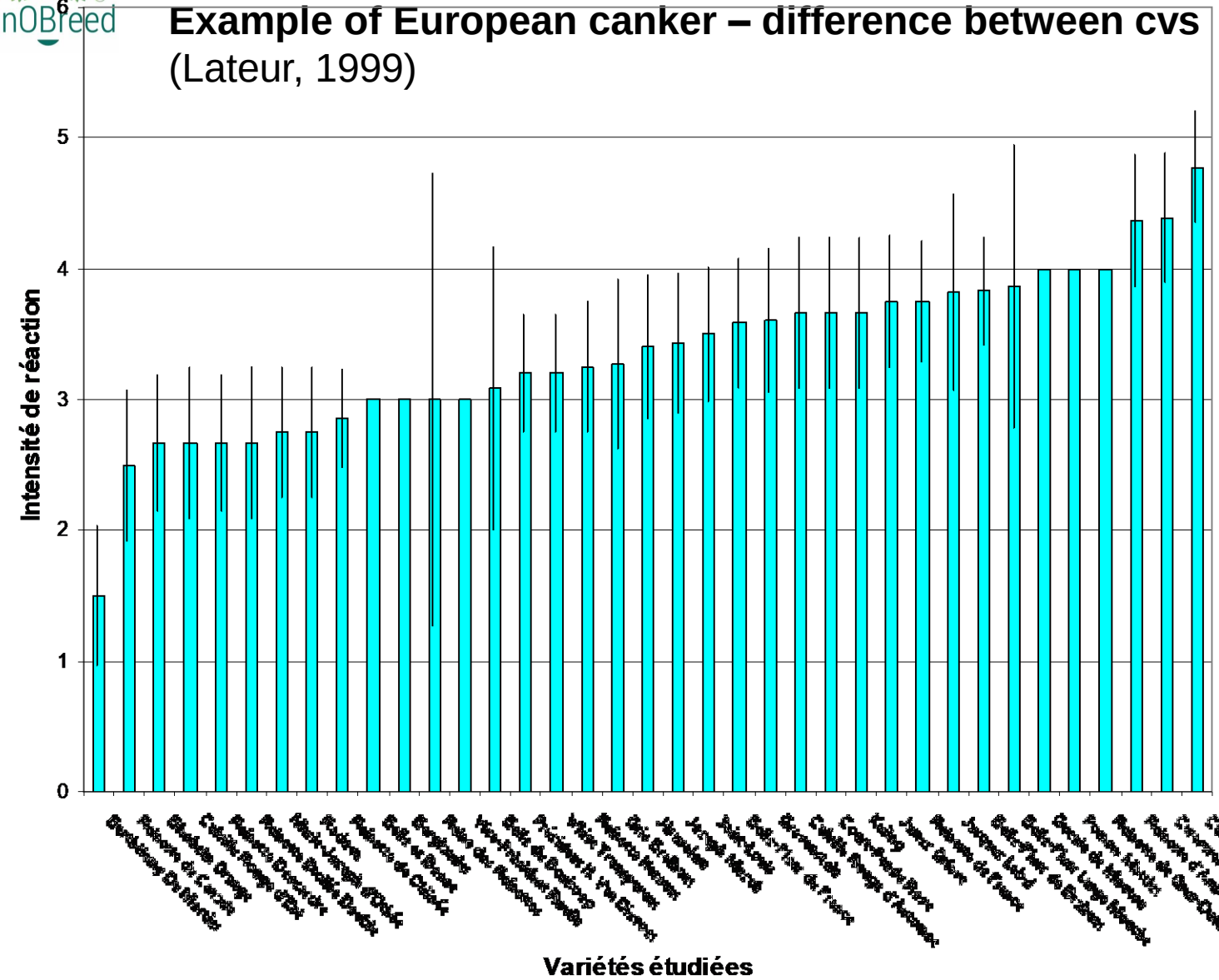
Disease tolerance >< resistance

Example of European canker – difference between cvs (Lateur, 1999)



Disease tolerance >< resistance

Example of European canker – difference between cvs
(Lateur, 1999)



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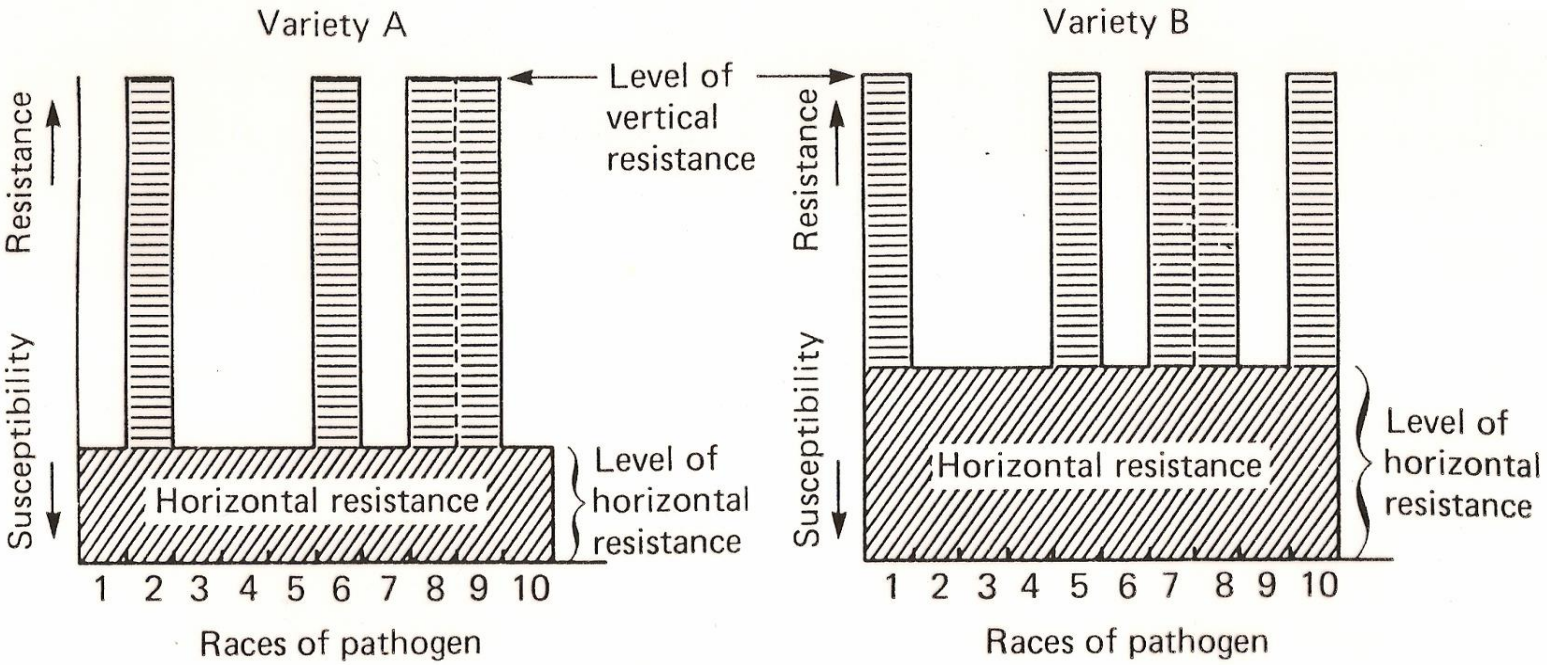
Disease tolerance >< resistance



Levels of horizontal and vertical resistance of two plant varieties toward ten races of a pathogen. (After Vanderplank, 1984).

Examples of direct uses of fruit tree genetic resources
Public-Private-People Partnership is a key element to meet the user's demand

COLLECTING

Ethno-botany
Passeport data

PROPAGATION

CONSERVATION | Regeneration | EVALUATION

NETWORK of duplication REPOSITORY ORCHARDS

Ex situ REPOSITORY ORCHARDS

Non-sprayed EVALUATION ORCHARDS

EVALUATION & CHARACTERIZATION

Data Bases

Traceability
HACCP

FIRST & SECOND SCREENING's

Budwood's
Quality management
Pest Risk Anal.

Promoting USES

Web sites
Leaflets

Nursery

Fruit growers & farmers

Processing SME's

Juice Cider Syrup

Breeding

Time (Years)

0

1

3

9

Examples of direct uses of fruit tree genetic resources Public-Private-People Partnership is a key element to meet the user's demand

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HORIZON EUROPE

Wallonie recherche CRA-W

1. Partnership with SME nurseries: « *Agronomistic attitude* »

- Screening and selection of best performing old cultivars adapted to::

- Non sprayed growing conditions (gardens, standard tree orchards,…) = disease tolerance, robustness, rusticity…
- Multiple and/or specific uses;
- Enlarge the existing diversity : originality ;
- Produce healthy fruit in different pedo-climatic conditions,….

All old and cultural heritage cvs are far not well adapted to be largely promoted! They need to be SCREENED with agronomical thresholds!

- **Testing candidates for :**

- Adaptability in different pedo-climatic conditions and rootstocks
- Pollination combinations
- Uses and properties
- Tree training and keeping abilities,……

Examples of direct uses of fruit tree genetic resources
Public-Private-People Partnership is a key element to meet the user's demand

Funded by HORIZON EUROPE

1. Partnership with SME nurseries: « *Agronomistic attitude* »

- Creation of a kind of label on the new concept of « selected FTGR *cvs* »:

  '***RGF-Gembloux*** ' = **F**ruit **G**enetic **R**esources

- Since 1985 onward, releasing 2-3 old cvs per year, currently up to **34 best performing *'RGF-Gembloux' cvs*** are released (apple, pear, plum, cherry,…)
- **Building partnership** with a network of **27** private SME nurseries.
- Agreement of propagation + official list of tree nursery producers
- Building a partnership for producing **quality propagation plant material** : budwood mother trees.
- **5000 to 7000** budwood sticks are yearly produced
- **20-25.000** '***RGF-Gembloux*** ' cvs trees are yearly released on the market.

Examples of direct uses of fruit tree genetic resources Public-Private-People Partnership is a key element to meet the user's demand

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1. Partnership with SME nurseries: « *Agronomistic attitude* »

'Beurré DILLY' *RGF-Gblx*

Bronzée·d'ENGHIEN·*RGF-Gblx*¶

'Reinette Professeur LECRENIER' *RGF-Gblx*

Reinette Dubois *RGF-Gblx*

Griotte de Schaerbeek *RGF-Gblx*

'Altesse Dorée' *RGF-Gblx*

Reinette de Waleffe *RGF-Gblx*

'RADOUX'

'Transparente de Lesdain' *RGF-Gblx*

'Prune de Prince' *RGF-Gblx*

'Poire de GROS' *RGF-Gblx*

Président Henry Van Dievoet *RGF-Gblx*
Cabarette *CRRG*

Examples of direct uses of fruit tree genetic resources
Public-Private-People Partnership is a key element to meet the user's demand

2. **Partnership with SME nurseries** : *'Too many trees on the market were not true to type trees'*

➢ Next step for enhancing the quality of '*RGF-Gblx*' cvs… since 2013.

○ Building on a **participative approach** with a group of private nurserymen a

QUALITY CHARTER that certified and promote:

- Selected **more robust** and **more disease tolerant old & new cvs**
- **Guaranteed identity** of the cvs on the market by using **TRACEABILITY** along the chain : budwood, label, unique ID / nursery;
- **Quality propagation material** (CAC, Virus Tested & Virus Free)
- Local handycraft family nurseries that offer **quality services** to customers

Examples of direct uses of fruit tree genetic resources
Public-Private-People Partnership is a key element to meet the user's demand

CERTIFRUIT RGF-GEMBLOUX®

CERTIFRUIT TRAD-RGF®

'CERTIFRUIT®' – Quality charter for selected old cvs with good disease tolerance and robustness

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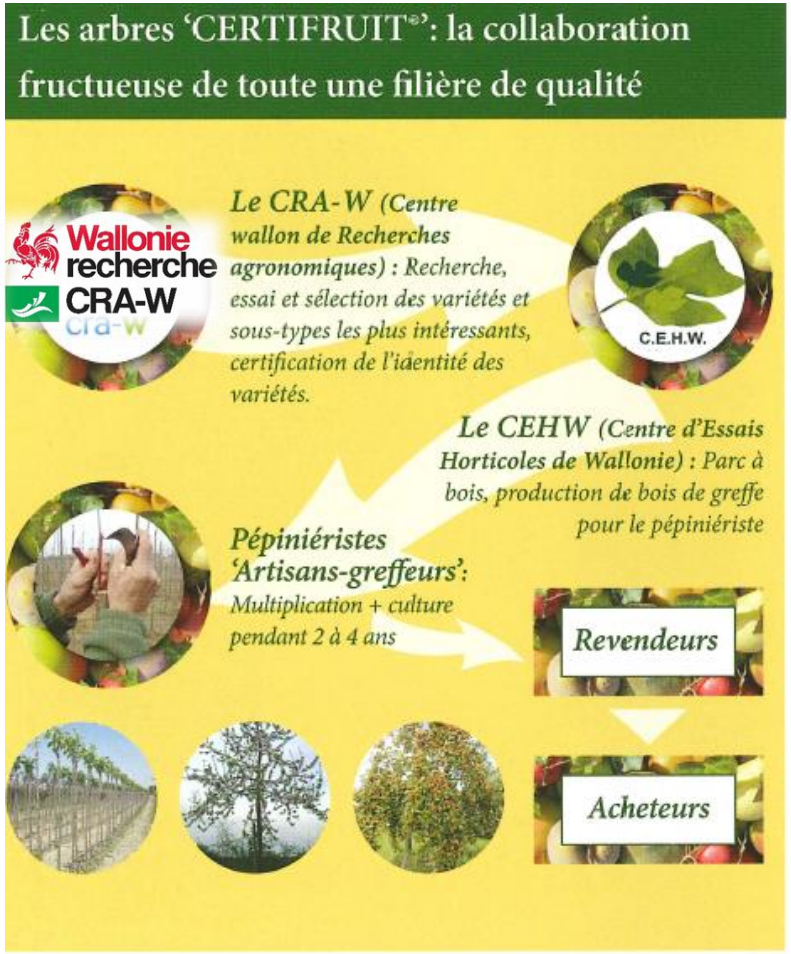

Revendeurs adhérents

Current status :

- 34 RGF-Gblx cvs
- 51 RGF-Trad cvs
- 16 tree nursery producers
- 21 retailers

Examples of direct uses of fruit tree genetic resources
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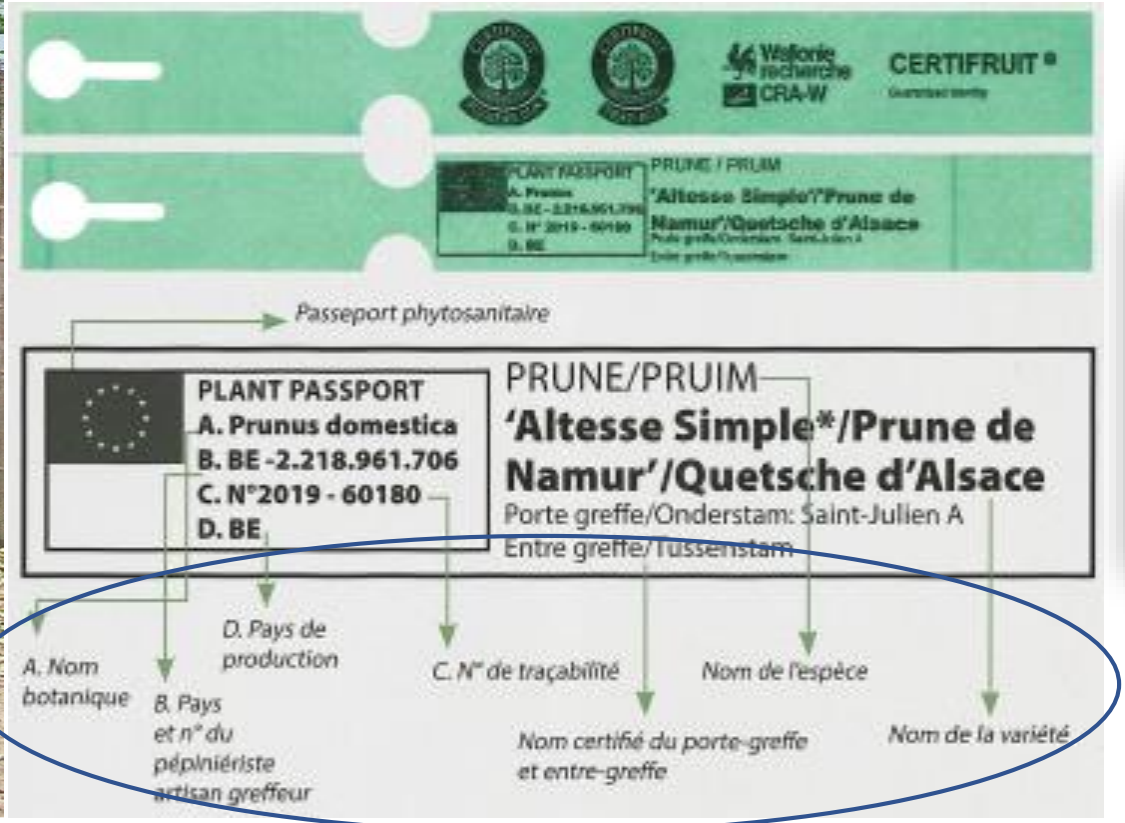
Wallonie recherche CRA-W

System of traceability – Labelling each tree



CERTIFRUIT RGF-GEMBLOUX

CERTIFRUIT TRAD-RGF

FWH

COLLÈGE des PRODUCTEURS

C.E.H.W. asbl

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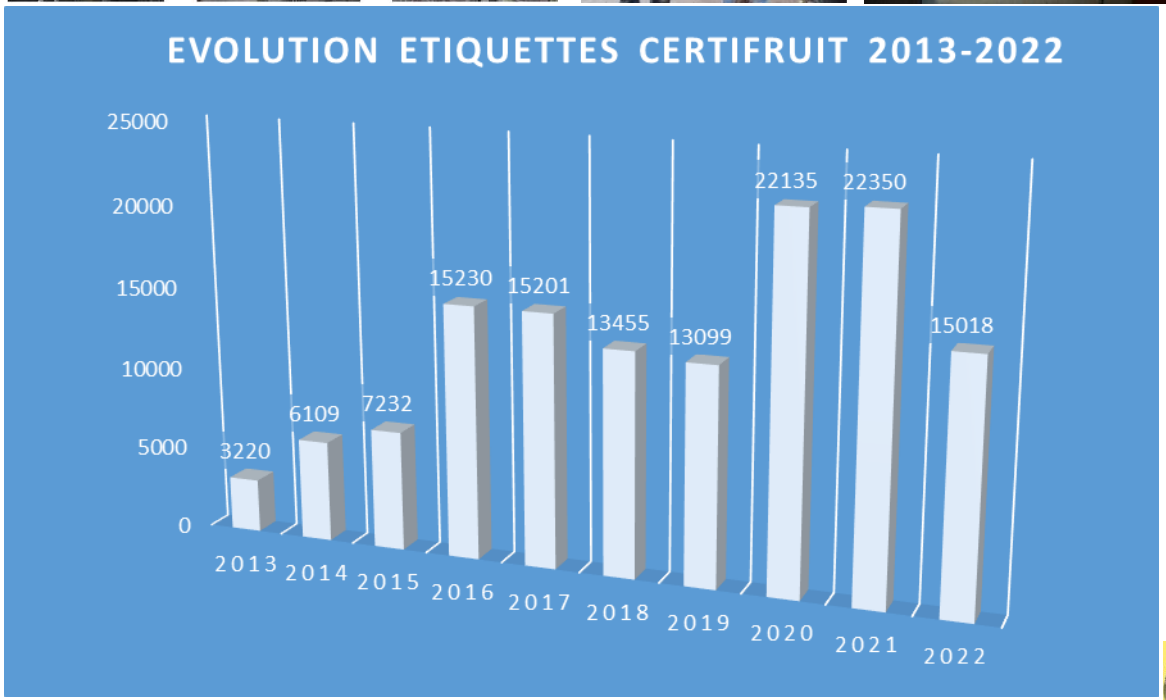
Wallonie recherche CRA-W

System of traceability – Labelling each tree







CERTIFRUIT RGF-GEMBLOUX

CERTIFRUIT TRAD-RGF

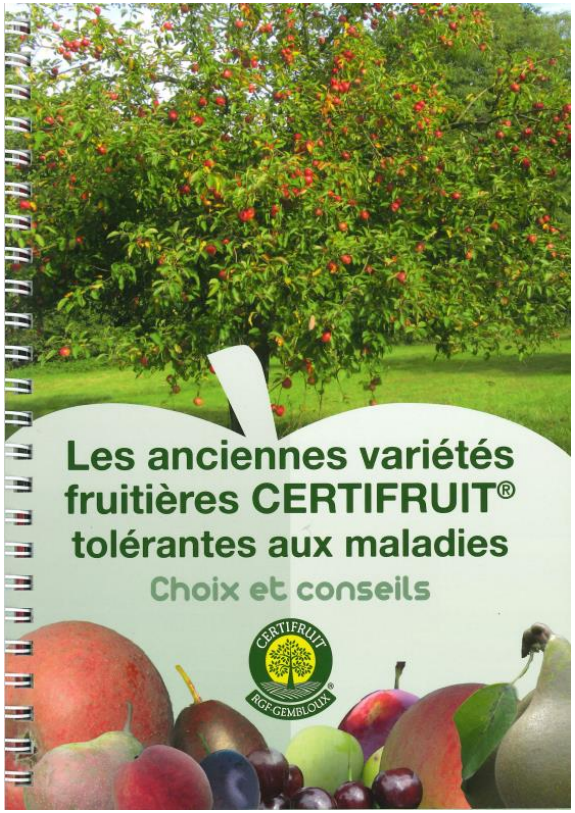
FWH

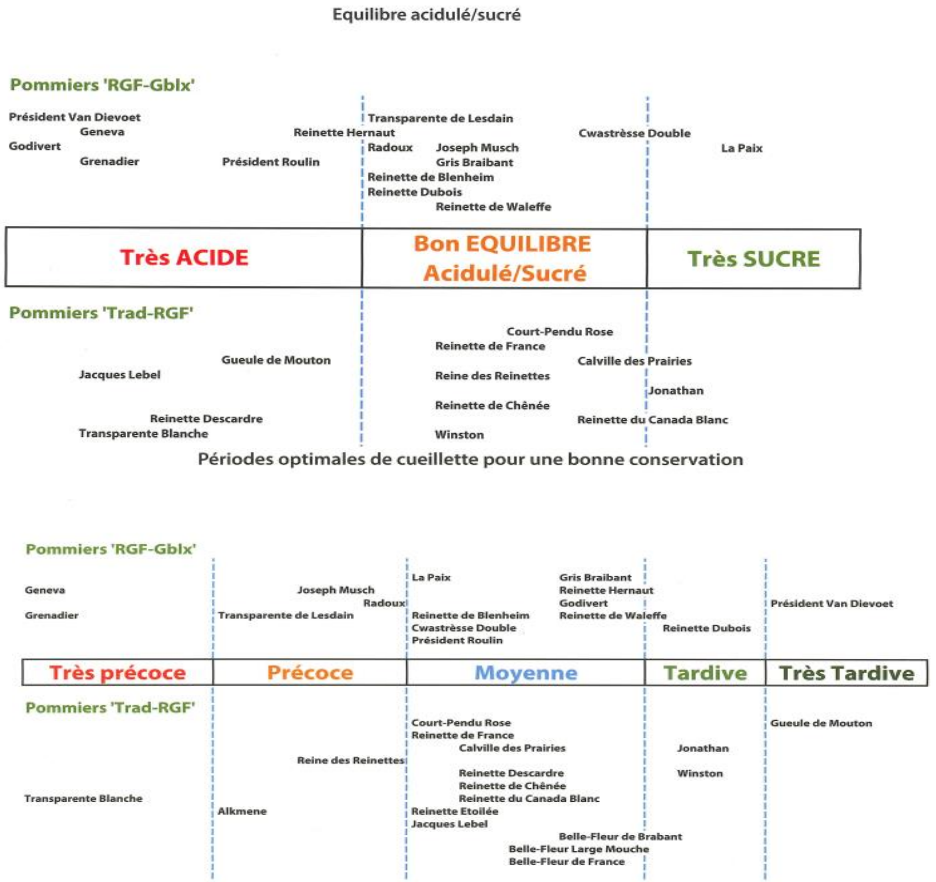
COLLÈGE des PRODUCTEURS

C.E.H.W. asbl

www.certifruit.be

Examples of direct uses of fruit tree genetic resources
Public-Private-People Partnership is a key element to meet the user's demand
=> Release of objective information for customers





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CERTIFRUIT RGF-GEMBLOUX
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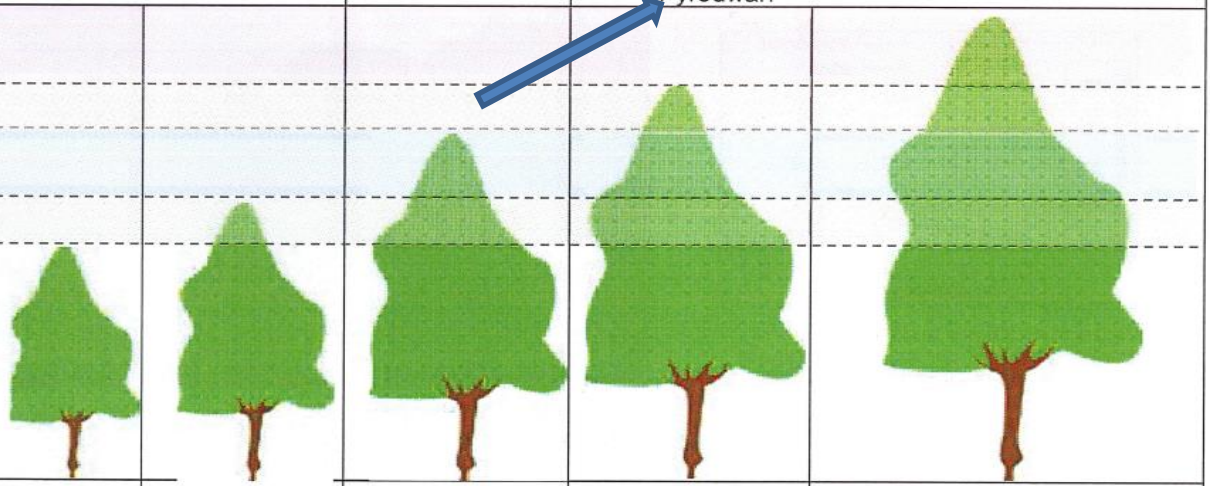
Variétés plantées ↓ / Choix de POLLINISATEURS →	Groupes relatifs de Floraison	Transparente Blanche	Transparente de Croncels	Belle de Boskoop	Grenadier	Joseph Musch	Reinette des Capucins	Geneva	Reinette Descardre	Alkmene	Président Roulin	Reinette de Blenheim	Jacques Lebel	Reine des Reinettes	Reinette de Chênée	Belle-Fleur Large Mouche	Gueule de Mouton	Reinette Evagil	Transparente de Lesdain	Cwastresse Double	Radoux	Reinette Hernaut	Gris Braibant	Godivert	Président Van Dievoet	La Paix	Reinette Etoilée	Belle-Fleur de France	Jonathan	Reinette de Waleffe	Winston	Cwastresse Simple	Court-Pendu Rose	Belle-Fleur de Brabant	Sabot d'Eijsden	Suntan	Reinette Dubois	Reinette de France	Reinette Prof. Lecrenier
Transparente Blanche Trad-RGF, Oogst Appel	2	x		x		x	x		x			x	x		x	x					x		x	x	x			x		x						x		x	x
Transparente de Croncels	2		x	x		x	x		x			x	x		x	x					x		x	x	x			x		x						x		x	x
Belle de Boskoop, Boskoop	2			x		x	x		x			x	x		x	x					x		x	x	x			x		x						x		x	x
Grenadier RGF-GLI-	2			x	±	x	x		x			x	x		x	x					x		x	x	x			x		x						x		x	x
Joseph Musch RGF-GLI-	2			x		x	x		x			x	x		x	x					x		x	x	x			x		x						x		x	x
Reinette des Capucins CREC	2			x		x	x		x			x	x		x	x					x		x	x	x			x		x						x		x	x
Geneva RGF-GLI-	2–3			x		x	x	x	x			x	x		x	x					x		x	x	x			x		x						x		x	x
Reinette Descardre Trad-RGF	3			x		x	x		x			x	x		x	x					x		x	x	x			x		x						x		x	x
Alkmene	3			x		x	x		x	±		x	x		x	x					x		x	x	x			x		x						x		x	x
Président Roulin RGF-GLI-	3			x		x	x		x		x	x	x		x	x					x		x	x	x			x		x						x		x	x
Reinette de Blenheim RGF-GLI- (Blenheim	3			x		x	x		x			x	x		x	x					x		x	x	x			x		x						x		x	x
Jacques Lebel Trad-RGF	4			x		x	x		x			x	x		x	x					x		x	x	x			x		x						x		x	x
Reine des Reinettes Trad-RGF (King of the Pippins)	4			x		x	x		x			x	x	±	x	x					x		x	x	x			x		x						x		x	x
Reinette de Chênée Trad-RGF	4			x		x	x		x			x	x		x	x					x		x	x	x			x		x						x		x	x
Belle-Fleur Large Mouche Trad-RGF, Lanscailler	4			x		x	x		x			x	x		x	x					x		x	x	x			x		x						x		x	x
Gueule de Mouton, Keuleman Trad-RGF	4			x		x	x		x			x	x		x	x	x				x		x	x	x			x		x						x		x	x
Reinette Evagil RGF-GLI-	4			x		x	x		x			x	x		x	x		x			x		x	x	x			x		x						x		x	x
Transparente de Lesdain RGF-GLI-	4			x		x	x		x			x	x		x	x			x		x		x	x	x			x		x						x		x	x
Cwastresse Double RGF-GLI-	4			x		x	x		x			x	x		x	x					x		x	x	x			x		x						x		x	x
Radoux RGF-GLI-	4			x		x	x		x			x	x		x	x				x	x		x	x	x			x		x						x		x	x
Reinette Hernaut, Dubbele Speeckaert RGF-GLI-	4			x		x	x		x			x	x		x	x					x		x	x	x			x		x						x		x	x
Gris Braibant RGF-GLI-	4			x		x	x		x			x	x		x	x					x		x	x	x			x		x						x		x	x
Godivert RGF-GLI-	4			x		x	x		x			x	x		x	x					x		x	x	x			x		x						x		x	x
Président Van Dievoet RGF-GLI-, Cabarette	4			x		x	x		x			x	x		x	x					x		x	x	x	x		x		x						x		x	x
La Paix RGF-GLI-	4–5			x		x	x		x			x	x		x	x					x		x	x	x		x	x		x						x		x	x
Reinette Etoilée, Ster Appel Trad-RGF	5			x		x	x					x	x		x	x					x		x	x	x			x		x						x		x	x
Belle-Fleur de France Trad-RGF, Belle-Fleur Double, Franse Belle Fleur	5			x		x	x		x			x	x		x	x					x		x	x	x			x		x						x		x	x
Jonathan Trad-RGF	5			x		x	x		x			x	x		x	x					x		x	x	x			x	x	x						x		x	x
Reinette de Waleffe RGF-GLI-	5			x		x	x		x			x	x		x	x					x		x	x	x			x		x						x		x	x
Winston Trad-RGF	5			x		x	x		x			x	x		x	x					x		x	x	x			x		x	x					x		x	x
Cwastresse Simple Trad-RGF, Calville des Prairies	6			x		x	x		x			x	x		x	x					x		x	x	x			x		x		x				x		x	x
Court-Pendu Rose Trad-RGF	6			x		x	x		x			x	x		x	x					x		x	x	x			x		x			x			x		x	x
Belle-Fleur de Brabant Trad-RGF, Belle-Fleur Simple, Brabantse Belle Fleur	6			x		x	x		x			x	x		x	x					x		x	x	x			x		x				x		x		x	x
Sabot d'Eijsden	6			x		x	x		x			x	x		x	x					x		x	x	x			x		x					x	x		x	x
Suntan	6			x		x	x		x			x	x		x	x					x		x	x	x			x		x						x		x	x
Reinette Dubois RGF-GLI-	6			x		x	x		x			x	x		x	x					x		x	x	x			x		x						x	x	x	x
Reinette de France Trad-RGF, Franse Reinette	7			x		x	x		x			x	x		x	x					x		x	x	x			x		x						x		x	x
Reinette Prof. Lecrenier RGF-GLI-	7			x		x	x		x			x	x		x	x					x		x	x	x			x		x						x		x	x

Examples of direct uses of fruit tree genetic resources
Public-Private-People Partnership is a key element to meet the user's demand

=> Release of objective information for customers – large importance on rootstock choice

Vigueur, performance agronomique et systèmes de verger

Porte-greffe	EMC	Adams	EMA	BA29	Franc
Autres sélections	*C 132* EMH *(QR 193-16)* Eline®		Sydo CTS 212	Pyriam (OH 11) Farold® 87 DAYTOR *(OHF 87)* Farold® 69 DAYNIR *(OHF 69)* Pyrodwarf	
Très vig. / Vigoureux / Moyen / Faible					
Entrée en production	Très précoce	Précoce	Moyenne	Moyenne	Tardive
Ancrage	Faible	Faible-moyen	Moyen	Bon	Excellent
Productivité	Elevée	Elevée	Moyenne	Moyenne	Similaire à légè-rement infé-rieure au BA29 (OHF, Pyriam)
Système de verger	Axial à densité moyenne - élevée	Axial à densité moyenne	Axial (variétés faibles à moyennes, Drilling)	Axial (variétés très faibles à faibles, Drilling, Mikado)	Formes libres pour le franc, Mikado ou palmette pour les clones de poirier.
Densité de plantation	1200-2000	1200-1700	1000-1500	800-1500	500-1000

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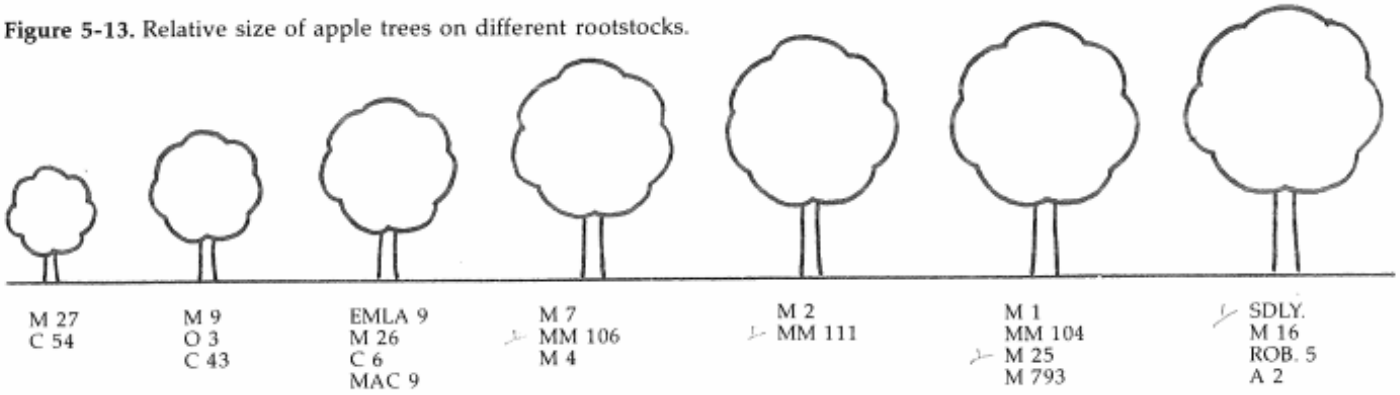
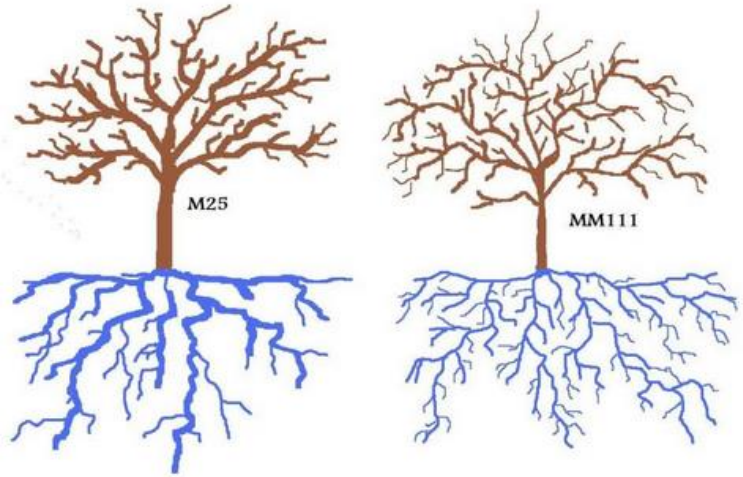
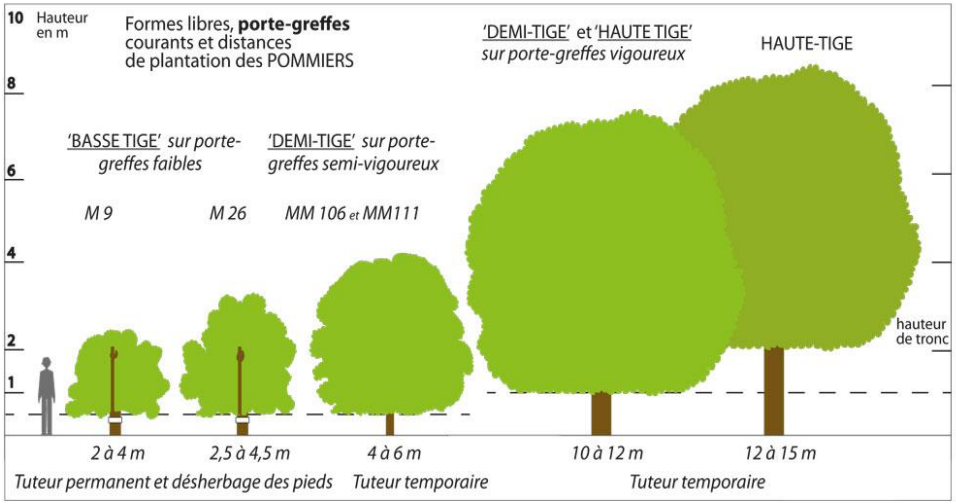
Funded by the European Union

Figure 5-13. Relative size of apple trees on different rootstocks.





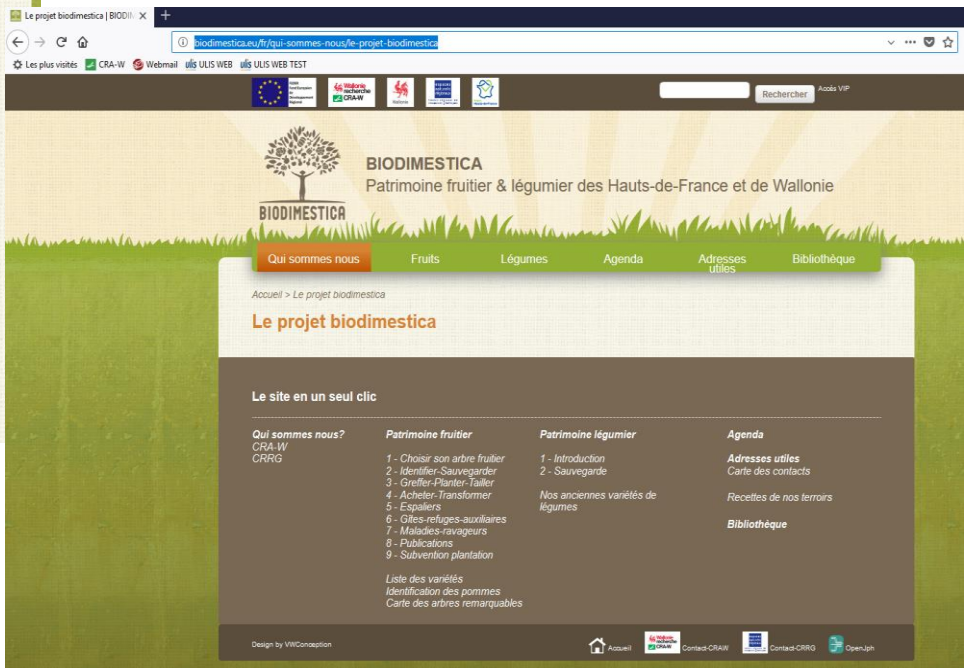


Examples of direct uses of fruit tree genetic resources
Public-Private-People Partnership is a key element to meet the user's demand
=> Enhancing fruit tree quality => central leader trees

'M 25' with central leader tree training

Examples of direct uses of fruit tree genetic resources
Public-Private-People Partnership is a key element to meet the user's demand

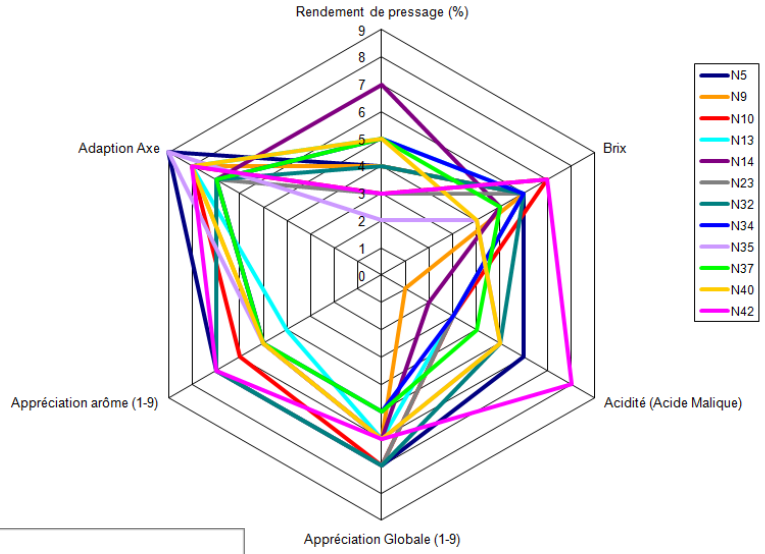
=> Transborder web site

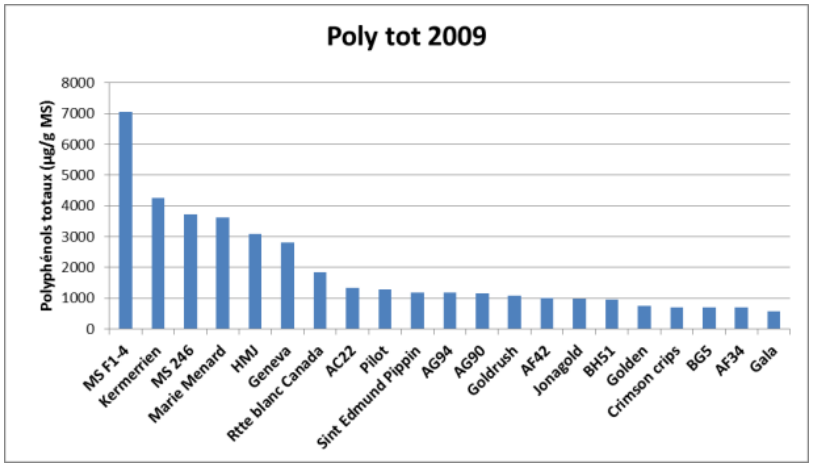


Examples of direct uses of fruit tree genetic resources
Public-Private-People Partnership is a key element to meet the user's demand

3. Partnership with apple & pear organic juice & cider producers

=> Study for selecting best blended cvs for non-spayed orchards with high gustative quality





Juice analysis
& sensorial analysis

Examples of direct uses of fruit tree genetic resources
Public-Private-People Partnership is a key element to meet the user's demand

3. **Partnership with apple & pear organic juice & cider producers**
=> Study for selecting best blended cvs for non-spayed orchards with high gustative quality

- Partnership with enterprises for screening old cvs for specific technologic properties and agronomic features (adaptation for semi-intensive industrial orchards):

- « Payottenlander » (Organic Fruit juices)

- « STASSEN »: Cider & juice
  + PPP breeding project red fleshed apple



- « Cidrerie du Condroz » : Cider & Juice - Agroforestry


Examples of direct uses of fruit tree genetic resources
Public-Private-People Partnership is a key element to meet the user's demand

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3. Partnership with apple & pear organic juice & cider producers

=> Participative cvs testing for selecting best blended cvs for non-spayed or organic orchards with high gustative quality

Examples of direct uses of fruit tree genetic resources
Public-Private-People Partnership is a key element to meet the user's demand

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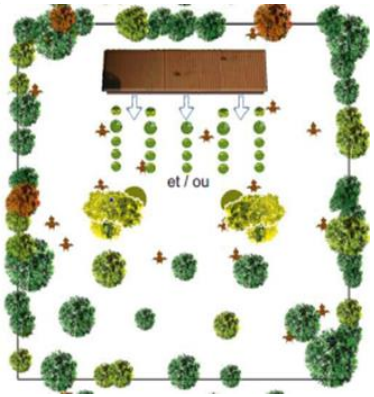
4. Partnership for alternative fruit production systems : non sprayed orchard meadows & agroforestry orchards

=> Participative cvs, rootstoks and tree training multilocal trials



Examples of direct uses of fruit tree genetic resources
Public-Private-People Partnership is a key element to meet the user's demand

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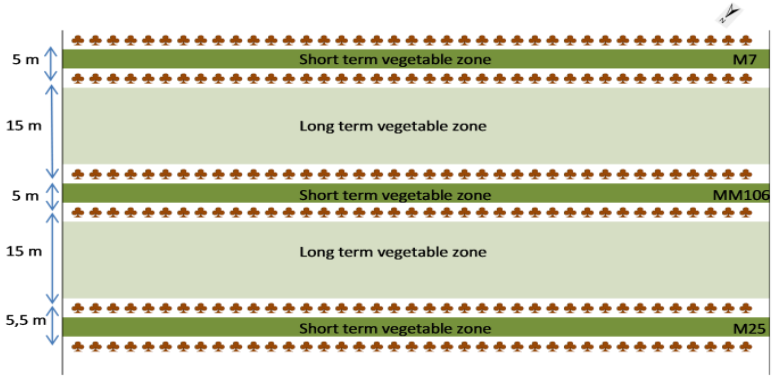

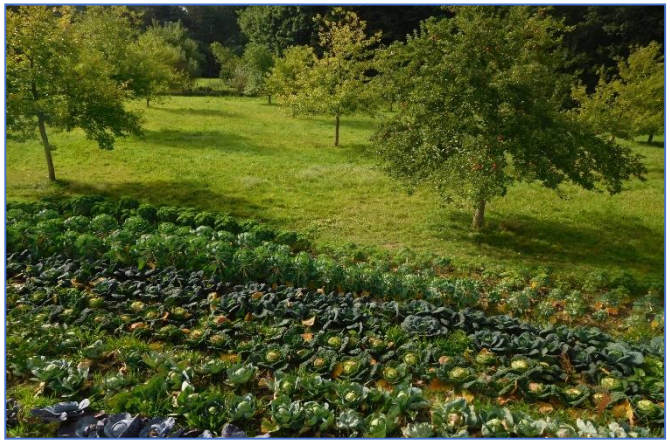

Examples of direct uses of fruit tree genetic resources
Public-Private-People Partnership is a key element to meet the user's demand

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4. Partnership for alternative fruit production systems : non sprayed orchard meadows & agroforestry orchards

⇒ 'Modern orchard meadows : a sector with a future – New way of non sprayed fruit agro-ecosystems??

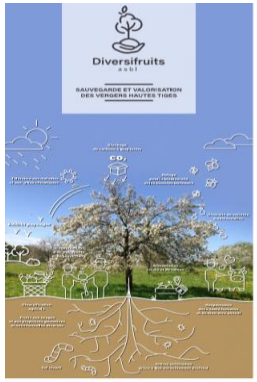
- **At least 30,000 trees** have been planted over **the last 15 years** in professional projects, not including individual plantations ...

- **Estimated production** based on orchards planted **over the last 10 years:** 3000 T/year by 2040 **< 50 000T ≈ volume of apples and pears produced in Wallonia**, of which ≈ 7000 T organically (College of producers)

Examples of direct uses of fruit tree genetic resources
Public-Private-People Partnership is a key element to meet the user's demand

⇒ 'Modern orchard meadows : a sector with a future

⇒ New way of non sprayed fruit agro-ecosystems??



Diversifruits asbl

New professional actors, nurseries, farmers, fruit SME processing

2017 Regional funded project 'Wal4Fruits'- NGO Diversifruits

Wallonie recherche CRA-W

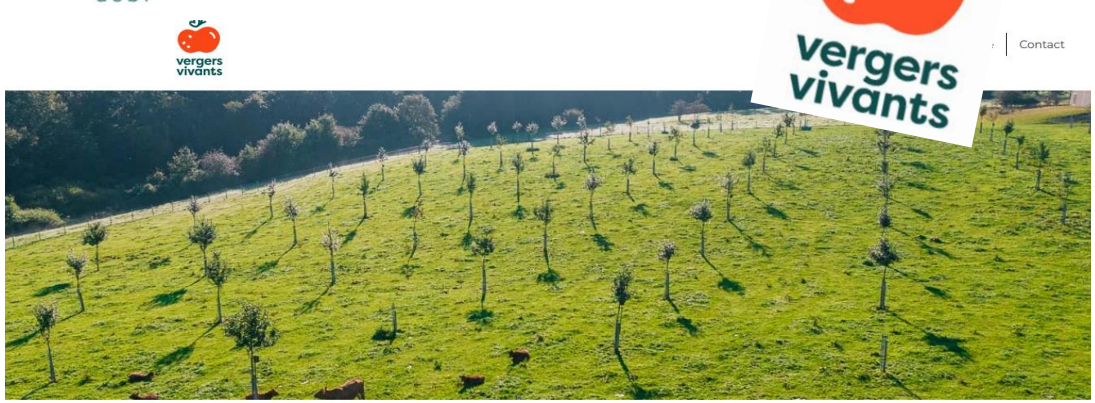
Saveguarding and valorisation of old fruit varieties (CRA-W) → selection of cvs, good quality trees,…

Examples of direct uses of fruit tree genetic resources
Public-Private-People Partnership is a key element to meet the user's demand

4. Partnerships for alternative fruit production systems : non sprayed orchard meadows & agroforestry orchards

⇒ 'Modern orchard meadows : a sector with a future

⇒ New way of non sprayed fruit agro-ecosystems??



Vergers vivants, un cahier des charges tourné vers demain

Le cahier des charges ⟶ | La documentation qualité ⟶

Vergers vivants a pour objectif de **certifier le mode de production** de fruits basé sur le verger hautes tiges **et d'en garantir la traçabilité** du verger au consommateur.

Recognized Marketing label **'Vergers Vivants'**

= To certify the **"high-stem orchards" fruit production method** and the **traceability of the resulting fruit of differentiated quality throughout the various stages (production, processing, marketing).**

Specific features:

⇒ **fruit without any spray scheme (only basic substances authorised), strong emphasis on**

⇒ **the presence of biodiversity, orchard meadows, grassland management and the choice of varieties and tree training .**

Examples of direct uses of fruit tree genetic resources
Public-Private-People Partnership is a key element to meet the user's demand

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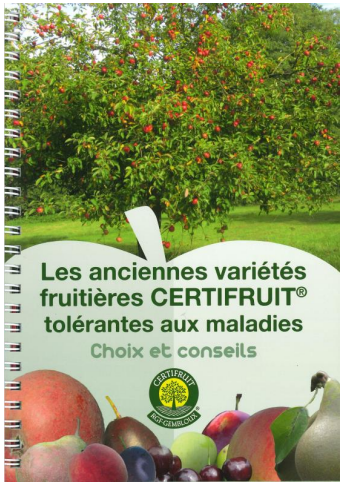
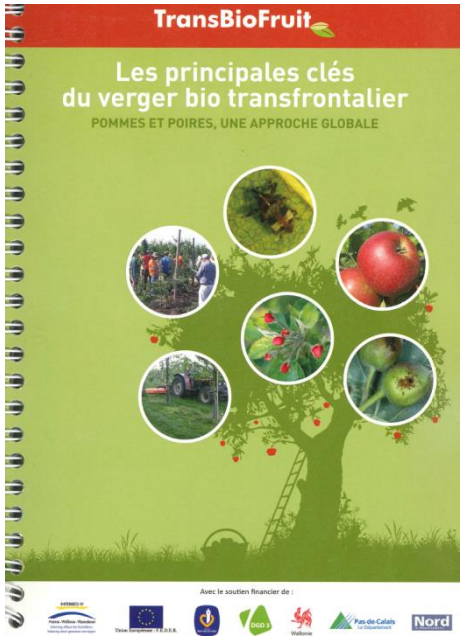
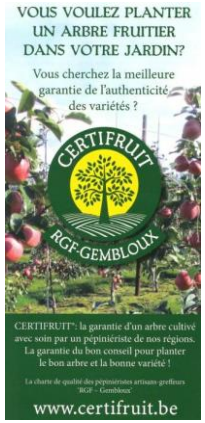
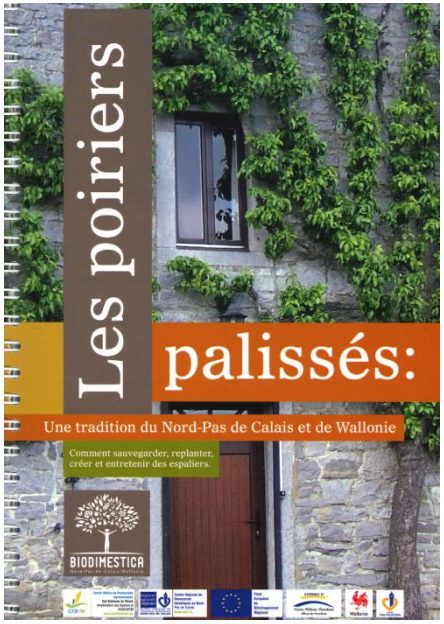
5. Further sources of information…

- www.biodimestica.eu : Transborder portail on FTGR with many practical information
- www.certifruit.be : Web page of « CERTIFRUIT »
- https://www.diversifruits.be/
- https://www.vergers-vivants.be/









Examples of direct uses of fruit tree genetic resources
Public-Private-People Partnership is a key element to meet the user's demand

6. Conclusions

- Collaboration with NGO's & private partners boost efficiency : more precise and short time objectives = **synergy between complementary expertises**,
- Scientific public Institutes **offer good confidence to citizens** and is an added value for private enterprises
- One key element is **fair & transparent** networking with **clear agreements**
- Such succesful **economical utilization** of FTGR is a **clear demonstration of usefulness of PGR conservation** for both citizens and decision makers – **it boosts public awareness!**
- One other key elemnt is the **need of elaborated process of EVALUATION** - here in **long term non-sprayed orchards** that offers co-evolution between host and pathogens strains
- Practical organization with private sector **needs to be at a professional level – a high level of efficiency is required**
- **Visibility and objective information is a must** : logo, trademark,….
- Scientist/private partners **need to speak same language**: time consuming, always looking for innovation and enhancement – and with the **long term objective of mankindness**

Examples of direct uses of fruit tree genetic resources
Public-Private-People Partnership is a key element to meet the user's demand

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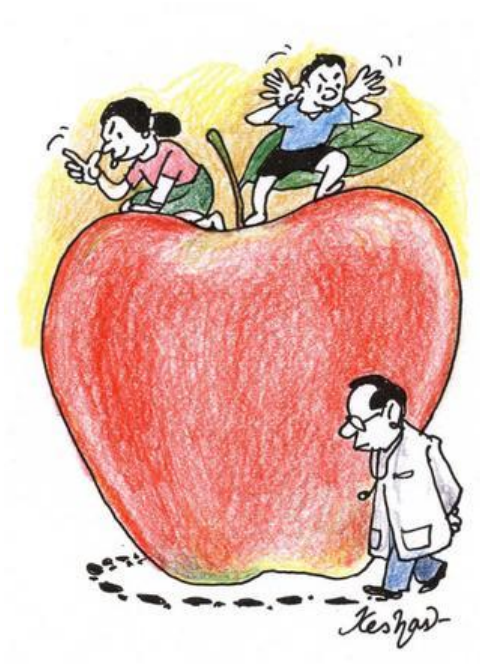

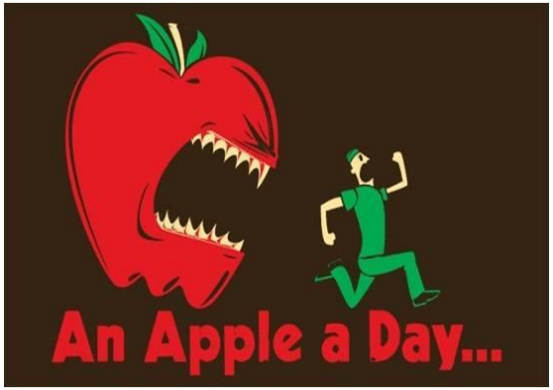

Thank you for your attention!