



AGROSCOPE and it's fruit breeding program



Simone Bühlmann-Schütz & Team

NIAB 2024 – East Malling



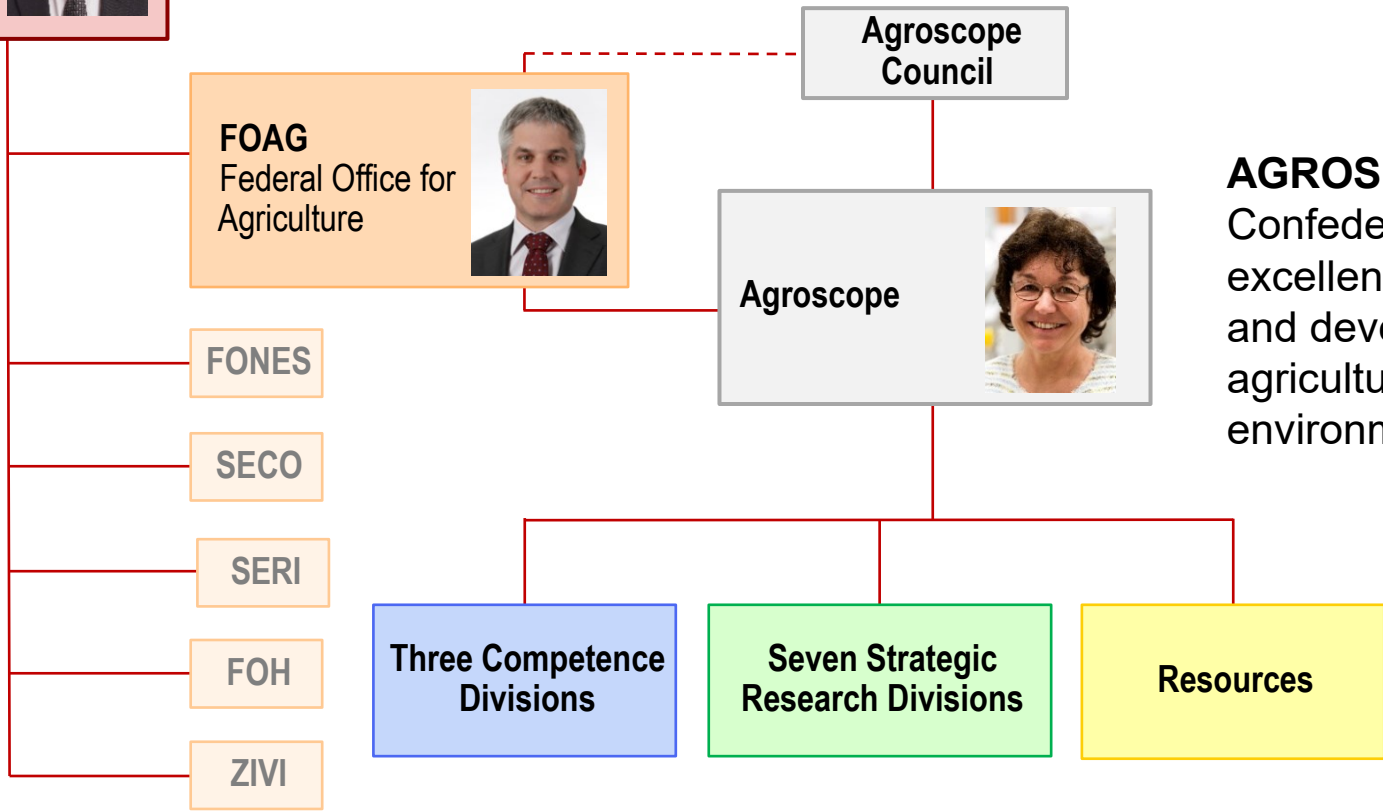
Agroscope

Good food, healthy environment



Agroscope within the EAER = Federal Department of Economic Affairs, Education and Research

EAER
Federal Department
of Economic Affairs,
Education and
Research



AGROSCPE is the Swiss Confederation Centre of excellence for research and development in the agriculture, food and environment sector.



AGROSCOPE



Competence Division (3)



Animals and Products of Animal Origin



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



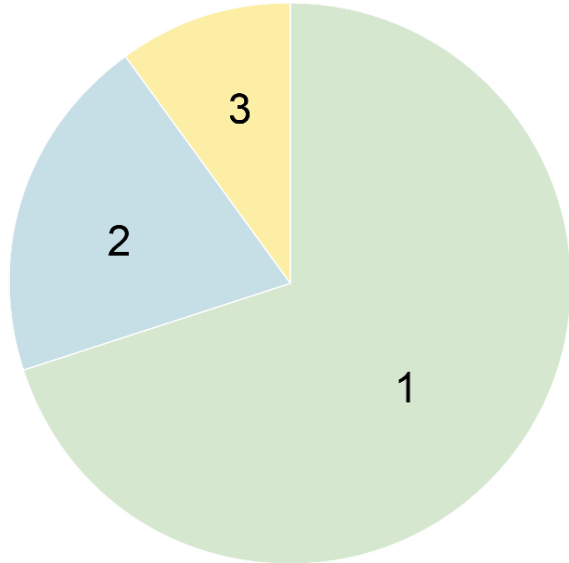
Agroecology and Environment



Sustainability Assessment and Agricultural Management



For Whom do We Research?



→ For the agriculture and food sector

Research and Development along the value chain according to the slogan “From farm to fork, from fork to farm”.

→ For legislation

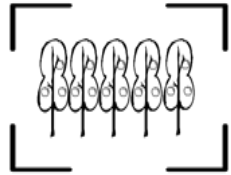
Enforcement tasks and enforcement tools within the scope of the legal provisions.

→ For policy

Scientific support of agricultural policy: Advising decision-makers, authorities and agricultural extension centres.



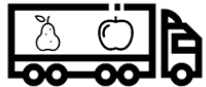
Apple and pear production in Switzerland



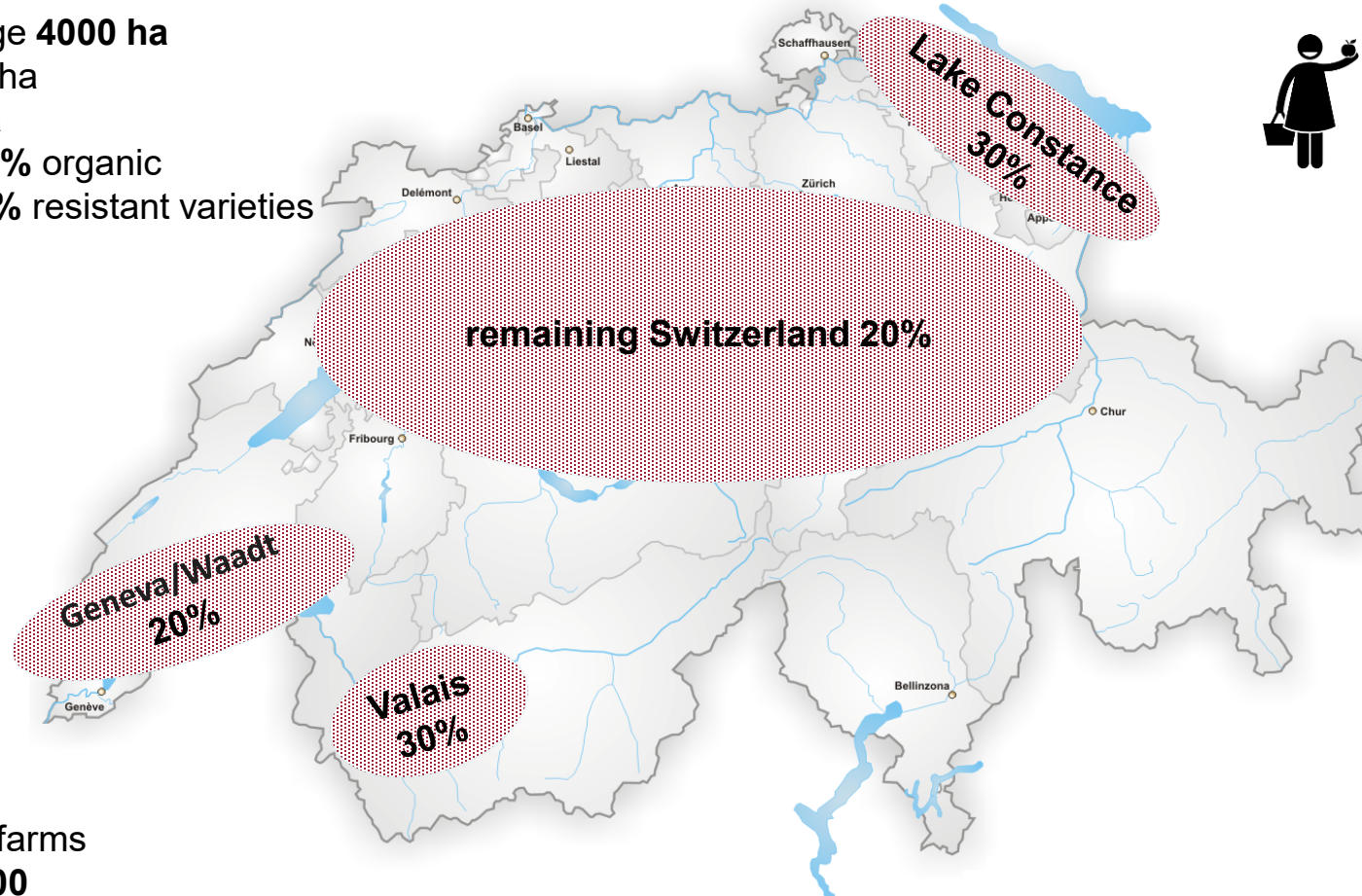
Total acreage **4000 ha**
 apple 3300 ha
 pear 700 ha
approx. 16 % organic
approx. 15% resistant varieties



Annual consumption per capita
 apple approx. **12.7 kg**
 pear approx. **3.2 kg**

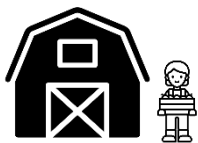


Net import
 apple approx. 8500 t (8%)
 pear approx. 9300 t (42%)



Dessert apple pre-harvest estimate for the year 2022:
114 351 t
 (www.swissfruit.ch)

World-wide apple production:
 approx. **85 Millionen t**
 (www.statista.com)



Number of farms
 approx. **1400**
 (year 2000 still approx. 2400)

*Kernobst allgemein, Daten 2023
 Quelle: Obst- und Tafeltraubenanlagen der Schweiz, BLW



Fruit Breeding at AGROSCOPE



Research Division Plant Breeding Breeding

Variety Testing



Head FG
«Fruit Breeding»
Andrea Patocchi

Simone Bühlmann-Schütz



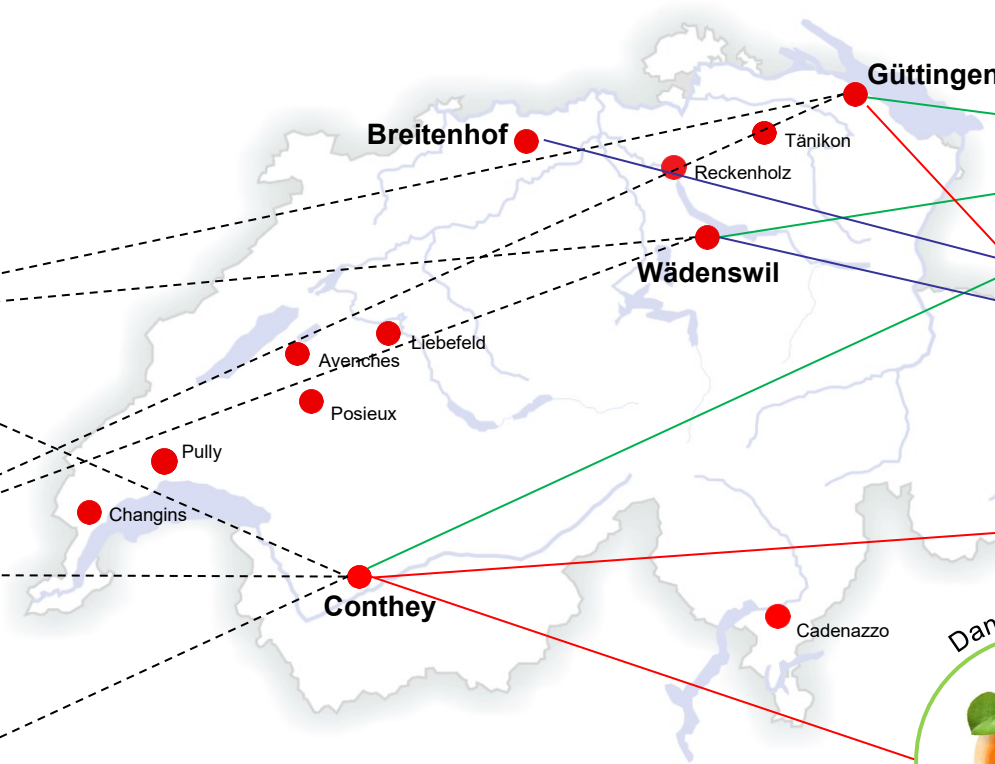
Damien Tschopp



Danilo Christen



Head FG «Fruit crops in the Alpine region»



Samuel Cia



Moritz Köhle



Louis Sutter



Danilo Christen





Renewed intensification of the pear breeding program at AGROSCOPE



- **Spring 2023** 26 cross combinations, more than 7'000 flowers pollinated in three different locations
- **Autumn 2023** more than 5'000 seeds extracted
- **January 2024** more than 3'200 seeds sown
- **February 2024** more than 2'600 seeds germinated
→ germination rate of 80%
- **Spring 2024** new crosses done

Contact: Damien Tschopp

damien.tschopp@agroscope.admin.ch





Our breeding strategy for

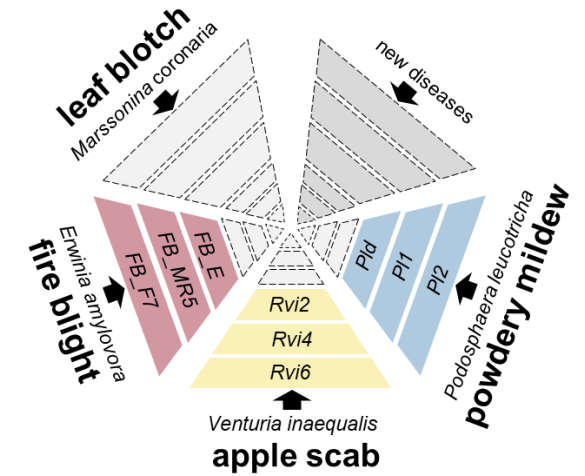


- stable fruit quality
- stable productivity
- good storability & shelf-life
- high level of resistance / tolerance to diseases and pests

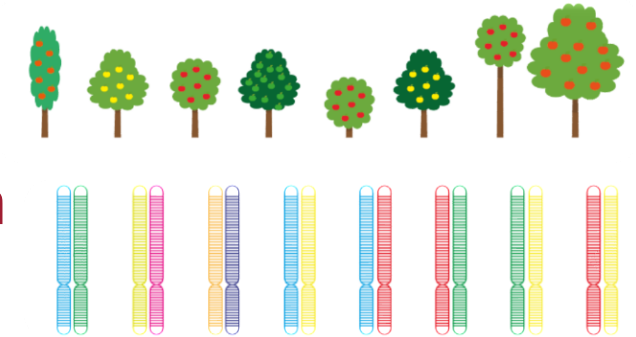
sources used:

- 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

stacking & combining



phenotypic & genomic selection



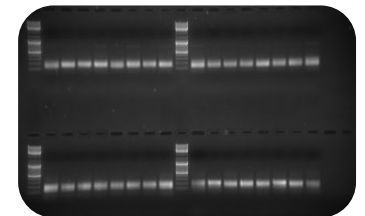
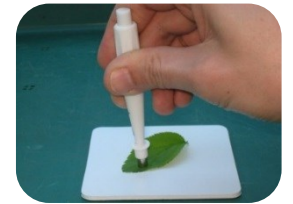
national & international collaborations





Marker-assisted selection

- When possible, at least two markers flanking the *R*-gene are used
- SSR or SCAR markers ► Ecogenics GmbH (CH, www.ecogenics.ch)
- SNP markers ► LGC Genomics Ltd. (UK, www.lgcgroup.com)



<i>R</i> -gene	LG ^a	Marker name	Marker type	Allele in coupling	Reference
Rvi2	2	CH05e03	SSR	173 (179/190) ^b	Bus <i>et al.</i> , 2005
Rvi2	2	OPL19	SCAR	438 (-) ^b	Bus <i>et al.</i> , 2005
Rvi4	2	CH02C02a	SSR	182 (148/184) ^b	Bus <i>et al.</i> , 2005
Rvi4	2	Hi22d06	SSR	132 (132/138) ^b	Silfverberg-Dilworth <i>et al.</i> , 2006
Rvi6	1	CH-Vf1	SSR	164 (146/146) ^b	Vinatzer <i>et al.</i> , 2004
Rvi2	2	FBsnRvi2.7_W242	SNP	A ^c	Jansch <i>et al.</i> , 2015
Rvi2	2	FbsnRvi2.1_M417	SNP	A ^c	Jansch <i>et al.</i> , 2015
Rvi4	2	FBsnRvi4.1_K146	SNP	T ^c	Jansch <i>et al.</i> , 2015
Rvi4	2	TNL1_Rvi4_R131	SNP	G ^c	Jansch <i>et al.</i> , 2015
Rvi6	1	M8S_Rvi6_Y124	SNP	T ^c	Jansch <i>et al.</i> , 2015
Rvi6	1	M18_Rvi6_Y32	SNP	T ^c	Jansch <i>et al.</i> , 2015

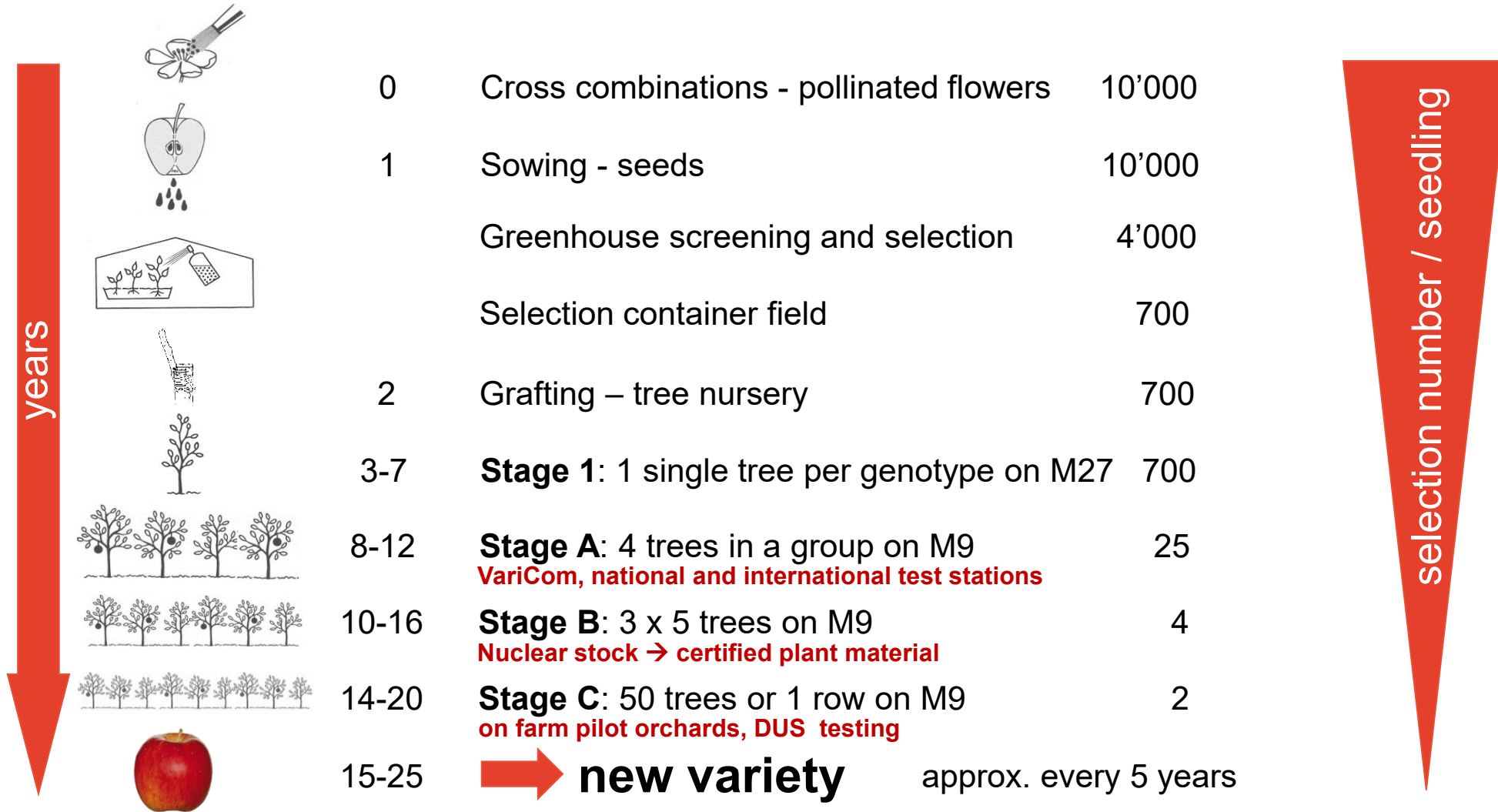
^aLinkage group

^bAllele in coupling with resistance and reference alleles of 'Gala' in brackets

^cAllele in coupling with resistance



Timeline in Apple Breeding at AGROSCOPE



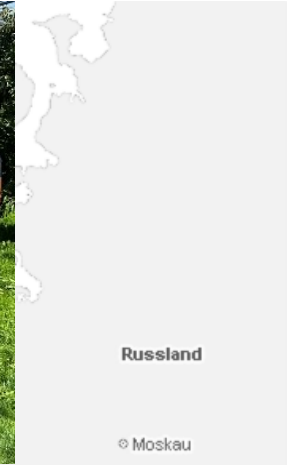


Development, testing and introduction of breeding selections and varieties

Varicom

Executive Management - Michael Weber

- Artevos (D)
- IFO (F)
- Konsortium Südtiroler Baumschuler (I)



Network:



Ongoing projects

Project AZZ

«Apfelzukunft dank Züchtung»

«Apple future thanks to breeding»



- Genomic selection
- Fast Track Breeding
- Neofabrea resistance screening

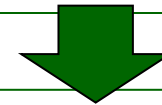
Description and use of Swiss Apple Genetic Resources



Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

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

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



NUBIG 2023-2026

«Use of the Swiss pear gene pool»

FRUCTUS   **Agroscope**



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

Project RESO

«Resiliente Obstproduktion für einen nachhaltigen Anbau»

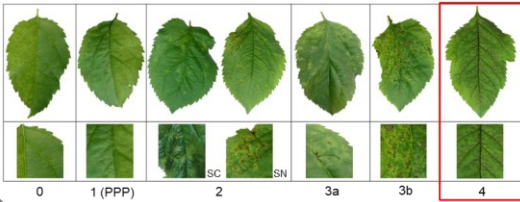
«Resilient fruit production for sustainable cultivation»



- Resilient fruit production with adapted varieties
- Reduced crop protection with adapted varieties
- Fruit quality for the point of sale (stone fruit only)



Disease screening – artificial inoculation



scab



→ search for possible sources of resistance



Bull's-eye rot
(*Neofabraea spp.*)



shoot test in the greenhouse

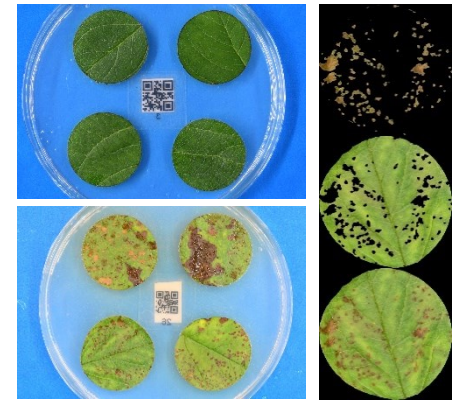


flower test under field conditions

fire blight



→ test development and search for possible sources of resistance



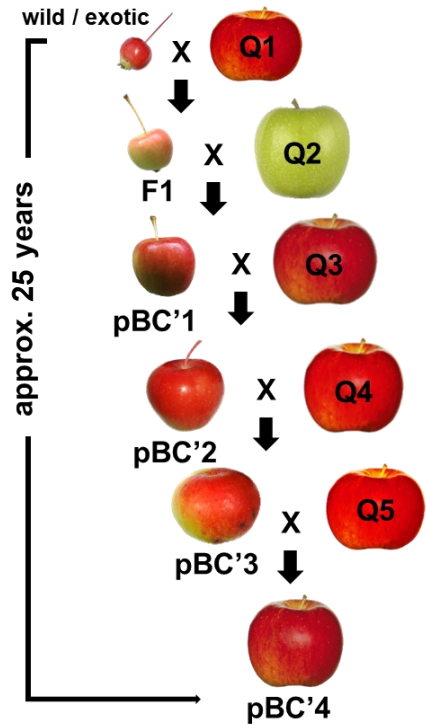
apple blotch
(*Diplocarpon coronariae*)



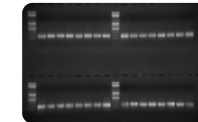


Accelerated generation cycle «Fast Track» Breeding at Agroscope

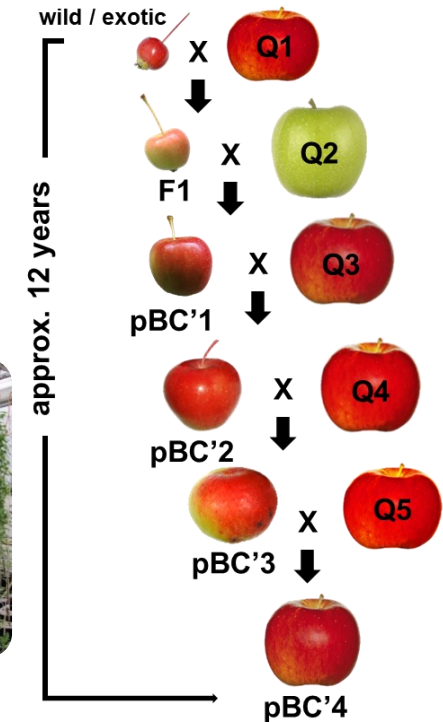
classical breeding



- classic breeding without GMO techniques
- strong resistance from wild apples or exotic material
- marker-assisted selection
- controlled conditions in a normal greenhouse
- artificial winter dormancy in a cold room at 3 to 4 °C
- at Agroscope since 2008
- Reduction of the generation time from 4 to 5 years in classical breeding to approx. 2 ½ years with Fast Track



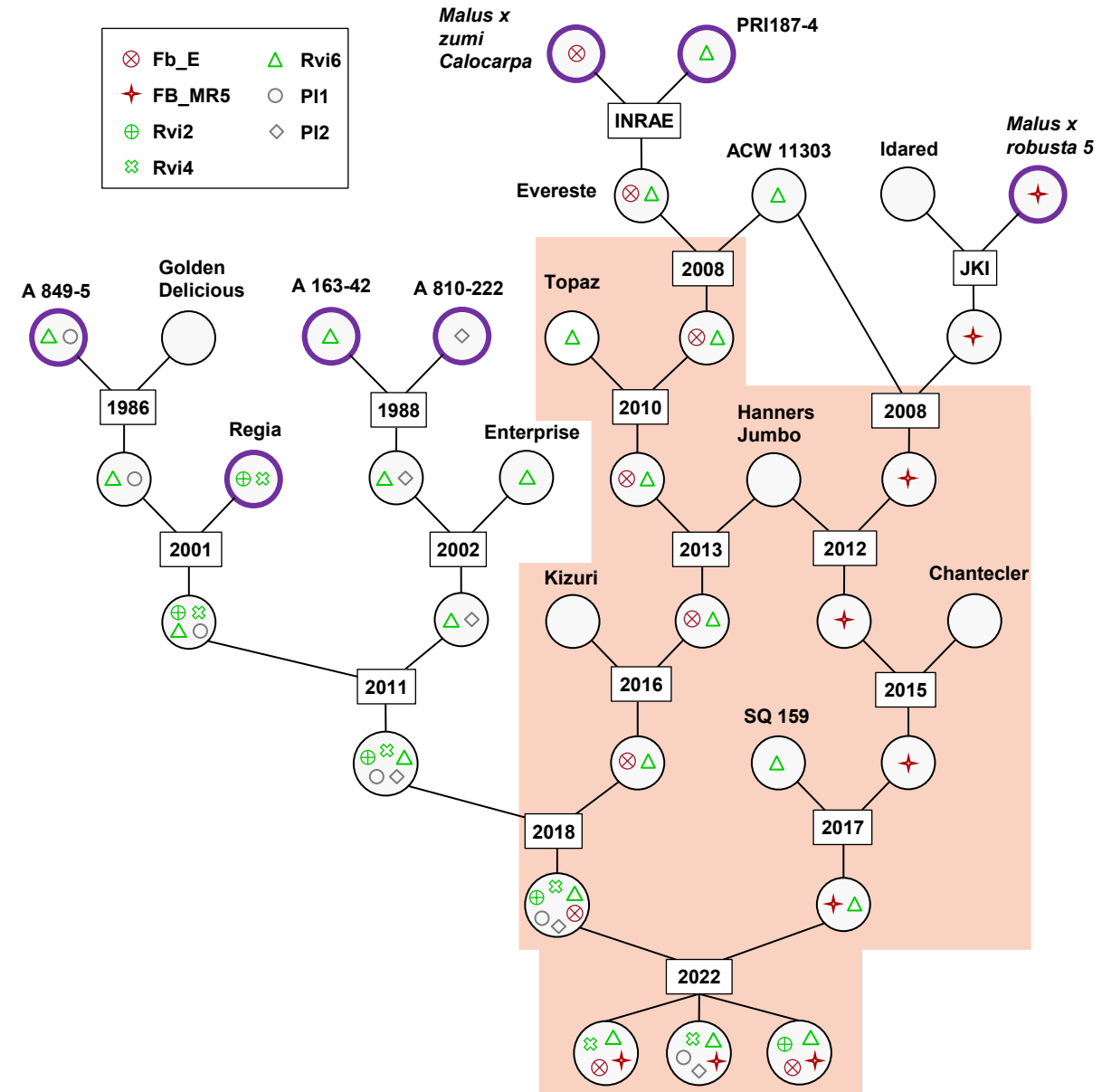
Fast Track





Latest results «Fast Track»

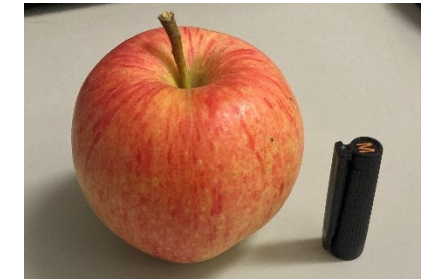
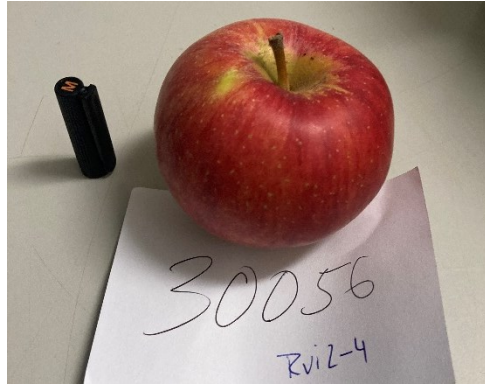
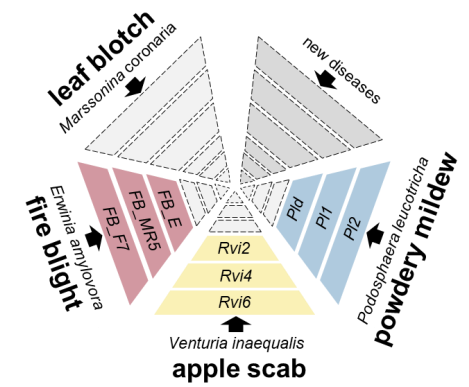
- Breeding selections with stacked fire blight resistance genes **Fb_E** from “Evereste” and **FB_MR5** from *Malus x robusta* 5 obtained in the fifth and sixth generation
- In addition: stacked *R*-genes for several diseases - *Venturia inaequalis* (**Rvi2**, **Rvi4** and **Rvi6**) and *Podosphaera leucotricha* (**PI1** and **PI2**) and *Erwinia amylovora* (**Fb_E** and **FB_MR5**) in different offspring populations
- 2023/24 fourth generation of the fire blight resistance gene (**FB_Mfu10**) from the wild apple *Malus fusca* obtained



Crosses made using the “Fast Track” method are indicated in the orange box.



Selections with combined resistance



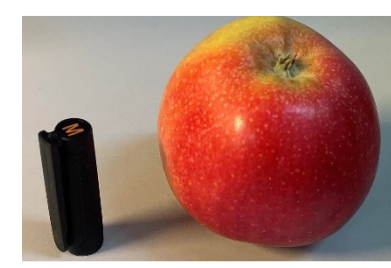
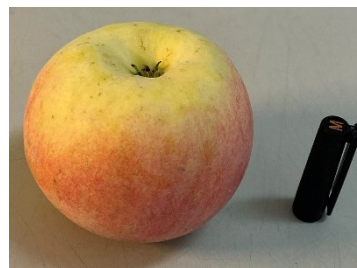
28960 Rvi2-4-6-PI1-FB_F7

ACW 28914
Rvi2-4-6-PI1-FB_F7

ACW 27747 Rvi2-4-6-PI1

ACW 30078 Rvi2-4-6

ACW 27742
Rvi2-4-6-PI1



ACW 28938
Rvi2-4-6-PI1-FB_F7

ACW 28953
Rvi2-4-PI1

ACW 24954
Rvi2-4-6-PI1-2-FB_F7

ACW 30143
Rvi2-4

ACW 27741
Rvi2-4-6-PI1



Three new apple varieties for the processing industry

- Application for Plant Variety Rights for Switzerland November 2023
- Tested for the production of high and low stem
- Juice production trials for several years
- New 2023/24 - pure variety trials for cider, distillate, dried slices and apple sauce



ACW 11303

juice super sweet

robust to powdery mildew/fire blight /
Rvi6/Vf apple scab resistance



ACW 15097

juice balanced

robust to powdery mildew/fire blight
Rvi6/Vf apple scab resistance



ACW 16426

juice super sour

robust to fire blight / *PI2* powdery mildew &
Rvi2/Vh2 apple scab resistance





Latest release New Agroscope Varieties

Varicom

KSB - Konsortium Sudtiroler
Baumschuler - Consorzio
Vivaisti Frutticoli Altoatesini



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



Thank you for your attention

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Agroscope good food, healthy environment
 www.agroscope.admin.ch

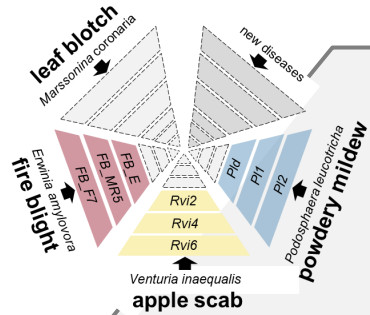


An
APPLE
 a day keeps
 the doctor away





Strategies for durable resistance / tolerance



diversity / tolerance / combination of major and minor resistances



adapted crop protection strategy

site adapted combination of varieties and cultivation techniques

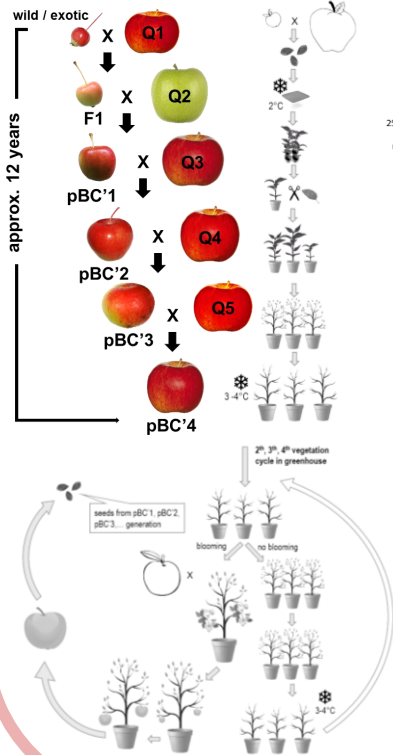
mono- vs mixed culture



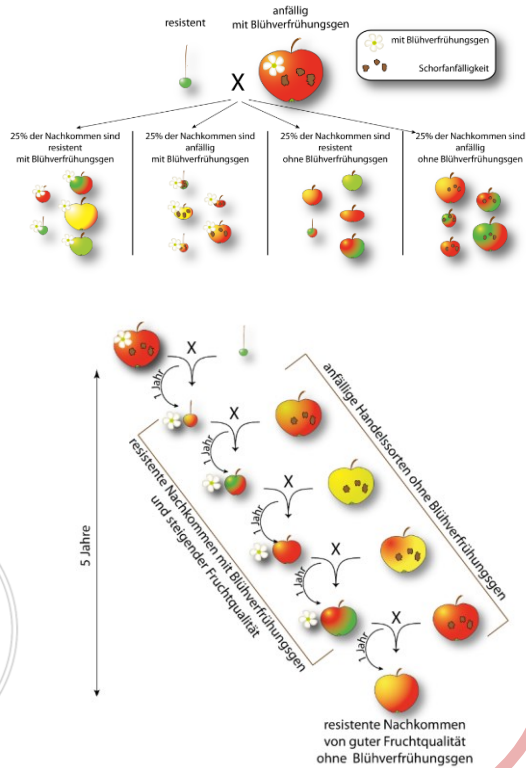
New breeding technologies as a solution for the future?

Accelerated Generation Cycle «Speed Breeding»

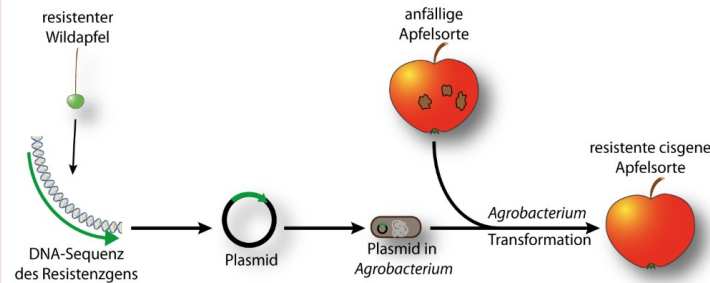
«Fast Track»



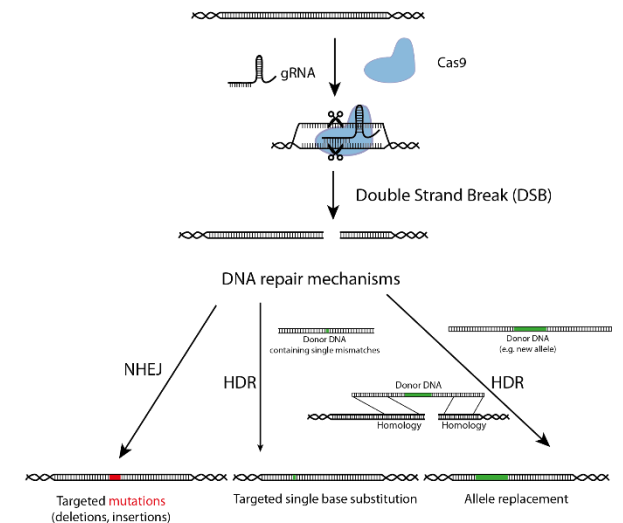
Early Flowering



Cisgenese



Genome Editing





Key Performance Indicators 2023

947 Full-time positions (FTE) with **1115** employees
of which **33** trainees, **37** interns, **62** doctorates, **43** postdocs

48% women

1444 publications
860 practice-oriented publications
584 scientific publications

1615 lectures and posters

109 supervised dissertations (number not definitive)

107 supervised semester, bachelor and master theses

1972 lessons (universities, technical colleges, vocational schools and courses)



Focus on Six Priorities

