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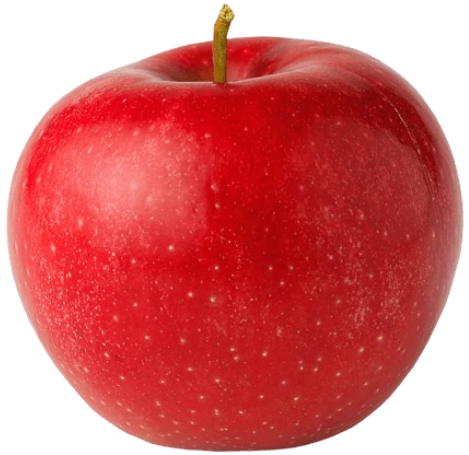
Federal Department of Economic Affairs,
Education and Research EAER

**Agroscope**

# AGROSCOPE's apple breeding program and the use of old treasures in modern breeding

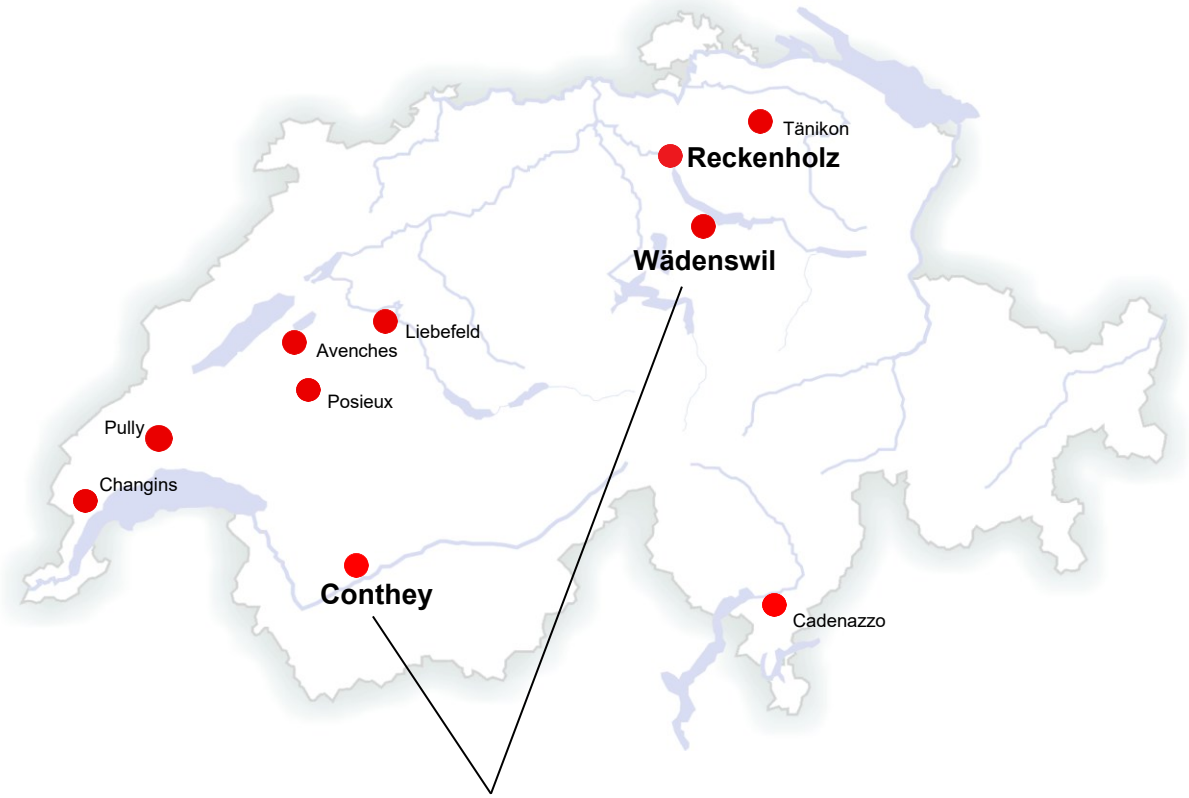
**Simone Bühlmann-Schütz & Team**

Europom 2025 - Basel



# AGROSCOPE

**AGROSCOPE** is the Swiss Centre of excellence for agricultural research and is affiliated with the Federal Office for Agriculture (FOAG).




**Research Group «Fruit Breeding»**

**Competence Division (3)**

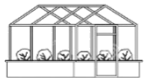
Animals, Products of Animal Origin and Swiss National Stud

Plants and Plant Products

Method Development and Analytics

**Research Division (7)**

Plant Breeding



Plant Production Systems

Plant Protection

Animal Production Systems and Animal Health

Food Microbial Systems

Agroecology and Environment

Sustainability Assessment and Agricultural Management

# Fruit Breeding at AGROSCOPE

## Research Division Plant Breeding

### Breeding

Head FG
«Fruit Breeding»
Andrea Patocchi

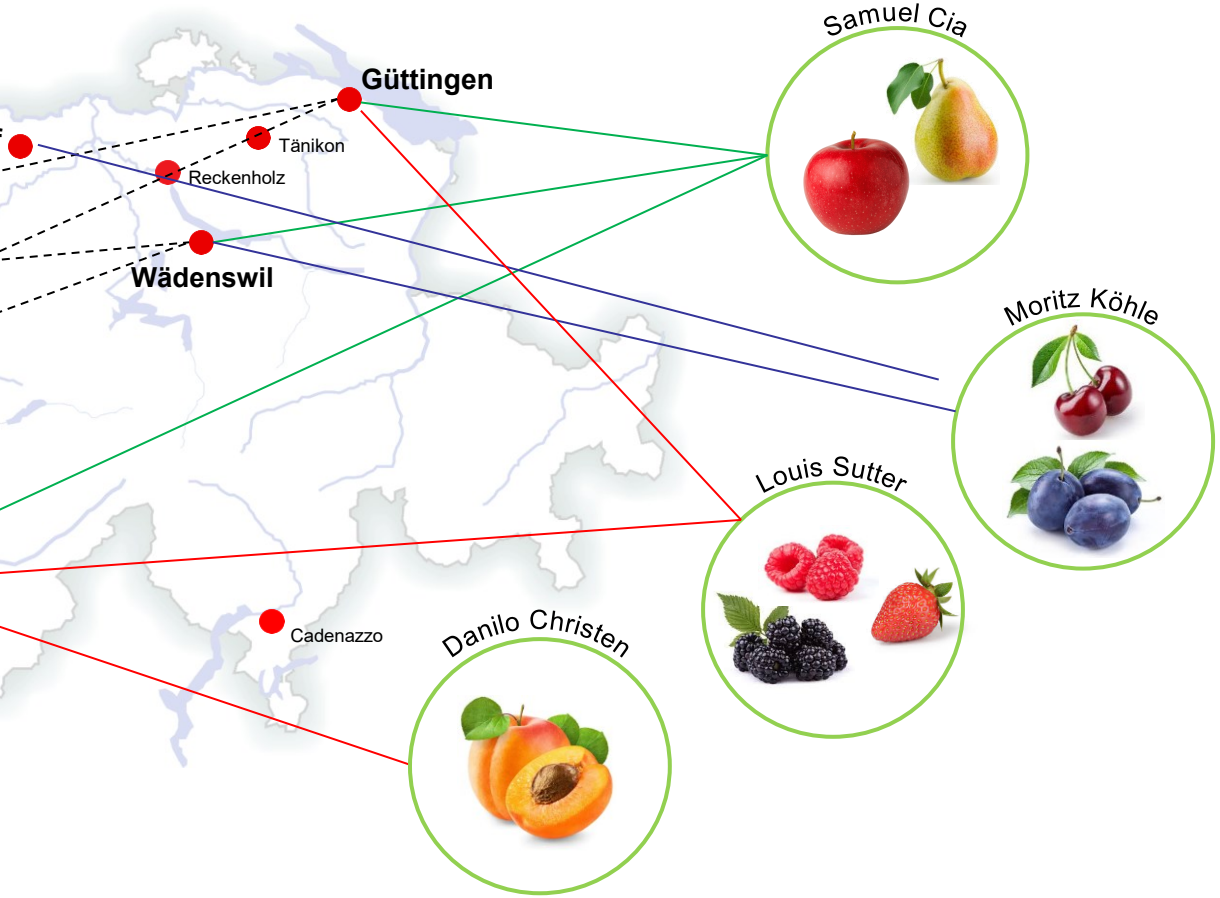
Simone Bühlmann-Schütz

Damien Tschopp

Danilo Christen

Head FG «Fruit crops in the Alpine region»

### Variety Testing

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# Breeding - long tradition and recent changes


Silk Road

source: South Tyrol Apple Consortium, 2022

Crab apple
(*Malus sylvestris*)

Settlement, agriculture and livestock farming

**Selection of plants**

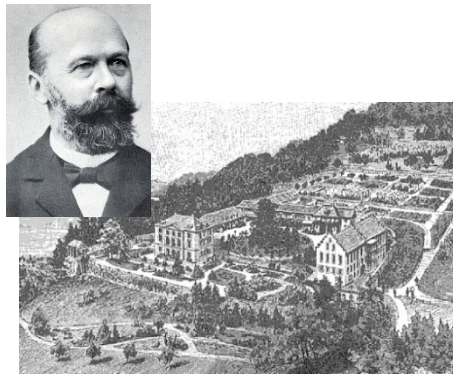
B.C.

Thomas Andrew Knight
British botanist and pomologist

Early 19th century

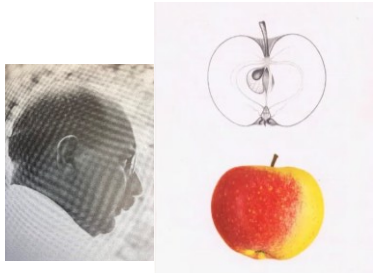
Mendel's Laws of Heredity

1866



Foundation of Deutsch-schweizerische Versuchsstation und Schule für Obst-, Wein- und Gartenbau in Waedensweil, first Director Hermann Müller-Thurgau
➔ 1892 Start of systematic cross-breeding of fruits

1890



Prof. Fritz Kobel
Breeder of the «Schweizer Orangen Apfel»

1939

Dr. Markus Kellerhals
Start of resistance breeding and since 2000 use of marker-assisted selection

1984

**Today**

2025

?

2050


source: ChatGPT

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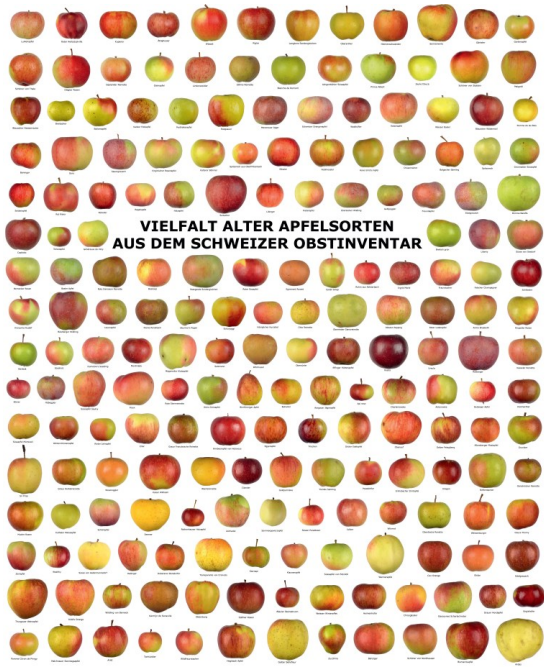
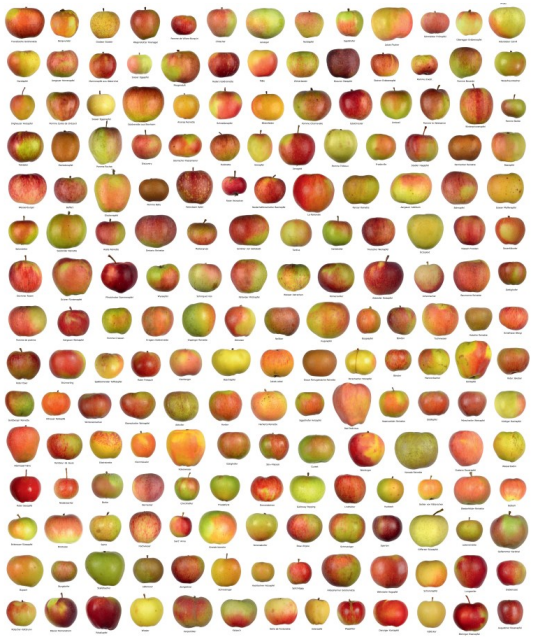
# Swiss diversity - then and now

**Swiss apple genetic resources**
**approx. 1200 accessions**




**390 accessions from the Swiss fruit inventory**



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Eidgenössisches Departement für Wirtschaft, Bildung und Forschung WBF
**Bundesamt für Landwirtschaft BLW**

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**National database:**
www.pgrel.admin.ch

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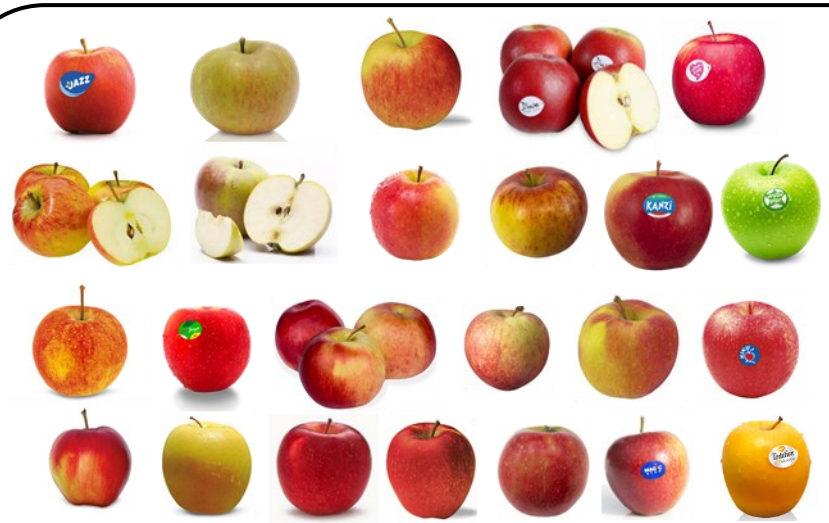
**current cultivars**


**3 cultivars account for approx. 50% of the cultivated area**



**another 24 cultivars approx. 40% of the cultivated area**

**= 27 cultivars account for 90% of the cultivated area**

Acreage CH 2023: ca. 3307.4 ha

*Source: Obst- und Tafeltraubenanlagen der Schweiz, BLW*

«Gala»

«Golden Delicious»

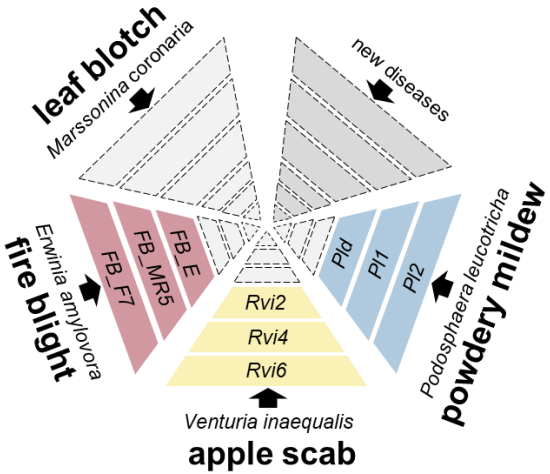
«Braeburn»

**These three varieties show good characteristics in production and storage, but are susceptible to diseases such as apple scab, powdery mildew and fire blight.**

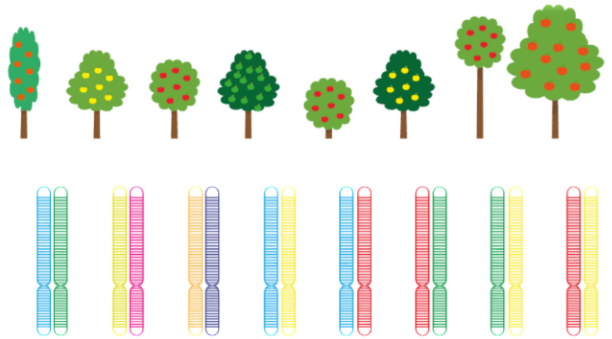
# Our breeding strategy for apple

- **Homogeneous and excellent fruit quality**
- **Good storability & shelf life**
- **Stable production and good yield**
- **High level of resistance or tolerance to diseases and pests**

**pyramiding/stacking & combining**




**phenotyping & genotyping**



**national & international collaborations**

Sources used:

- Related wild species with major *R*-gene
- Heirloom varieties with high level of resistance / tolerance
- Modern cultivars with high level of resistance / tolerance
- Constant integration of new findings from breeding research

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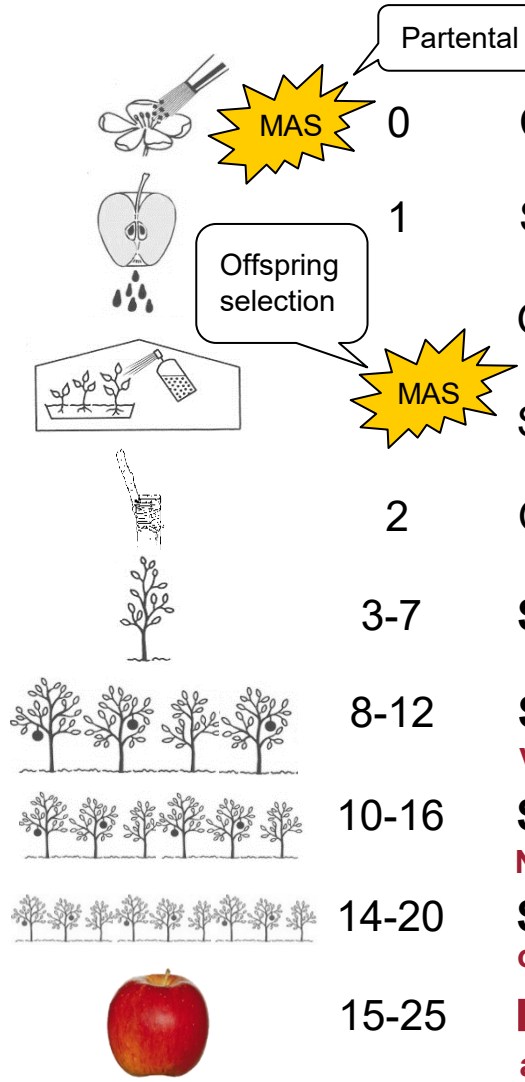
# Timeline in apple breeding at AGROSCOPE

years




| | | |
|---|---|---|
| 0 | Cross combination - pollinated flowers | 10’000 |
| 1 | Seed - stratification – sowing | 10’000 |
| | Greenhouse screening and selection | 5’000 |
| | Selection in the container field | 800 |
| 2 | Grafting – tree nursery (1year) | 800 |
| 3-7 | **Stage 1**: 1 tree per genotype on M27/M9 | 800 |
| 8-12 | **Stage A**: 4 trees on M9<br>VariCom, national and international test stations | 25 |
| 10-16 | **Stage B**: 15 trees on M9<br>Nuclear stock ➔ certified plant material | 4 |
| 14-20 | **Stage C**: 50 trees on M9<br>on farm pilot orchards, DUS testing | 2 |
| 15-25 | ➡ **New cultivar**<br>approx. every 5 years | 1 |

selections / seedlings

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# AGROSCOPE apple breeding - process

# Segregating offsprings

## Fiesta x Discovery

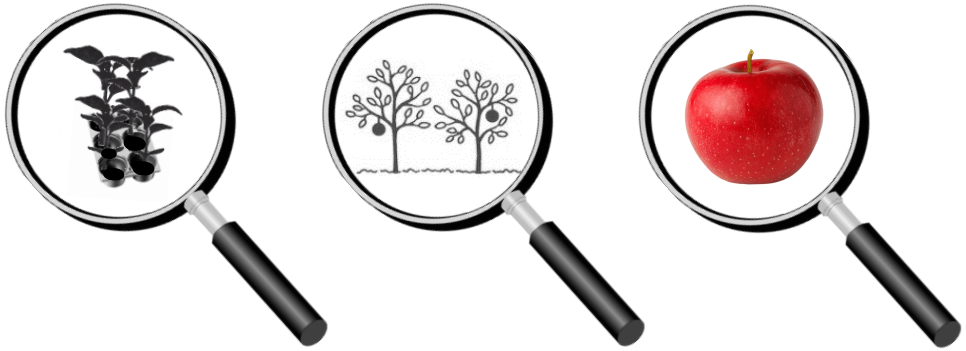
# AGROSCOPE apple breeding - process

# Selection of offspring

## Phenotyping

**Several years of observation and analysis...**

- Disease screening
- Selection in the container field
- Scoring and selection in the field
- Tasting of fruit samples
- Calibration and fruit quality analysis
- Storage trials
- Sensory panel
- National and international networks
- Consumer tasting
- ...



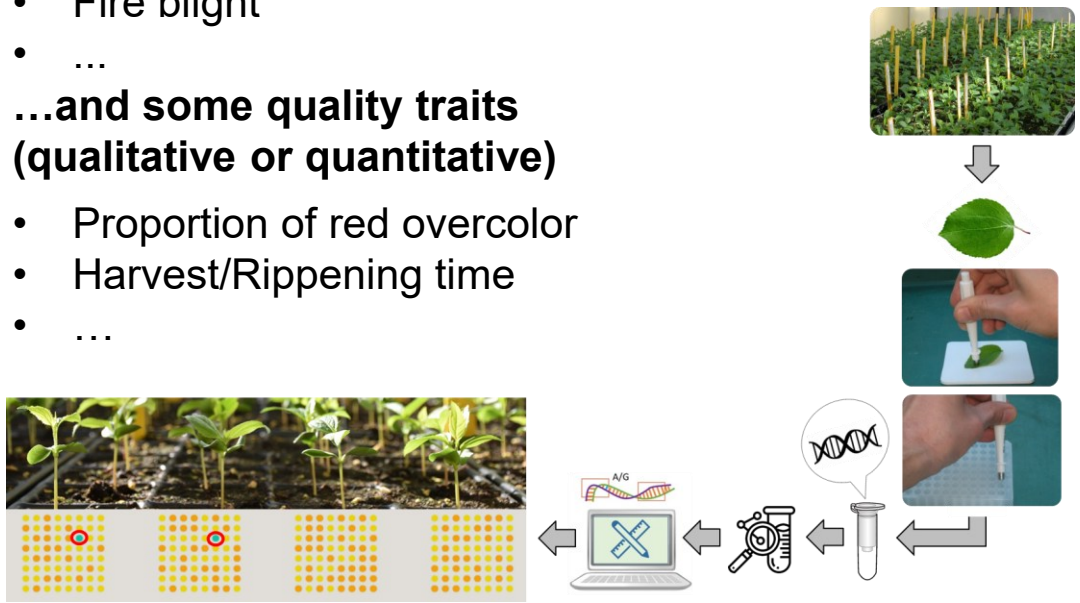
## Marker-assisted selection

**Possible for known monogenic/qualitative or quantitative (QTL) resistances…**

- Apple scab
- Powdery mildew
- Fire blight
- ...

**…and some quality traits (qualitative or quantitative)**

- Proportion of red overcolor
- Harvest/Rippening time
- …



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# Latest release – dessert apple Agroscope Cultivars

VariCom

KSB - Konsortium Sudtiroler Baumschuler - Consorzio Vivaisti Frutticoli Altoatesini

ARTEVOS® DALIVAL ifo

## Ladina

Cross 1999
Registered 2012

Topaz x Fuji

- scab resistance (*Rvi6*)
- fire blight tolerant
- approx. 1 week before Golden Del.
- medium vigour
- good and regular yields
- tropical taste
- very juicy
- limited shelf life

## Mariella

Cross 1982
Registered 2013

Maigold x Arlet

- Harvest +/- equal to Fuji
- good and regular yields
- very crunchy & juicy
- well balanced taste
- very good storability

## Rustica

Cross 1994
Registered 2014

La Flamboyante x H 23-10

- scab resistance (*Rvi6*)
- Harvest +/- equal to Braeburn
- good and regular yields
- very healthy tree
- more acid than sweet
- crunchy & juicy

## CH201-Fred®

Cross 2000
Registered 2018


Harrow Sweet x Verdi

- 10 days after Conference
- good and regular yields
- crispy, very juicy

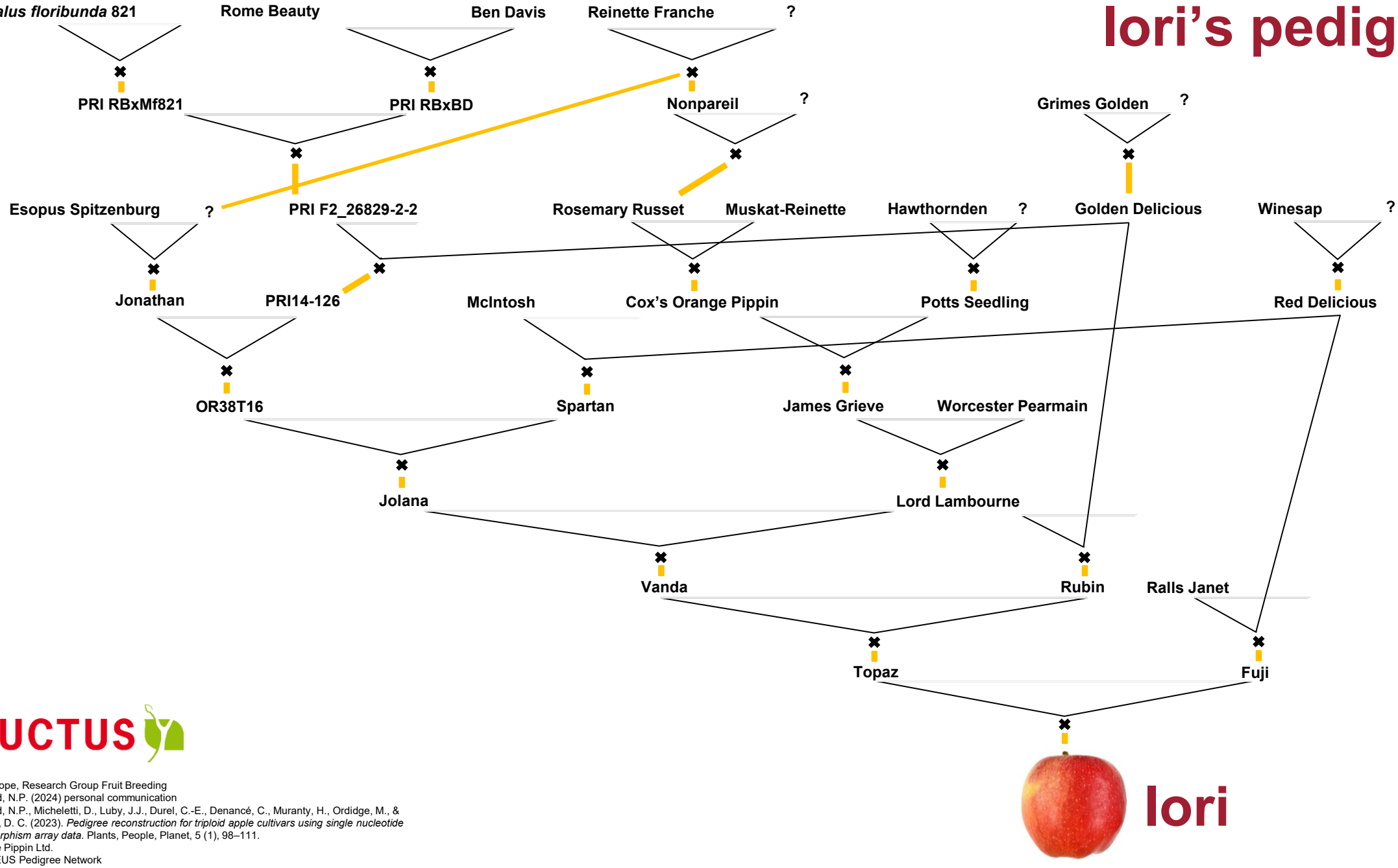
## Iori

Cross 1999
Registered 2023

Topaz x Fuji

- scab resistance (*Rvi6*)
- approx. 3 week after Golden Del.
- medium vigour
- good yields
- intense flavour
- Storability under examination

# Iori's pedigree

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Source:

- Agroscope, Research Group Fruit Breeding
- Howard, N.P. (2024) personal communication
- Howard, N.P., Micheletti, D., Luby, J.J., Durel, C.-E., Denancé, C., Muranty, H., Ordidge, M., & Albach, D. C. (2023). *Pedigree reconstruction for triploid apple cultivars using single nucleotide polymorphism array data.* Plants, People, Planet, 5 (1), 98–111.
- Orange Pippin Ltd.
- PERSEUS Pedigree Network
- www.pomiferous.com

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# Current and past projects on the use of genetic resource in breeding

## Description and use of Swiss Apple/Pear Genetic Resources

ETH Eidgenössische Technische Hochschule Zürich Swiss Federal Institute of Technology Zurich
FRUCTUS
POMA CULTA
Agroscope
FiBL
CPC-SKEK
Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Bundesamt für Landwirtschaft BLW
Office fédéral de l'agriculture OFAG
Ufficio federale dell'agricoltura UFAG
Uffizi federal d'agricultura UFAG

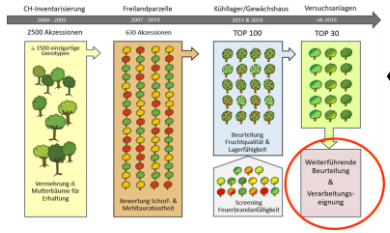
*National Action Plan for the Conservation and Sustainable Use of Plant Genetic Resources for Food and Agriculture (NAP-PGREL)*

## NAGBA *2016-2019* NAGBA II *2020-2023*

«Use of apple genetic resources for organic farming»

FiBL Agroscope POMA CULTA

## NUVOG *2015-2018*




«Use of fruit genetic resources»

- Pre-Breeding and Cider

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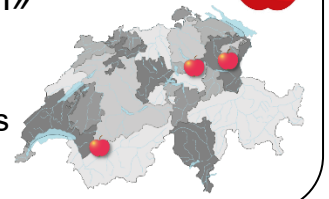
## current projects

## SACC **Phase 1** *2019-2022* **Phase 2** 2023-2026

«Swiss Apple Core Collection»

ETH Agroscope

3 Locations
330 Accessions



## BEVOG V 2023-2026

«Description of the genetic resources of fruit»

- Verification of varieties
- Surveys to identify robust varieties
- Robust and valuable apple varieties for high-stem cultivation

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## NUBIG 2023-2026

«Use of the Swiss pear gene pool»

- Swiss Pear Core Collection (SPCC)
- Planted 2019 in Boezberg (CH)
- 155 accessions / 4 trees per genotype

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# Latest crosses using accessions from the Swiss apple gene pool

## Crosses 2024

- Gala x Batschueli (MUNQ 3514)
- ACW 17220 x Beffert (MUNQ 1160)
- Golden Del. x Grauer Hordapfel (MUNQ 1343)
- Ladina x Schoggiapfel Liestal (MUNQ 3364)

## Crosses 2023

- Gala x Schorenapfel (MUNQ 1436)
- ACW 19896 x Roter Herbstkalvill (MUNQ 1114)
- ACW 24539 x Waldkircher Himbeerapfel (MUNQ 3720)

MUNQ 3514

MUNQ1160

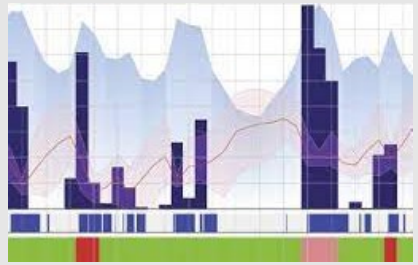
MUNQ 1343

MUNQ 1436

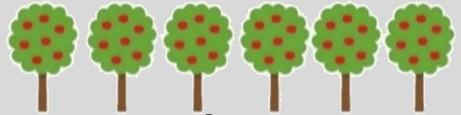
MUNQ 1114

MUNQ 3720

# Strategies for durable resistance / tolerance

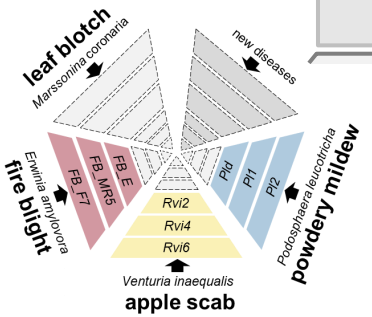


adapted crop protection strategy



monoculture versus mixed culture

locally adapted, used combination of cultivars and cultivation techniques




diversity, tolerance, combination of qualitative and quantitative resistances

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# Thank you for your attention


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