EN

Versuchszentrum
Centro di Sperimentazione
Research Centre

LAIMBURG

NATURE & SCIENCE: HAND IN HAND

22-23

RESEARCH AND INNOVATION IN AGRICULTURE AND FOOD PROCESSING

LAIMBURG REPORT

AUTONOME PROVINZ BOZEN - SÜDTIROL
PROVINCIA AUTONOMA DI BOLZANO - ALTO ADIGE
PROVINZIA AUTONOMA DE BULSAN - SÜDTIROL

INDEX

Dear Readers,

It is a great pleasure for me to be able to present the new edition of Laimburg Report to you. This edition arrives at a time when the importance of sustainable agricultural practices and the quality of and appreciation for our agricultural produce are coming increasingly to the fore.

In the last two years, the research at Laimburg Research Centre has made significant advances, with the clear goal of improving the quality and sustainability of the produce from our region.

Increasing the value of our agricultural produce is a central pillar of our policies. We work to ensure that the fruits of the labour of our farmers are recognised not only in South Tyrol, but beyond.

The research and experimental activities at Laimburg Research Centre form the foundation for this. It generates well-founded and practical knowledge and drives innovation so that our agricultural and food processing sector companies can remain competitive and be preserved.

The activity programme of the Research Centre is developed every year in collaboration with all of the sector's main stakeholders. The involvement of over 130 representative organisations from the South Tyrolean agricultural and food processing industries in the creation of the activity programme guarantees a participative approach and ensures that the research is directly tailored to the real needs of farmers and producers. This results in practical and directly applicable solutions.

The regular exchange of knowledge with stakeholders promotes a joint development of innovative approaches and guarantees that the research findings are broadly accepted and can be quickly and effectively implemented. This close cooperation not only strengthens the regional economy, but also ensures the long-term relevance of the research initiatives, which underlines our commitment to a forward-looking and resilient agricultural industry.

Our aim for the coming years is to continue to invest in research and development and thus help agriculture in South Tyrol to face the challenges of the future.

I invite you to read this report and form a picture of the accomplishments and challenges for yourself. Your support and commitment are crucial for us to be able to achieve our aims and place our agricultural production on a sustainable footing for the future.

Best regards,
Provincial Councillor Luis Walcher

Dear Readers,

The global challenge of "producing more with less" aims to bring about a sustainable intensification of agriculture, since by 2050 it will be necessary to feed nine billion people. In Europe, the number of chemical ingredients permitted for plant protection is gradually being reduced, with increasing reliance on safer substances. Added to this scenario are the effects of climate change, the emergence of new invasive pests and the growing consumer awareness for sustainably produced food.

Laimburg Research Centre uses applied research to promote precision treatments and **biological pest control** and is exploring the development of resistant and resilient plant varieties in agriculture. For example, tests are carried out with **entomopathogenic microorganisms** such as fungi that specifically target pests. Other research work, some of which is funded by the European Union, is concerned with the use of parasitoids, such as the samurai wasp to combat the **brown marmorated stink bug**. Our research activities with semiochemicals, that is, substances that control the communication between organisms, includes the investigation of pheromones. These substances, which have already been used to biologically control the **codling moth**, have a great potential for influencing the behaviour of insects and preventing pests in orchards and vineyards. The latest "omics" technologies, such as genomics and metabolomics, will increasingly contribute towards identifying new substances for the development of sustainable biological control methods.

To give additional impetus to these topics, Laimburg Research Centre has expanded its **research capacity in the Institute for Plant Health**. In the process, the new the new Research Area Pests and Plant Diseases and three new working groups have been set up - "Natural Substances", "Biological Plant Protection Methods" and "Sustainable Cultivation Systems".

In the last two years, our research infrastructure has been extended - at the main site in Vadena, the new **Laboratory for Sensory Science**, and at the NOI Techpark in Bolzano, the **Laboratory of NMR Spectroscopy** have both been inaugurated. This has enabled us to expand our service offering for companies and tailored research services. Our aim is to support agricultural and food processing companies with experience and certified expert knowledge.

Modern technologies such as artificial intelligence and sensors will increasingly assist farmers to make informed decisions and reduce waste. Automation and the use of robots will bring about more targeted and efficient farming. **Digitalisation and precision agriculture** are fundamental developments that must be supported by research, especially in view of the urgent necessity of making more efficient use of environmental resources. Laimburg Research Centre places great value on this aspect and is engaged in innovative projects that follow the **"test-before-invest"** philosophy. This approach involves testing and evaluating technologies before they are rolled out more widely. This enables companies and organisations to make safe and strategic investments. The **LIDO - Laimburg Integrated Digital Orchard** infrastructure, which opened in 2022, is an outstanding example of this philosophy in practice. The outdoor laboratory for fruit and grape growing, which is situated in Vadena, covers one hectare and provides a platform on which companies, research institutions and start-ups are able to test advanced technologies in a real-life environment. The **FylloClip leaf sensor** is one of the innovations tested in the field by the experts at Laimburg Research Centre. This device detects water stress directly from the leaves of plants and enables early intervention to optimise irrigation.

The new Laimburg Report summarises our activities for the two-year period from 2022 to 2023. It contains many practical examples of our efforts to make the required knowledge and technologies available to companies and organisations, to help them overcome their day-to-day challenges and sustainably increase their productivity.

Enjoy your read!

Michael Oberhuber
Director of Laimburg Research Centre

OUR MISSION

Laimburg Research Centre was founded in 1975 as the first research institute in South Tyrol.

Through scientifically-substantiated experimentation and applied research, we develop know-how, solutions and pioneering innovations for the South Tyrolean agriculture and food industries.

We focus on the following crops: fruit and grape growing, vegetables, berries and stone fruit, herbs, arable crops, grassland management and horticulture. We develop sustainable cultivation strategies that preserve natural resources such as water, soil, biodiversity and the climate. Through a profound understanding of the biological interrelationships, breeding and testing of robust varieties and rootstocks, the needs-based use of plant protection products and the use of digital technologies, we promote sustainable and resilient cultivation systems.
Our purpose is to cover the entire food production chain, from cultivation through to the finished product. We develop innovative methods with which farms are able to produce food of assured quality and origin.

In order to add value to regional mountain produce, we support the diversity of high quality products from South Tyrol's mountain regions and work on developing a circular economy in the region.
In our specialised laboratories, reliable analyses are carried out as services for private organisations as well as for our own research projects.

Our activity programme is discussed every year with representatives of South Tyrolean agriculture and the food processing industry. This ensures that our research programme is directly aligned with the specific needs of the industry. More about this on page 16.

Over 200 employees work on around 380 research and testing projects - both in our laboratories in Vadena and at the NOI Techpark as well as on the trial plots of the Provincial Property Agency, with which we maintain a historic and cooperative partnership.

FACTS 2023

384
RESEARCH PROJECTS AND ACTIVITIES

335
LECTURES

198
PUBLICATIONS

29.086
LABORATORY ANALYSES

23
CONTRACT RESEARCH PROJECTS FOR PRIVATE COMPANIES

343
GUIDED TOURS OF THE RESEARCH CENTRE

69
(JOINTLY) ORGANISED EVENTS

TIMELINE

Since 1962
Initial tests with lower tree forms and beginning of clone selection, varieties and rootstock trials in viticulture

1968
Establishment of the first research fields

1972–73
Construction of the experimental fruit storage facility

1975
Official founding of Laimburg Research Centre for Agriculture and Forestry, in accordance with Provincial Act Number 53, issued November 3rd 1975

1977–79
Rebuilding of Laimburg's former stable in order to create the first offices of the research centre

1978
Renovation of the farmhouse "Mair am Hof" in Teodone (Dietenheim) near Brunico (Bruneck) for experimentation in arable crop and grassland farming

1979
Opening of the Agricultural Chemistry Laboratory

1982
First trials for herb cultivation

1984
Establishment of the reference library

1986–89
Development of a mechanical-biological method for chafer control

1989–90
Construction of the stone cellar

1990
Construction of a field office in Oris (Eyrs) for research into vegetable growing, arable crops and grassland farming

1997
Beginning of Laimburg's apple variety breeding programme

2002
Opening of the Laboratory of Molecular Biology and establishment of the Gene Bank

2003
Accreditation of several laboratories of Laimburg Research Centre according to ISO 17025

2005
Fruit storage technology with a dynamically controlled atmosphere (DCA), developed at Laimburg Research Centre, is put into practice.

2011
Establishment of the Laboratory for Flavours and Metabolites

2014
Laimburg Research Centre takes on responsibility for coordinating the food sciences division of the NOI Techpark and the establishment of research facilities in the field of Food Technology.

2015
The South Tyrol provincial government adopts the "2016–2022 Action Plan for Research and Training in the areas of Mountain Agriculture and Food Sciences".

2016–17
Laimburg Research Centre is given a new statute and a new organisational structure.

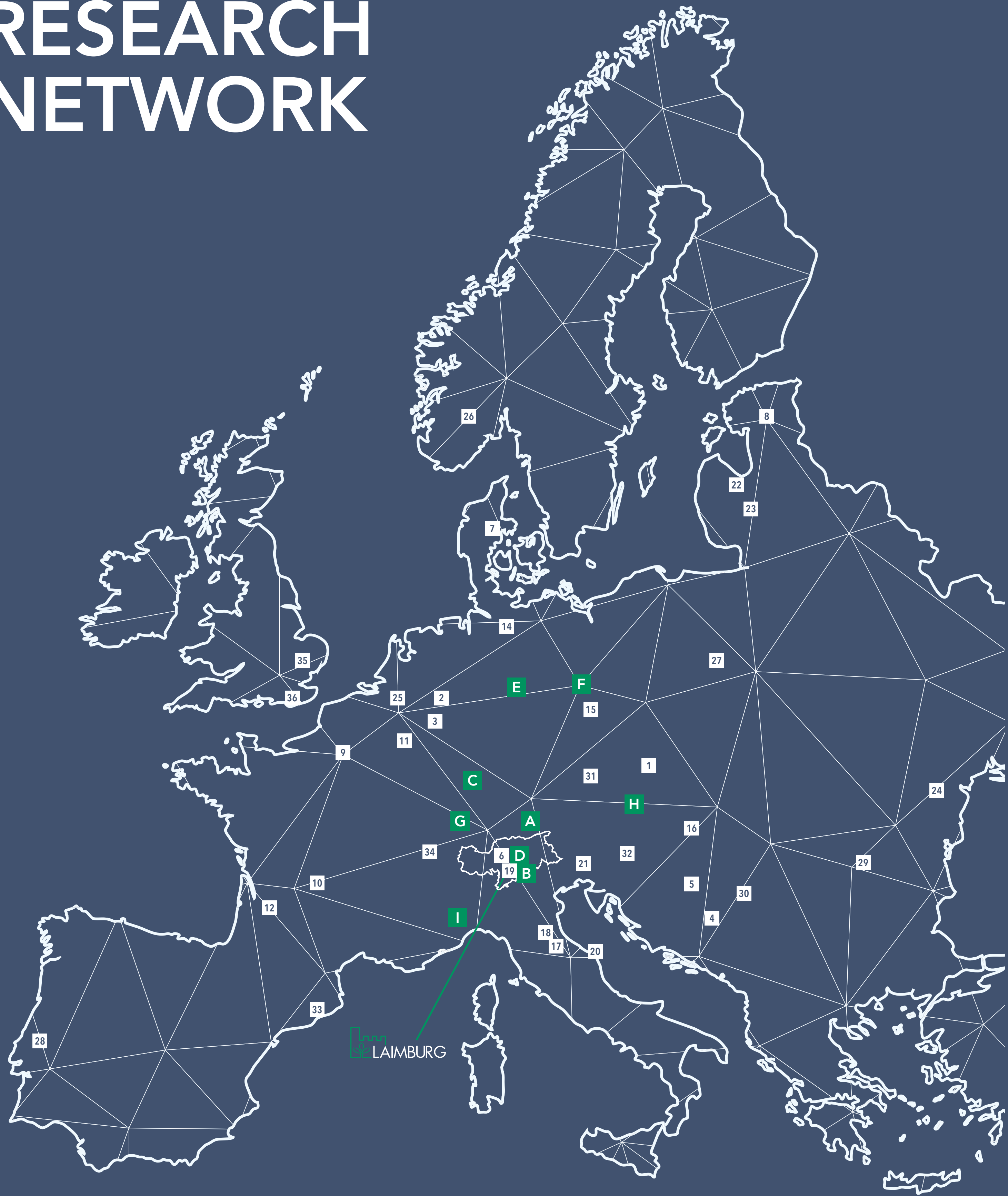
2018
Opening of the Laboratory of NMR Spectroscopy at the NOI Techpark in Bolzano

2019
The first breed numbers of Laimburg's apple variety breeding programme reach market readiness. Invitation to submit bids and award of exploitation rights.

2022
Start of the relocation of some facilities to the new Stadlhof building in Vadena

2023
Inauguration of the new Laboratory of NMR Spectroscopy at the NOI Techpark in Bolzano

THE RESEARCH NETWORK



RESEARCH PARTNERS OF LAIMBURG RESEARCH CENTRE IN SOUTH TYROL

Free University of Bolzano
Eurac Research
Fraunhofer Italia
Eco-Research GmbH
NOI Techpark

THE LAIMBURG RESEARCH CENTRE MAINTAINS GENERAL COOPERATION AGREEMENTS WITH:

- A University of Innsbruck (A)
- B Edmund Mach Foundation, San Michele all'Adige (TN)
- C Division 22 (Agriculture, Forestry and Home Economica Training) of the province government and the State Ministry for Rural Areas, Nutrition and Consumer Protection in Baden-Württemberg (D)
- D Free University of Bolzano
- E Julius Kühn Institute, Federal Research Centre for Cultivated Plants (D)
- F Swiss Federal Office for Agriculture (CH)
- G Research institute Agroscope Changins-Wädenswil (CH)
- H Klosterneuburg Federal Higher Institute and Federal Office for Winegrowing and Fruit Cultivation (Austria)
- I Agrion Foundation for Research, Innovation and Technical Development (Piedmont)

EUFRIN – EUROPEAN FRUIT RESEARCH INSTITUTES NETWORK

LAIMBURG RESEARCH CENTRE IS A MEMBER OF THE EUROPEAN FRUIT RESEARCH INSTITUTES NETWORK (35 EUROPEAN RESEARCH INSTITUTES).

1. Universität für Bodenkultur Wien, Institut für Obst- und Gartenbau; Wien, Austria
2. Research Center for Fruit npo (pcfruit npo); Sint-Truiden, Belgium
3. Unité d'Horticulture, Fac. Agronom. Sci., Dépt. Biotechnologie; Gembloux, Belgium
4. University Sarajewo, Faculty of Agriculture and Food Sciences; Sarajewo, Bosnia and Herzegovina
5. University of Banja Luka, Faculty of Agriculture; Banja Luka, Bosnia and Herzegovina
6. Cyprus University of Technology, Department of Agriculture Sciences, Biotechnology & Food Science; Lemesos, Cyprus
7. Aarhus University, Department of Food Science; Aarhus, Denmark
8. Estonian University of Life Sciences, Polli Horticultural Research Centre; Karksi Nuia, Estonia
9. Centre Technique Interprofessionnel des Fruits et Légumes (C.T.I.F.L.); Dép. Fruits et Technologie; Paris, France
10. Centre Technique Interprofessionnel des Fruits et Légumes (C.T.I.F.L.); Prigonrieux, France
11. INRA (Institut National de la Recherche Agronomique); Genetics and Fruit Breeding; Paris, France
12. INRA (Institut National de la Recherche Agronomique), Biologie du Fruit et Pathologie; Villenave d'Ornon Cedex, France
13. SRCA -Scientific-Research center of Agriculture; Tblisi, Georgia
14. ESTEBURG Fruit Growing Research Center; Jork, Germany
15. Julius Kühn-Institut, Institut für Züchtungsforschung an Obst; Dresden-Pillnitz, Germany
16. National Agricultural Research and Innovation Centre, Research Institute for Fruit Growing; Budapest, Hungary
17. Consiglio per la Ricerca e la Sperimentazione in Agricoltura (CRA), Unità di Ricerca per la Frutticoltura di Forlì, Fruit Tree Research Unit; Forlì, Italy
18. University of Bologna, Department of Agricultural Sciences; Bologna, Italy
19. Laimburg Research Centre; Ora-Auer, Italy
20. Università Politecnica delle Marche; Ancona, Italy
21. Università di Udine, Dept. Scienze agrarie e ambientali; Udine, Italy
22. Latvia University of Agriculture, Institute of Horticulture; Dobele, Latvia
23. Lithuanian Institute of Horticulture, Dept. of Horticulture Technologies; Babtai, Lithuania
24. Moldova Agrarian State University; Chi□inău, Moldova
25. Wageningen UR – Applied Plant Research – fruit; Zetten, the Netherlands
26. Norwegian Institute for Agricultural and Environmental Research, Bioforsk Ullensvang; Lofthus, Norway
27. Research Institute of Pomology; Skierniewice, Poland
28. Instituto Superior de Agronomia, Seccao de Horticultura; Lisboa, Portugal
29. University of Agronomic Sciences and Veterinary Medicine, Faculty of Horticulture; Bucureşti, Romania
30. University of Belgrade, Faculty of Agriculture; Belgrade, Serbia
31. National Agriculture and Food Centre –Research Institute of Plant Production; Pieštşany, Slovakia
32. Agricultural Institute of Slovenia, Department of Fruit Growing, Viticulture and Oenology; Ljubljana, Slovenia
33. Institut de Recerca i Tecnologia Agroalimentàries (IRTA); Catalonia, Spain
34. Agroscope; Wädenswil, Switzerland
35. University of Greenwich, Natural Resources Institute; Chatham Maritime, UK
36. NIAB East Malling; East Malling, UK

OUR RESEARCH PRIORITY PROGRAMME 2021-2030

Together with representatives of the South Tyrolean agriculture and food processing sector, Laimburg Research Centre has devised its own research priority programme for the period from 2021-2030.

The aim is to adapt to the consequences of climate change, to make sustainable use of natural resources, to diversify production and keep pace with digitalisation. The Research Centre has identified the challenges and burning questions for which its applied research can develop new solutions in order to equip agricultural and food processing businesses in South Tyrol for the future. Each focal area of research includes specific action areas, which Laimburg Research Centre puts into practice in its activity programmes with its own projects and activities.

Sustainable and Resilient Cultivation Systems

Unlocking nature's full potential:
We develop sustainable and demand-oriented cultivation techniques to protect and preserve resources and biodiversity, and to support agricultural businesses in the Alpine region.

Digital Innovation and Smart Technologies

Developing future-oriented cultivation and processing techniques:
We implement digitalisation and modern breeding technologies into actual practice.

Local Diversity and Circular Economy

Valorising regional mountain products:
We promote the diversity of high-quality mountain products and ensure that they are utilised in a (supra-)regional circular economy.

Quality and Health

Safe and healthy food products from South Tyrol:
We develop innovative methods which companies in South Tyrol can employ to produce food products of certified quality and origin.

Climate-Neutral Agriculture

Developing cultivation and processing methods that are more climate-friendly:
We develop agricultural practices with a smaller climate footprint and higher carbon capture rate, and we adapt cultivation methods to future climate conditions.

COORDINATION BETWEEN SCIENCE AND PRACTICE

This is how **Laimburg Research Centre** sets the priorities for its **Programme of activities**

Laimburg Research Centre carries out around 380 projects and activities every year. But who actually decides which topics will be addressed in the annual research programme?
The activity programme of the Research Centre is developed every year in late summer in collaboration with the Centre's stakeholders. Already in the following year, Laimburg Research Centre is thus able to solve concrete problems and concerns of the practice by conducting research and experimentation.

STEP 1

PROPOSALS FOR PROJECTS AND ACTIVITIES TO BE ADDRESSED

As an applied research institution, Laimburg Research Centre places particular importance on aligning its research activities with the requirements and specific problems of agricultural practice.
For this reason, every year the Research Centre invites over 130 representative organisations of the South Tyrolean agricultural and food processing sector to present their issues to research and to submit proposals for research projects. These external suggestions are collated and brought together with the internal project proposals that the scientists at the Research Centre have developed.

STEP 2

ADVISORY BOARD MEETINGS

Every year in late summer, the annual advisory board meetings are held at Laimburg Research Centre for each subject area that the Research Centre deals with.
In these meetings, the respective experts from the Research Centre and the local stakeholders of the South Tyrolean agricultural and food processing sector jointly discuss all of the proposals received for new research projects and activities. The proposals are assessed in terms of feasibility and prioritised.

A
- Projects and activities that the Research Centre is already conducting
- Currently suspended projects that are in urgent need of being continued
- Proposals that can be integrated into activities or projects that are already ongoing

B Proposals for new projects and activities that must be implemented, for example because they are intended for developing solutions to combat currently occurring agricultural pests.

C Proposals that may be worthy of implementation, but at the present time for various reasons (lack of finance, shortage of experimental fields, unavailability of basic knowledge, manpower shortages) cannot be put into practice.

D Proposals that cannot be implemented in this form or for which a separate research project is not necessary or meaningful.

Prioritisation of project proposals for the annual research programme

Advisory Board

Proposal	Priority
....	A
....	C
....	D
....	B
....	B

→ Scientific Advisory Board

Priority
A
B
D
B
C

→ presentation to the Provincial Councillor →

Proposal	Priority	
....	A	
....	B	realisable
....	B	
....	C	
....	D	not realisable

STEP 3

SCIENTIFIC ADVISORY BOARD

In autumn, the prioritisation undertaken in the advisory board meetings is presented to the scientific advisory board of the Research Centre for comment.

STEP 4

ACTIVITY PROGRAMME FINALISED

If the scientific advisory board approves the priorities established jointly in the initial meetings, the Director of the Research Centre draws up the activity programme for the following year and agrees it with the Provincial Councillor.
The agreed activity programme is then published on the website of the Research Centre.

THE 2024 ACTIVITY PROGRAMME

2024

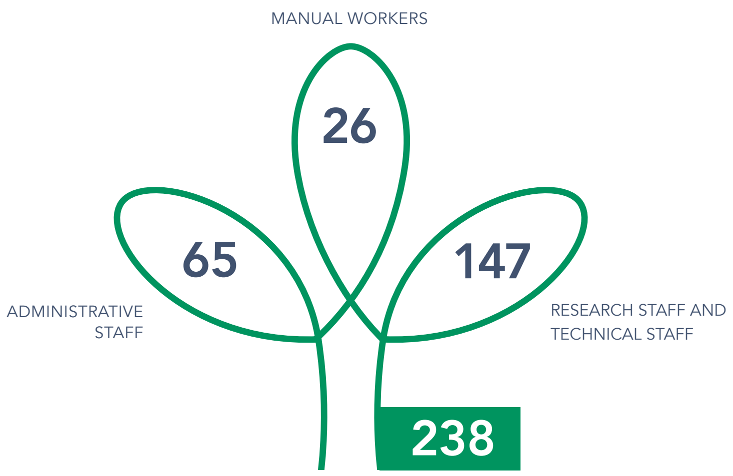
360
RESEARCH PROJECTS AND ACTIVITIES

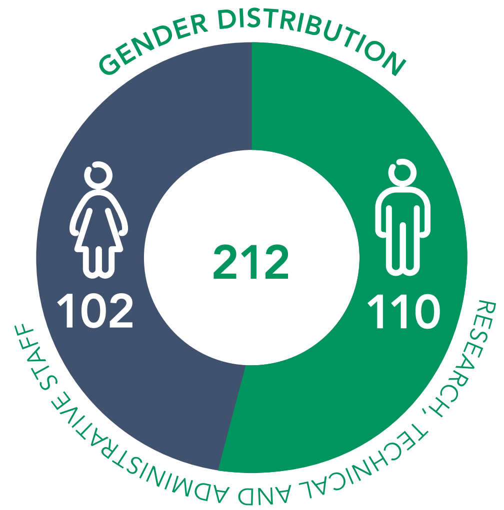
118
PROJECT PROPOSALS SUBMITTED BY THE STAKEHOLDERS

49
PROPOSALS INTEGRATED INTO ONGOING PROJECTS

35
NEW PROJECTS INITIATED

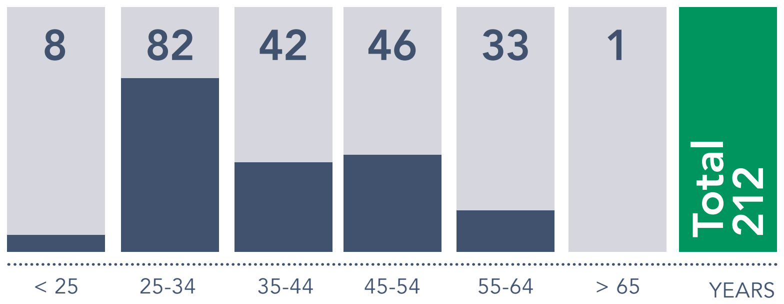
TEAM 2023

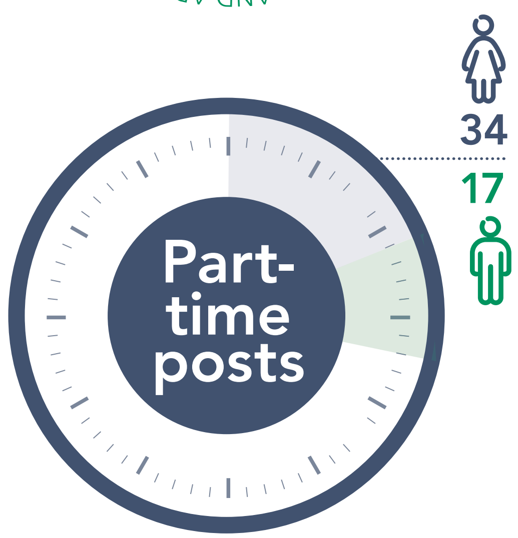




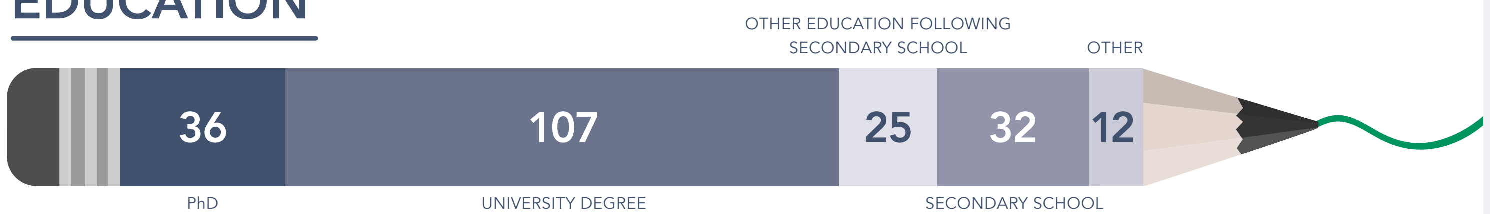
AGE DISTRIBUTION

(RESEARCH, TECHNICAL AND ADMINISTRATIVE STAFF)

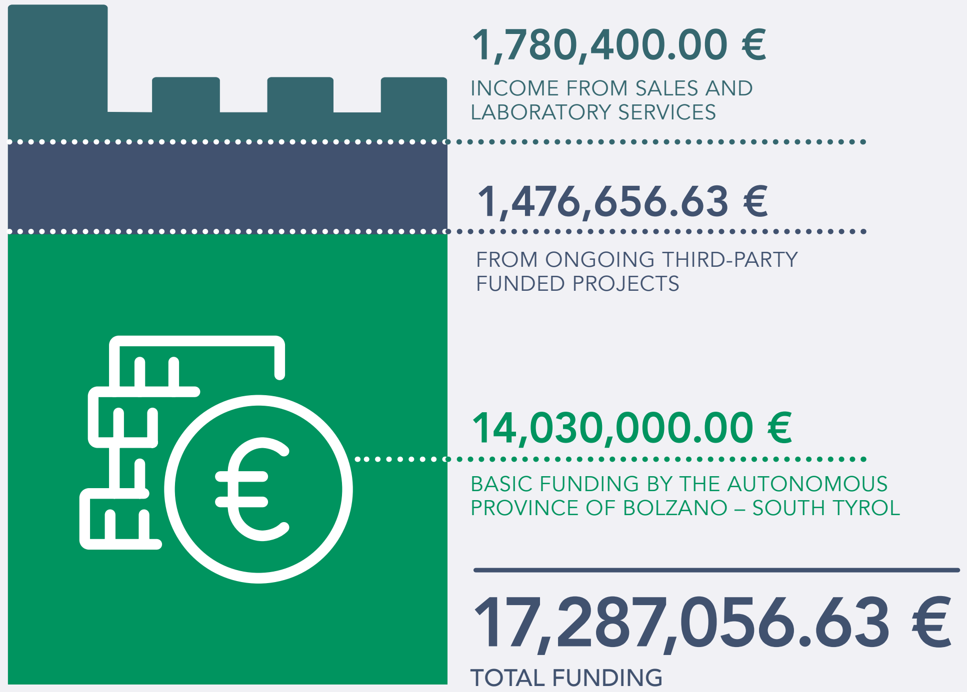




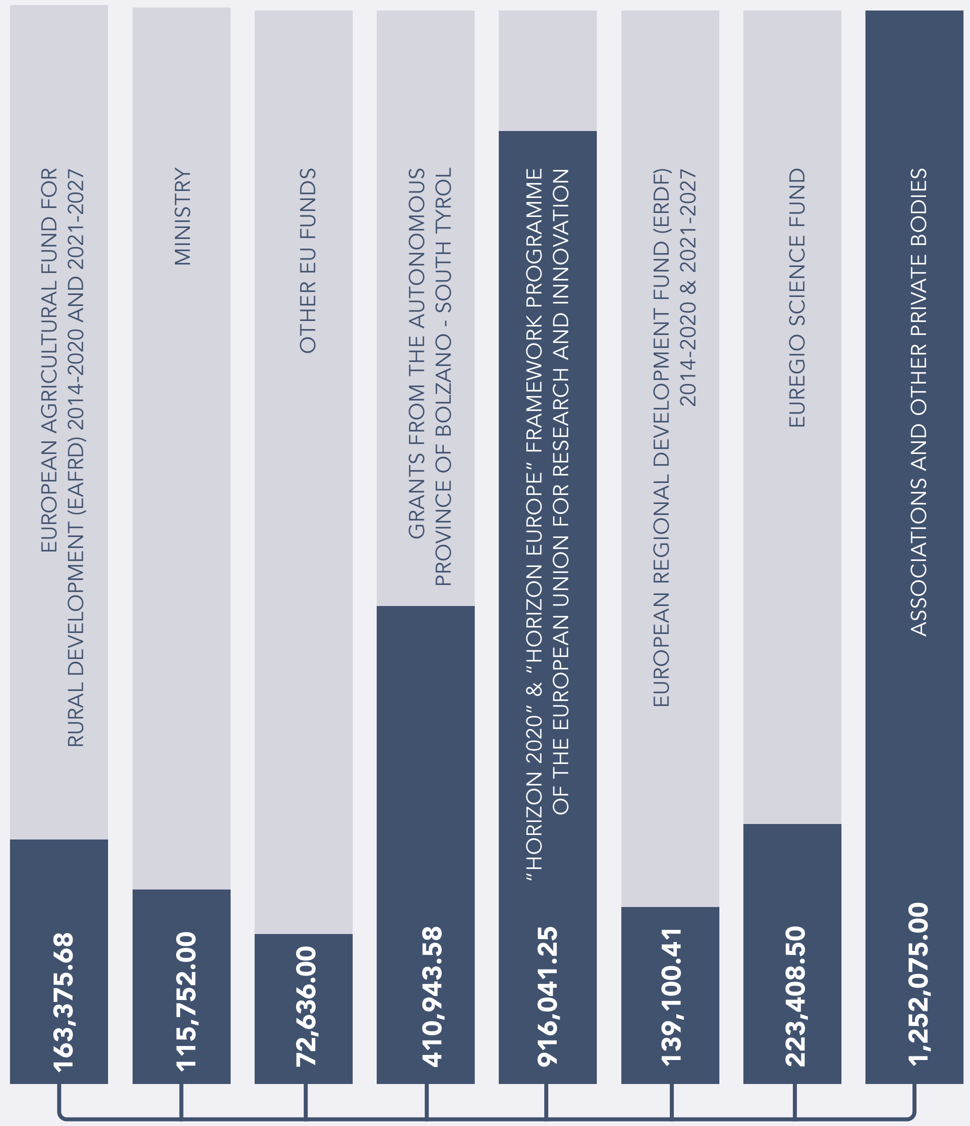
EDUCATION



FUNDING 2023



THIRD-PARTY FUNDS



3,293,332.42

Total budget of all in th year 2023 active third-party funded projects.

33

SUPERVISED THIRD-PARTY FUNDED PROJECTS
IN THE YEARS 2022-2023

35

PROJECT STAFF,
WHO WORKED AT LAIMBURG RESEARCH CENTRE IN THE YEAR 2023 AS PART OF THIRD-PARTY FUNDED PROJECTS

EU FINANCED AND CO-FINANCED PROJECTS

AppleBIOME – Microbiome and genome analysis in the apple gene bank to expand genetic resources for the breeding of resilient varieties

Funded by: MASAF – Joint FACCE-JPI SusCrop
Project duration: 03.2023 - 02.2026
Budget: €115,752

G4B – Grasslands for biodiversity: supporting the protection of species-rich grassland and appropriate cultivation methods in the Alps and the Carpathians

Funded by: Autonomous Province of Bolzano and co-financed by the European Union – Biodiversa+
Project duration: 04.2023 - 12.2025
Budget: €106,250

BIOFRUITNET – Boosting innovation in organic fruit production through stronger networks

Funded by: Horizon 2020
Project duration: 11.2019 - 04.2023
Budget: €148,625

REALISM – Regionalism and circular economy in foodstuffs for the prevention of metabolic syndrome

Funded by: Autonomous Province of Bolzano, Department of Research and Innovation (LG 14)
Project duration: 01.2022 - 12.2023
Budget: €125,812.50

Grazing4Agroecology – European network to promote grazing and to support grazing-based farms on their economic and ecological performance as well as on animal welfare

Funded by: Horizon Europe
Project duration: 09.2022 - 02.2026
Budget: €168,600

HAYMILK – Chemical markers in milk for the detection of added silage in feedstuffs for dairy cattle

Funded by: EFRE 2014-2020
Project duration: 01.2019 - 03.2022
Budget: €386,499.11

INNONutrients – Optimising regional organic nutrient cycles with the focus on alternatives to mineral fertiliser use in fruit and grape growing

Funded by: ELER 2014-2020
Project duration: 09.2022 - 03.2025
Budget: €119,616.19

INVITE – INnovations in plant VarIety Testing in Europe

Funded by: Horizon 2020
Project duration: 07.2019 - 06.2024
Budget: €108,398.75

LIDO – Establishment of a digital outdoor laboratory for fruit and grape cultivation

Funded by: EFRE 2014-2020
Project duration: 10.2020 - 11.2022
Budget: €620,791.75

OG INNOProducts – Product innovation as the foundation of successful agricultural direct marketing in South Tyrol

Funded by: ELER 2014-2020
Project duration: 07.2020 - 12.2023
Budget: €43,759.49

ResiTrac – Resilient food production with green tractors

Funded by: EIT Food
Project duration: 01.2023 - 12.2024
Budget: €67,636

SYMBIOSYST –From planning to implementation – finding new synergies where photovoltaics and agriculture can have a mutually beneficial relationship

Funded by: Horizon Europe
Project duration: 01.2023 - 12.2026
Budget: €202,562.50

HIPPA – Hyperspectral imaging for the detection of physiologically and parasitically-determined patterns of damage in apples during harvest and in the post-harvest period

Funded by: FESR-EFRE Cohesion Italy 21-27 South Tyrol, co-funded by the European Union
Project duration: 12.2023 - 11.2026
Budget: €139,100.41

SERVICES FOR COMPANIES

We can help your company put innovative ideas into practice with the help of scientific research

Laimburg Research Centre is the leading research institution for agriculture and food processing in South Tyrol. We also work directly with companies from these sectors to support them in their research and development projects and thus reinforce their competitiveness and innovative strength.
We offer a comprehensive range of research services that are tailored to the needs of our clients:

CONTRACT RESEARCH
(IN THE LABORATORY AND THE FIELD)

Would you like to implement your R&D objectives with the support of an experienced team of experts?

Laimburg Research Centre offers **contract research projects of various scopes in the form of standardised service packages**. Be it small projects or large, complex projects - we tailor our offering to the needs of the company.

For project funding, South Tyrolean companies and start-ups can apply to the Lab Bonus programme via the NOI Techpark Südtirol/Alto Adige. This will cover up to 65% of the costs incurred.

For more information, prices and contact details, visit our website or scan the QR code below.

MORE INFORMATION, CURRENT PRICE LIST AND CONTACTS

COOPERATION

We offer consulting and research services and charge value-for-money prices for private partners who are prepared to share the intellectual property of the project outcomes and to disseminate them in specialist journals and at conferences.

In addition, there are various financing options for co-operations between companies and research institutes such as provincial innovation grants in accordance with provicial law 14/2006, projects that are financed by the European Regional Development Fund (ERDF), Horizon Europe, EIC etc.

HERE ARE OUR STANDARDISED SERVICE PACKAGES FOR RESEARCH PROJECTS:

"CONSULTING" PACKAGE:

- Analysis of specialist scientific and technical literature and any data already gathered for a more in-depth understanding of the subject area
- Individual consultation in the planning of more complex research projects
- Preparation of an individual scientific and technical report

"SMALL" PACKAGE:

- Planning and execution of laboratory and/or field tests and studies
- Analysis or processing of a number of samples for small, short-term projects
- Preparation of an individual scientific and technical report

"MEDIUM" PACKAGE:

- Extension of the service offering included in the "small" package for medium size / duration research projects
- Increased number of samples and/or complexity of the equipment used to answer more detailed or extended research questions
- Preparation of an individual technical and scientific report

"LARGE" PACKAGE:

- Extension of the service offering included in the "medium" package for larger research projects of longer duration
- Increased number of samples and/or complexity of the equipment used to answer more detailed or extended research questions
- Preparation of a more detailed technical and scientific report

CUSTOMISED CONTRACT RESEARCH:

- Special agreement for contract research with an extension to the service offering included in the "large" package for large-scale, more complex and/or longer-lasting research projects
- Possibility of specifying the project activities and costs in detail
- Preparation of more detailed technical and scientific reports

OPEN LAB

Open Lab is a programme run by Laimburg Research Centre that is aimed at South Tyrolean companies and start-ups wishing to make use of the space and equipment offered by our laboratories. The Lab Bonus, which is available via NOI Techpark Südtirol/Alto Adige, can cover up to 65% of the costs for South Tyrolean companies for this service.

The option of using the following special laboratories is available:

- Laboratory of Flavours and Metabolites
  (at the NOI Techpark site)
- Laboratory of Food Microbiology
- Laboratory for Wine and Beverages Analysis
- Laboratory of Residues and Contaminants
- Laboratory for Soil and Plant Analysis
- Laboratory of Molecular Biology

LABORATORIES AND SERVICES

Laimburg Research Centre has several specialist laboratories that offer a broad range of laboratory analyses both for internal research projects and as a service for private organisations.

Experts from a multitude of different disciplines use their specialist knowledge and state-of-the-art laboratory equipment to seek answers to questions identified by the various stakeholders on the ground. They translate scientific findings from the laboratory into practicable applications and in the process support companies in their development. Accredited laboratory methods and constant development of the laboratory technology ensure analyses of the highest quality.

LABORATORY FOR FODDER ANALYSIS

The laboratory works on analysing the ingredients in hay, silage and concentrated feed in order to ensure balanced and performance-oriented nutrition for livestock. Alongside traditional wet-chemical analysis methods, the experts also work with Near Infra-Red Spectroscopy (NIRS), a non-destructive method that is used to quantitatively measure the ingredients in animal feeds.

Laboratory head: Evelyn Soini
Tel. +39 0471 969 559
Evelyn.Soini@laimburg.it

LABORATORY FOR SOIL AND PLANT ANALYSIS

The laboratory examines nutrients in farmland soils, plant material (leaves, buds, branches, roots etc.), fruits, horticultural soils/substrates, composts, organic fertilisers, farm manure, mineral fertilisers and irrigation water. These analyses are fundamental to ensuring an optimum supply of nutrients to plants. The recommendations derived from these analyses for targeted fertilisation make a significant contribution to successful and environmentally-friendly agriculture. Modern chemical analytical methods are used.

Accredited according to ISO/IEC 17025 since 2014

Laboratory head: Aldo Matteazzi
Tel. +39 0471 969 553
Aldo.Matteazzi@laimburg.it

LABORATORY FOR WINE AND BEVERAGES ANALYSIS

This laboratory examines a multitude of chemical parameters in wine, grape must and grapes. It is equipped, among other things, with an FT-IR (Fourier Transform-Infrared) machine that makes it possible to measure the most important parameters in very little time with minimal sample preparation; free sulphur and total sulphur can also be determined. Every year the laboratory prepares the maturation test for grapes, an important tool for growers and wine cellars for observing the progression of the maturation of grapes and determining the optimum harvesting point. In addition, the laboratory also conducts analyses of fruit juice, fruit wine, beer and spirits.

Accredited according to ISO/IEC 17025 since 2003 3

Laboratory head: Eva Überegger
Tel. +39 0471 969 585
Eva.Ueberegger@laimburg.it

LABORATORY OF MOLECULAR BIOLOGY

The genetic foundations for the cultivation of new varieties and for the emergence and/or prevention of plant diseases, for example apple proliferation disease, are explored in this laboratory. Using molecular biological, biochemical and bioinformatic methods, the experts identify factors that have an influence on this disease with the aim of developing innovative control strategies. The cultivation of apple and vine varieties is supported by the use of new technologies in the laboratory. Using molecular markers, seedlings can be selected whose genetic traits come closest to the cultivation aims. Furthermore, the laboratory offers variety proof of authenticity for apple and vine varieties and root stocks.

Laboratory head: Katrin Janik
Tel. +39 0471 969 518
Katrin.Janik@laimburg.it

LABORATORY OF VIROLOGY AND DIAGNOSTICS

This laboratory is concerned with diagnosing diseases in crops and ornamental plants that are caused by various pathogens such as bacteria, fungi, phytoplasmas, viruses and viroids. As part of statutory health controls, the experts conduct tests on propagation materials in fruit, wine, vegetable and ornamental plant cultivation. In addition, the laboratory is tasked with conducting phytopathological testing on behalf of the Plant Protection Service of the Autonomous Province of Bolzano. Microbiological, serological and/or molecular biological processes are used to identify pathogens.

Laboratory head: Yazmid Reyes Domínguez
Tel. +39 0471 969 641
Yazmid.Reyes-Dominguez@laimburg.it

LABORATORY OF RESIDUES AND CONTAMINANTS

In this laboratory, agricultural products are tested for residues of plant protection products. Using conventional extraction methods, the experts separate any residues of plant protection products that may be present (fungicides, insecticides, herbicides) from the samples, purify them and analyse them using suitable laboratory instruments based on mass spectrometry coupled with gas chromatography (GC-MS) or liquid chromatography (LC-MS).

Accredited according to ISO/IEC 17025 since 2011

Laboratory head: Andrea Lentola
Tel. +39 0471 969 569
Peter.Robatscher@laimburg.it

LABORATORY OF FLAVOURS AND METABOLITES

Using modern chemical methods, the experts analyse naturally occurring ingredients in agricultural products (apples, apple juices, grapes, wines, cheese, milk) and plant organs (leaves, roots, wood) to test their quality, characteristics and purity. The laboratory is equipped with state-of-the-art laboratory instruments such as GC-MS (gas chromatography coupled with mass spectrometry) and LC-MS (liquid chromatography coupled with mass spectrometry) and the most common analytical techniques. However, it also has high-resolution mass spectrometers for identifying new, unknown substances and a near-infrared device for non-destructive analyses.

The laboratory is located at the NOI Techpark in Bolzano Sud.

Laboratory head: Peter Robatscher
Tel. +39 0471 969 760
Peter.Robatscher@laimburg.it

LABORATORY OF FOOD MICROBIOLOGY

The microbial status of foodstuffs is characterised in this laboratory. The analyses used are based either on detecting and quantifying a certain microorganism or on identifying all of the germs in a foodstuff. The laboratory has relevant experience in characterising microorganisms in wine, beer and other fermented drinks. At present, the analyses are conducted using traditional microbiological methods and are supported by mass spectroscopy (MS)-based proteomics. In this connection, MALDI-TOF (Matrix-Assisted Laser Desorption Ionisation Time Of Flight) mass spectroscopy is of central importance. In future, the analyses offered will also be expanded to include other typical South Tyrolean products such as fruit, meat, milk and cheese.

Laboratory head: Andreas Putti
Tel. +39 0471 969 577
Andreas.Putti@laimburg.it

LABORATORY OF NMR SPECTROSCOPY

The Laboratory of NMR Spectroscopy deals with the qualitative and quantitative characterisation of small molecules and proteins in foods and plant parts using high-resolution nuclear magnetic resonance (NMR). The non-invasive and non-destructive NMR spectroscopy makes it possible to create a "fingerprint" of a molecule and to examine its structure and molecular dynamics. This technology can be used to test the authenticity, typicity and origin of local agricultural and food products and to clarify the chemical structure and function of unknown biological molecules.

The laboratory is located at the NOI Techpark in Bolzano Sud.

Laboratory head: Alberto Ceccon
Tel. +39 0471 969 753
Alberto.Ceccon@laimburg.it

OENOLOGY

The role of this department is to support the South Tyrolean wine industry with applied research and advice. As viticultural measures can influence the quality of the grapes, the experts examine the relationship between viticultural interventions and the flavour of the wines. This includes the variety-growing area studies and the testing of new vine clones in terms of the quality of the wine that they produce. It is important for the quality potential present in the grapes to be exploited to the greatest possible extent. To this end, tests are conducted in the trial cellars as to how best to optimise the wine ageing process. The objective is to improve in particular the typicity and mouth feel, but also the shelf life of the wines. For this purpose, many wines are matured, chemically analysed and subject to sensory testing by trained taster panels. Furthermore, oenological consulting and specialist training are offered.

Department Head Ulrich Pedri
Tel. +39 0471 969 624
Ulrich.Pedri@laimburg.it

FERMENTATION AND DISTILLATION

This working group is concerned with fermentation processes for the production and processing of foodstuffs as well as the testing of spirits, brandies and liqueurs. The aims of the research are to test and implement food technology processes involved in making primary products; the development and improvement of processing protocols for the production of fruit-based fermented beverages (cider), cereal-based beverages (beer) and honey-based beverages (mead). A further aim is to test the distillation process with particular attention being paid to the optimum separation of the heads and tails and on the assessment of the flavours during the distillation phase. Studies are also carried out to increase the added value of foods and experiments for the formulation of new fermented products and distillates.

Working Group leader: Lorenza Conterno
Tel. +39 0471 969 591
Lorenza.Conterno@laimburg.it

FRUIT AND VEGETABLE PROCESSING

This working group is interested in the processing of local fruit and vegetable varieties and concentrates on the development of innovative products as well as on optimising processing methods. It supports local producers with food technology know-how, in order to optimise the quality of traditional products and support the development of new processed products. To this end, the experts use pilot plants for homogenisation (including high pressure), for drying at low temperatures, for controlled instantaneous decompression and for the production of juices and purées. The chemical, physical and microbiological stability of foods are also tested as well as the thermo-physical and mechanical properties of the individual ingredients and the final products.

Working Group leader: Elena Venir
Tel. +39 0471 969 621
Elena.Venir@laimburg.it

LABORATORY FOR SENSORY SCIENCE

In the Laboratory for Sensory Science, foods are characterised using sensory and instrumental methods and consumer preferences are identified. To describe the characteristics that determine the quality of a foodstuff as accurately and objectively as possible, findings (appearance, smell, taste, mouth feel) from the sensory perception of trained testers are brought together with physical and chemical analyses and the results of consumer tests. The work of the laboratory concentrates on characterising the sensory quality and shelf life of products. In addition, the effects of innovative processing technologies in food production on the sensory characteristics of the products are tested. Sensory science plays an important part in product development, the quality assurance of foodstuffs and in market research.

Laboratory head: Elisa Maria Vanzo
Tel. +39 0471 969 682
Elisa-Maria.Vanzo@laimburg.it

MEAT PRODUCTS

The aim of this working group is to support the meat processing sector in South Tyrol with scientific research, to promote local products with innovations, to optimise processing methods and to develop new products. The experts seek to answer the question of how the quality of traditional South Tyrolean products can be preserved and further increased at the same time as complying with food industry rules.

Working Group leader: Elena Venir
Tel. +39 0471 969 621
Elena.Venir@laimburg.it

LIDO – LAIMBURG INTEGRATED DIGITAL ORCHARD

Automated irrigation and fertilisation systems, innovative plant management methods, the integration of sensor technologies, stationary application of plant protection products and advanced forecasting models and decision-making systems are integral parts of LIDO - Laimburg Integrated Digital Orchard. The aim of the smart and sustainable outdoor laboratory of Laimburg Research Centre is to advance innovation in the field of digitalisation and robotics in agriculture. LIDO is available to companies and research institutions in order to test existing and new technologies under real outdoor conditions and to demonstrate them to the public.

There are two of these high-tech laboratories at Laimburg Research Centre: the digitalised apple orchard is 0.65 hectares in size and is located in the valley bottom. The late-ripening variety, Rosy Glow Pink Lady® is planted in orderly rows here to ensure that the data collection period is as long as possible. The apple trees were grown using the Guyot production system with multiple leaders, which is considered to be robot-friendly. A buffer zone providing a habitat for various species of flora and fauna has a place here too. The outdoor laboratory for viticulture is located in a 0.4 hectare vineyard with terraces and a gradient of 70 per cent. The Chardonnay variety thrives here using the Guyot cultivation system. There is a 24 m2 office space on site where the various processes are monitored and remotely controlled. The data obtained are fed into a cloud-based management system.

LIDO was financed by the European Regional Development Fund (ERDF 2014–2020, "Investments in Growth and Employment").

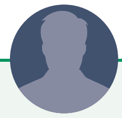
LIDO WEBSITE

LIDO IMAGE FILM

LIDO
LAIMBURG INTEGRATED DIGITAL ORCHARD

REPORTS FROM THE INSTITUTES

CHANGES IN THE RIPENING DEVELOPMENT OF THE GRAPES

Barbara Raifer
Viticulture Department

Andreas Sölva
Laboratory for Wine and Beverage Analysis

Nowadays, in many years the grape harvest takes place considerably earlier than it did decades ago, the sugar content of the musts is higher and the acidity values lower. But just how big are these changes actually? To answer this question, we evaluated the ripening data recorded in multiple locations every year since 1985 for the most important varieties. The data come from ripening tests conducted every Monday in the weeks before harvest following a standard procedure in selected vineyards and processed and analysed in the Laboratory for Wine and Beverage Analysis at Laimburg Research Centre using standard methods.

HIGHER SUGAR CONTENT SHOWS LOW IMPACT ON OVERALL ACIDITY: THE EXAMPLE OF PINOT BLANC IN APPIANO MONTE

In the years before the millennium, the sugar content on 1 September was between 8 and 14 °KMW, whilst after the millennium it was considerably higher at between around 13 and almost 19 °KMW (Fig. 1). In many years in the last two decades, very high sugar contents of around 19 to 20 °KMW were reached, mostly in the first half of September. Before the millennium, this was only very rarely the case.
In terms of overall acidity, the picture is somewhat different. Whilst in the past, before 1 September the values still differed widely, they continued to converge with increasing ripeness (Fig. 2). Overall the acidity values after the millennium did not drop off as significantly as might have been expected due to the increase in sugar content. Rather, the overall acidity, with the same sugar levels, always tended to be higher after the year 2000 (Fig. 3) than in previous years.
In the case of the pH values, there was a similar picture to the overall acidity. Whilst the values on 1 September may have been considerably higher than before in the years after the turn of the millennium due to the higher overall ripeness, towards the end of the ripening period close to harvest they only achieved higher values than previously in a few very warm years. The year 2003 is still an exception with regard to the strikingly high pH values of the musts.

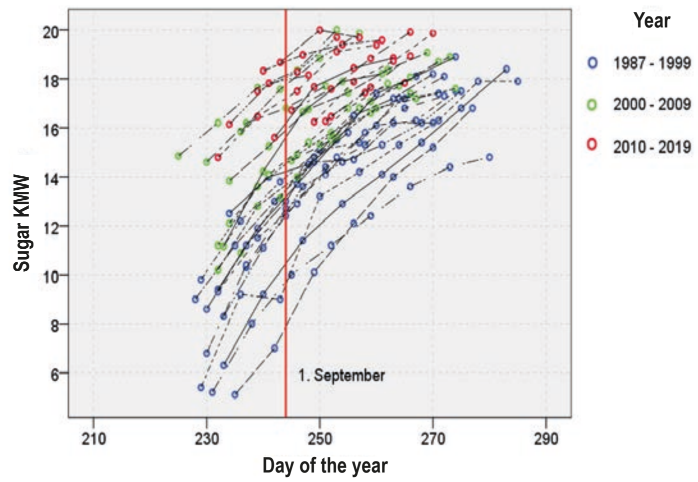


Fig. 1. Must sugar contents of the Pinot Blanc variety in the Appiano Monte vineyard from 1985-2019.

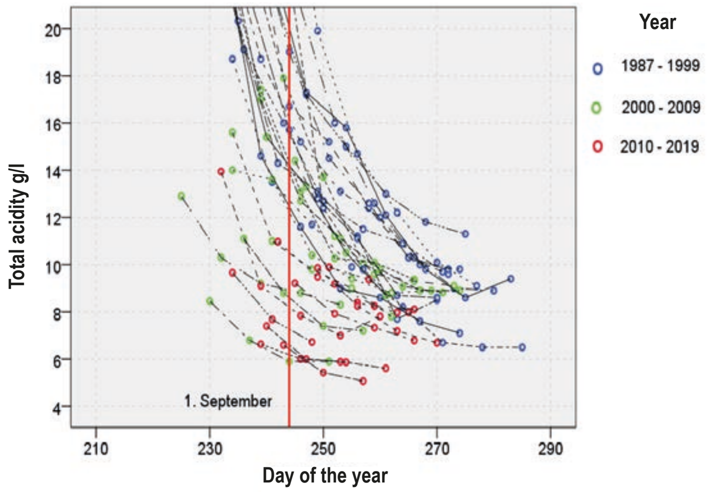


Fig. 2. Overall must acidity contents of the Pinot Blanc variety in the Appiano Monte vineyard from 1985-2019.

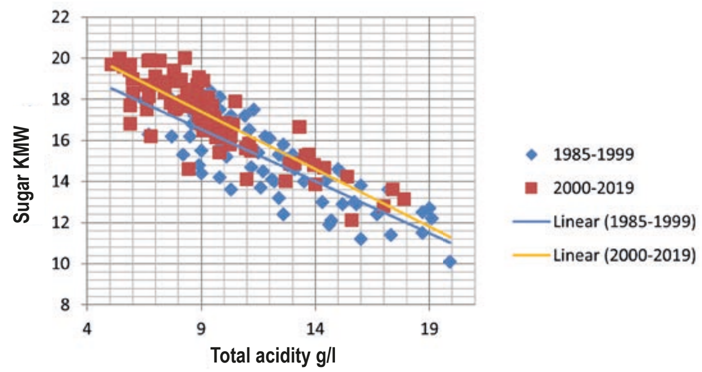


Fig. 3. Relationship between the must sugar contents and the overall must acidity values of the Pinot Blanc variety in the Appiano Monte vineyard from 1985-2019.

Fig. 4. Pinot Blanc variety

CONCLUSION

The changes found cannot solely be attributed to climate change. A number of things have changed in recent decades due to the efforts made by the South Tyrolean wine industry to improve the quality of its wines, for example in terms of cultivation systems, targeted yields, and varieties and clones, among other things. The extent to which these changes in cultivation practices may also have had an impact on ripening developments cannot be defined using the available data.

A comprehensive evaluation of ripening data can be found in the Laimburg Journal:

GRAPE MATURITY EVALUATION

VALIDATION OF DIGITAL SYSTEMS FOR PREDICTING YIELD AND FRUIT SIZE

Elias Holzknecht, Walter Guerra
Pomology Working Group

Christian Andergassen, Daniel Pichler
Physiology Working Group

Predicting economically-relevant variables plays an important role in apple production. Manual yield estimations are usually labour-intensive, time-consuming, financially costly and frequently return inaccurate results. Modern image recognition systems and Artificial Intelligence could be used to quickly forecast yield and fruit size distribution. With the data gathered, targeted cultivation measures could be optimised and resources saved. Particular challenges faced by such systems include being able to detect the fruit and count concealed fruits as well as poor light conditions. Many new applications are entering the market, making it important to test their results for accuracy and reproducibility, which Laimburg Research Centre has been doing since 2018.

TESTING OF FOUR COMMERCIALLY AVAILABLE SYSTEMS

Three yield determination systems were tested: Intelligent Fruit Vision, Perfrutto and Pixofarm. Additionally, the Clarifruit application was also tested to determine the size class distribution and quality of the fruit after harvesting in bulk bins. The various systems were each tested for one to two seasons between 2018 and 2021 with different varieties. The Intelligent Fruit Vision camera system was mounted on a tractor and tested at a speed of 8 km/h. In the case of Perfrutto, the data, which were collected with a calliper, were processed by HkConsulting and size class distribution forecasts produced. The Pixofarm and Clarifruit applications were installed on a smartphone, with a sticker on the fruit or a table tennis ball in the bulk bin serving as a reference for the measurements. When determining the size distribution, the data were compared with the sorting results or the effective diameter was determined on site using a digital calliper.

DISCREPANCIES WITH ALL TESTED SYSTEMS

All of the yield prediction systems tested showed discrepancies of up to 29%. The discrepancies differed depending on the location and also between the different varieties.
With Intelligent Fruit Vision there were discrepancies ranging from 2% (Cripps Pink Pink Lady®) to 29% (2018 with Gala) per linear metre. Almost every time that the fruits were quantified, too few fruits were counted. Different discrepancies were also identified between the varieties, which may be attributable to their differing growth types. It was also observed that as the harvesting date approached, there was a closer agreement with the values measured manually (Fig. 2).
In the case of the Perfrutto system that was tested, the measurements were taken manually using a calliper. In comparison with the Intelligent Fruit Vision system, smaller fluctuations in deviation were noted in all locations. For example, in the case of the Golden Delicious and Cripps Pink Pink Lady® varieties, the discrepancy was less than 10%, which can still be tolerated in line with the users' requirements. In the case of Gala, in contrast, discrepancies of over 10% were observed. From August onwards, the average discrepancy in the overall distribution was below 10%, irrespective of the variety and location. Across all varieties and locations, on average the largest differences were noted at a diameter of 70-80 mm.
The Pixofarm application, which was installed on a smartphone, showed large discrepancies between the diameters recorded by the application and those measured by the calliper. The maximum difference across all data collection dates in the case of Cripps Pink Pink Lady® was 8.5 mm, whilst the smallest, in contrast, was -0.8 mm. As the outline of the fruits was not detected, up to 38% of the diameters recorded had to be manually corrected. The uneven light conditions during the measurement process might be primarily responsible for this, with no difference being ascertained between fruits in the light and those in the shade. Furthermore, the amount of time needed for exposing hidden fruits, attaching stickers to the fruits (Fig. 1) and correcting the diameters, should not be underestimated.
In the case of the Clarifruit application, overall there were only small discrepancies. Discrepancies of up to 9% were identified by scanning the same bulk bin multiple times. The comparison of the results from the application with the results of manual sorting, in contrast, only showed very low average differences of 1%. It was also striking that particularly in the case of larger calibres, discrepancies occurred more frequently than with smaller ones.

Fig. 1: Sticker as reference point for determining fruit size by Pixofarm

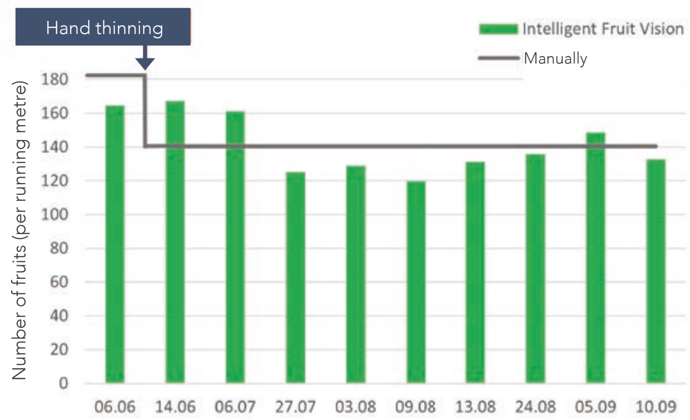
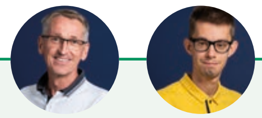


Fig. 2: Number of Golden Delicious variety fruits per linear metre (2018), detected by the Intelligent Fruit Vision system. The grey line represents the number of fruits detected manually.

CONCLUSION AND OUTLOOK

Some applications and systems already provide relatively accurate predictions. However, the majority of the systems tested still featured excessive discrepancies. The time taken to record the data was often greater than that taken for manual measurements using callipers. The results from the callipers were usually more accurate than those of the systems being tested. For this reason, the technologies and especially object and image recognition must be developed and improved.

TESTING OF APRICOT VARIETIES FOR SUCCESSFUL CULTIVATION IN THE VENOSTA VALLEY



Massimo Zago, Michael Gasser
Berries and Stonefruit Working Group

The apricot growing areas in the Venosta Valley cover around 70 hectares and in recent years have remained relatively constant. With a share of 55 per cent, the local variety, "Vinschger Marille" (Fig. 1) holds the leading position in the range of varieties grown and is largely marketed in the region. Due to its short shelf life, the „Vinschger Marille" apricot has to be brought to market within a very short time after harvesting. In high-yielding years this leads to local over-saturation of the market. Furthermore, the consumption of this fruit drops sharply after the middle of August, which means that selling the Venosta Valley apricots from the growing areas at higher altitude that ripen later due to natural delays in reaching maturity is further complicated in some years. To counteract this, it is essential to grow a targeted and location-dependent choice of variety.

OVER 70 VARIETIES TESTED TO THE PRESENT DAY

In 2016, the first new international apricot varieties were planted in triplicate at the Kühsteinhof (Tomberg, Castelbello-Ciardes, 700 m a.s.l.) on the standard rootstock, St. Julien 'A'; many more varieties were added each year. To test the varieties' suitability for cultivation, yield, fruit size, shape and colour, phenological characteristics, fertilisation compatibility, ripening time/harvesting window and different qualitative characteristics were all recorded.

In recent years, over 70 different varieties have been harvested and evaluated in the trial location from mid-June to the end of July (Fig. 2). Alongside different ripening times, there were stark differences in terms of colour. This characteristic made it possible to categorise the varieties of apricots into five colour classes (Fig. 3). For example, the colour class 1 'Vinschger' variety (light yellow base colour) contrasts with the 'Luxared' and 'Rubista' varieties, which are both colour class 5 (red base colour). In between are varieties with an orange base colour (colour class 2), a light red cheek (colour class 3) or a predominantly red body colour (colour class 4; see photos). Dividing the fruit up into colour classes makes it easier to select varieties with regard to marketing opportunities. Moreover, in terms of fruit size, there were also significant differences between the varieties. For example, the 'Monstercot' and 'Luxared' varieties, at almost 90 g per fruit, reach a considerable size, whilst the 'Pieve', 'Visalia' and 'Bergeval' varieties, at almost 35 g per fruit, belong to the group of smaller-fruiting varieties.

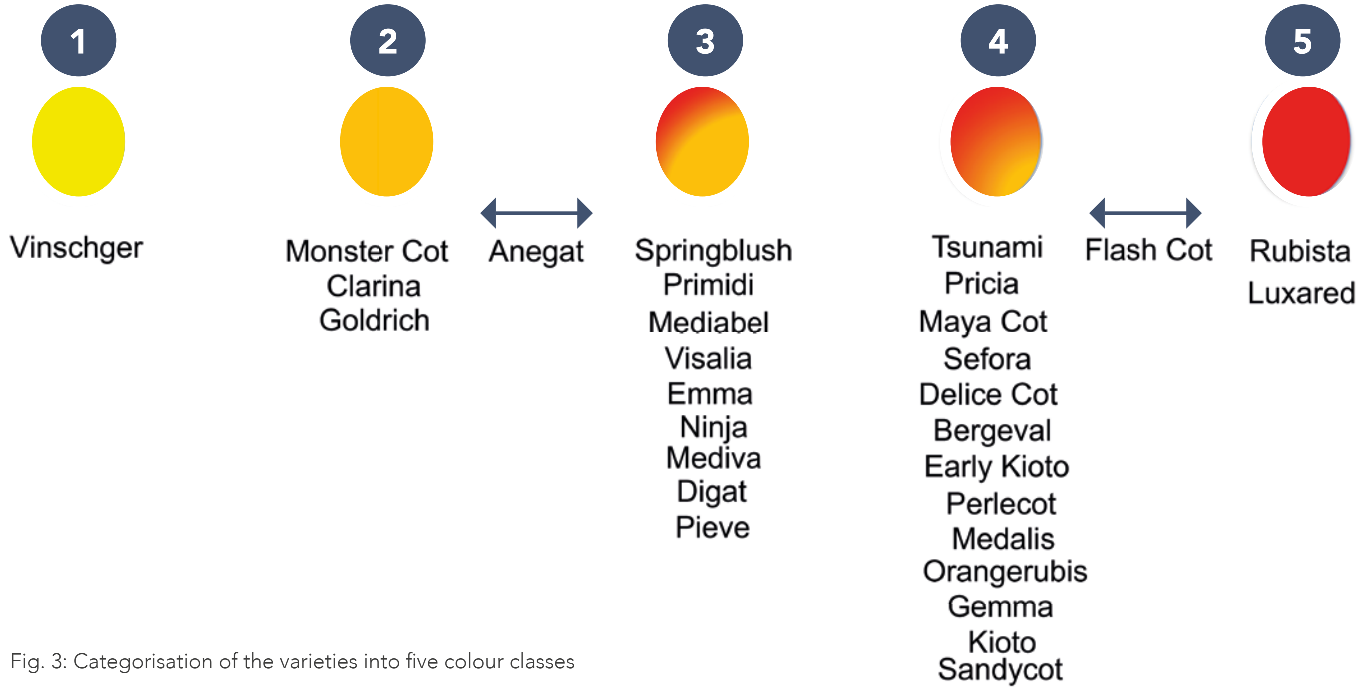


Fig. 3: Categorisation of the varieties into five colour classes

Vinschger	2016	Anegat	2017	Primidi	2017
Clarina	2016	Bergeval	2017	Rubista	2017
Early Kioto	2016	Delice Cot	2017	Samourai	2017
Emma	2016	Digat	2017	Sandycot	2017
Faralia	2016	Farbaly	2017	Tsunami	2017
Flavorcot	2016	Farbela	2017	Luxared	2019
Gemma	2016	Flash Cot	2017	Maya Cot	2019
Goldrich	2016	Koolgat	2017	Sefora	2019
Hilde	2016	Lady Cot	2017	Swigold	2019
Kioto	2016	Medalis	2017	Swired	2019
Maya	2016	Mediabel	2017	Vanilla Cot	2019
Mino	2016	Mediva	2017	Visalia	2019
Orangerubis	2016	Monster Cot	2017	Sushi	2020
Pieve	2016	Ninja	2017	Tornado	2020
Springblush	2016	Perlecot	2017	Banzai	2020
		Pricia	2017		

Fig. 2: Range of apricots at the Tomberg, ordered by planting year

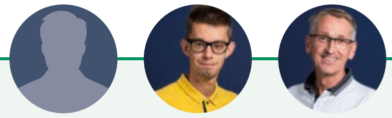
Fig. 4: Typical colouring of the 'Sefora' variety

Fig. 1: 'Vinschger Marille' apricot ready for picking

CONCLUSION AND OUTLOOK

The following varieties received an overall positive evaluation and passed on to the second stage of selection: From the early varieties, 'Pricia', 'Spring Blush' and 'Tsunami' were judged positively due to their outstanding fruit characteristics. The 'Sefora' (Fig. 4), 'Orange Rubis', 'Flash Cot' and 'Clarina' varieties produced excellent results among the mid-to-late ripening varieties. These varieties will in future be planted in larger numbers at a range of locations in the Venosta Valley and assessed in more detail in the near future.

EVALUATION OF DIFFERENT PLANTING DENSITIES IN STRAWBERRY CULTIVATION



Sebastian Soppelsa, Michael Gasser, Massimo Zago
Berries and Stonefruit Working Group

Increasing added value is a constant challenge faced by strawberry growers if they are to survive in a highly-competitive environment. In this connection, planting density and its influence on agronomic and economic parameters plays a vital role. The aim of a two-year study was to investigate the influence of planting density on plant growth and yield in order to determine operating profits. To this end, "Elsanta" variety strawberry plants were planted in banked rows at the Martello trial plots with five different planting densities (30,000, 45,000, 60,000, 90,000 and 100,000 plants per hectare) and evaluated during the following two years from agronomic and economic perspectives (Fig. 1).

PROMISING RESULTS

The results of the trial showed that the surface biomass of the plants with a low planting density increased by 50% at the end of the first year and doubled in the second year (Fig. 2). The low yields in the case of those plants grown with a high planting density can be attributed on the one hand to the lower fruit size and on the other to a smaller number of flowers (Fig. 3). Although the highest plant yield was achieved with low and medium planting densities, the highest yields per hectare were achieved with 90,000 or 100,000 plants per hectare (Fig. 4). Nevertheless, the cost (especially for plants, planting work and harvesting) has to be taken into account; in the case of higher planting densities these are higher in comparison with the other trial variants. In relation to quality, fruits grown at lower planting densities have a significantly higher colour index, that is, more red colouring, than fruits from more densely grown plants.

Fig. 2: Biomass development

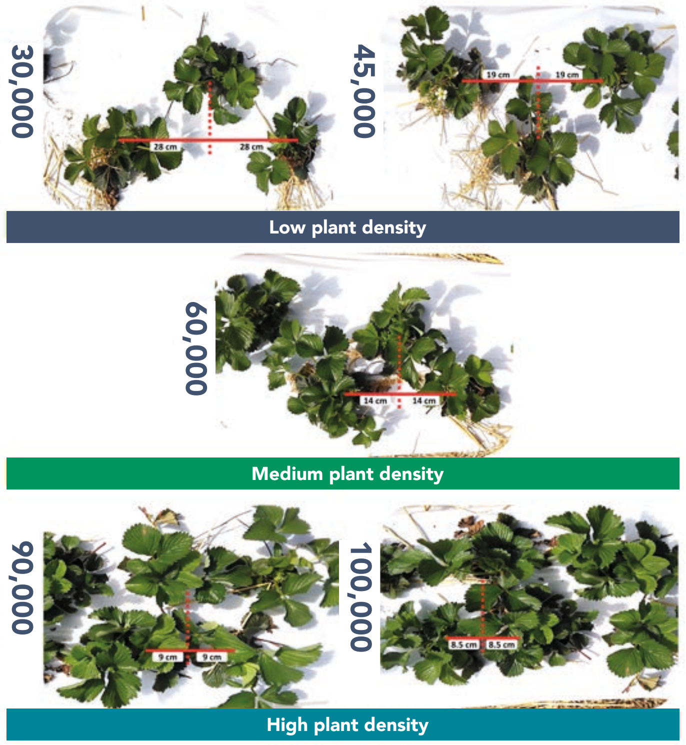


Fig. 1: A comparison of different planting densities

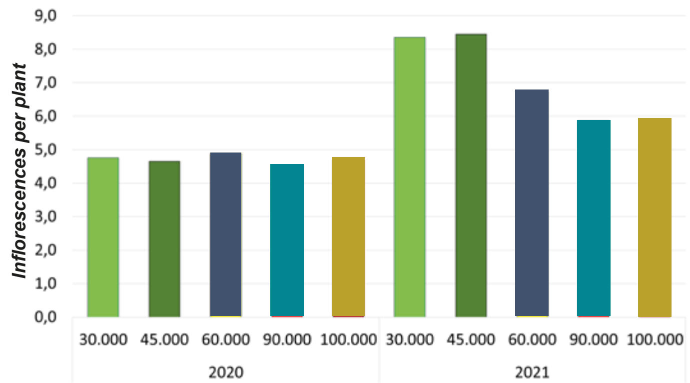


Fig. 3: Number of inflorescences per plant (2020 and 2021)

Plants per ha	Grade 1	Grade 2	Total yield
30.000	789.2	184.1	973.3
45.000	673.9	175.3	849.2
60.000	533.5	180.1	713.6
90.000	465.3	156.5	621.8
100.000	423.5	130.1	553.6

Fig. 4: Cumulative yield in g per plant (total of the years 2020 and 2021)

CONCLUSION

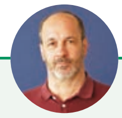
Selecting the right planting density can increase yields and optimise operating profits. Based on the trial results, it is possible to make the following recommendations:

- A planting density of 100,000 plants per hectare should not be exceeded, as this entails economic disadvantages.
- It is advisable to select low or medium planting densities in order to promote a more sustainable cultivation of strawberries (the susceptibility to powdery mildew is lower with decreasing planting density).
- In the case of lower planting densities, the harvesting times must be planned carefully in order to avoid a higher proportion of overripe fruits due to the faster ripening time.
- A lower number of plants reduces the overall costs, but can increase the business risks, e.g. due to plant losses caused by crown and root rot or production losses caused by the strawberry blossom weevil, *Anthonomus rubi*.

In summary, the results indicate that a medium planting density ensures strong plant growth, a satisfactory yield and sustainable operating profits.

CULTIVATION VALUE OF THE PINOT NOIR MASS SELECTION "FINS"

Josef Terleth
Grapevine Varieties and Propagation Material Working Group



Ulrich Pedri
Vinification and Viticultural Issues Working Group

The Pinot Noir variety is still an up-and-coming variety in South Tyrol. In 2023 it achieved a cultivation area of 568 hectares, which equates to a proportion of 9.87% of the total winegrowing area. This makes Pinot Noir the most-cultivated red wine variety in South Tyrol today.
Due to its importance, in recent decades Laimburg Research Centre has consistently tested Pinot Noir clones for their suitability for cultivation. In the last few years, in addition to the clones, what are known as "mass selections" of this variety have also often been promoted. The main difference between a clone and a mass selection is the fact that clones emerge from a single vine, whereas mass selection involves several "starter vines" with similar characteristics. The mixture of these starter vines should enhance variety and biodiversity in the vineyard as well as lending the wine greater complexity.

COMPARISON BETWEEN CLONING AND MASS SELECTION

To test the proposition, in 2018 a comparison was set up in the Caldaro location of Trifall. In addition to the "ATVB fins" selection, the two French quality clones "ENTAV 828" and "ENTAV 943" were planted (Fig. 3-5). Above all, there were large differences in the grape cluster shape. Whilst clone 828 was striking for its regular, compact and large clusters, clone 943 proved to be somewhat more irregular with smaller clusters which also tended to have mixed berries. The "ATVB fins" selection was the one that demonstrated the greatest shape variety. From small clusters with loose berries through to large, compact clusters, all shapes were present. This variety made it impossible to identify an exact pattern (Fig. 1). Susceptibility to botrytis and vinegar rot differed greatly due to the varying cluster shapes. The highest infestation was recorded in clone 828, with the lowest being in clone 943. The mass selection lay between the two clones, with infestation being higher particularly among the vines with compact grape clusters. There were also slight differences in must weight and cluster size; these were somewhat higher in the case of clone 828 than the other variants.

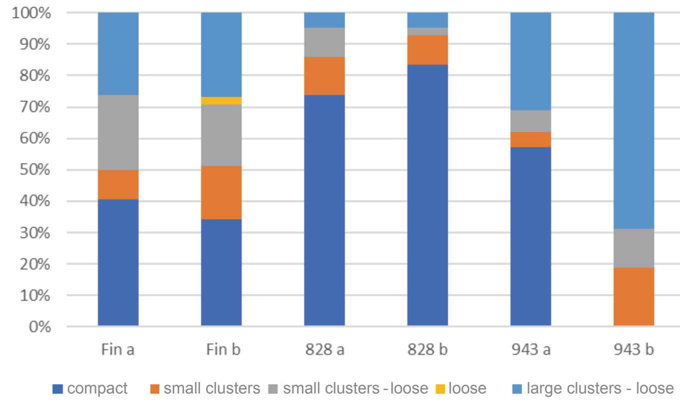


Fig. 1: Analysis of vines with regard to grape cluster shape.

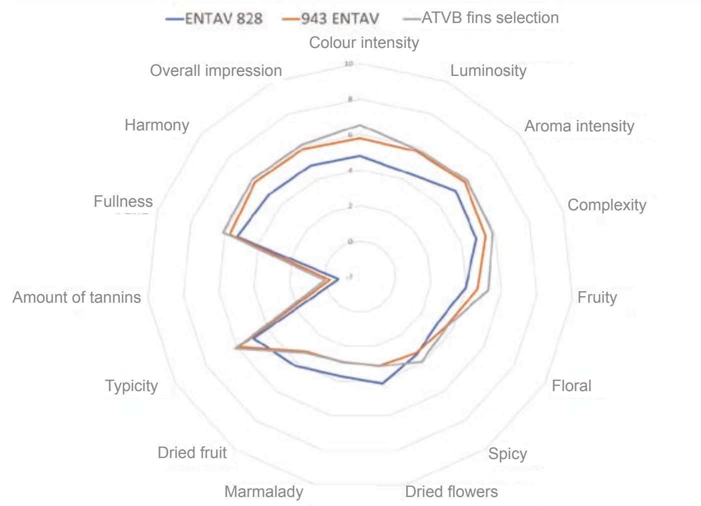


Fig. 2: Sensory profile of the trial wines tasted.

Characteristic evaluation scale from "less pronounced" (0) to "very pronounced" (10) - except for the amount of tannins criterion from "less pronounced" (--10) to optimal (0) to "very pronounced" (10).

WINE TASTING

The wines from the "ENTAV 828" clones were described as being qualitatively worse in many aspects than those from the "ENTAV 943" clone and those of the "ATVB fins" selection (Fig. 2). The wines made with the "ENTAV 828" clone tended, for example, to have marmalade-like aromas and hints of dried fruit. The differences between the "ENTAV 943" clone and the "ATVB fins" selection, were, in contrast, relatively small, although the "ATVB fins" selection featured certain advantages, in particular in relation to colour intensity, complexity and spiciness of the wines. In terms of chemistry, the slightly higher anthocyanin content of the "ATVB fins" selection is noteworthy. The high pH value in the must and wine of the "ENTAV 828" clone and also its somewhat higher alcohol content point to its tendency to ripen early.

Fig. 3: Pinot Noir clone 828

Fig. 4: Pinot Noir clone 943

Fig. 5: Pinot Noir "fins" selection

CONCLUSION

In summary, it can be claimed that the "ENTAV 943" clone and the "ATVB fins" selection produced good results, whilst the "ENTAV 828" clone cannot be recommended without reservations under current growing conditions.

FYLLOCLIP – A NEW LEAF SENSOR FOR DETECTING DROUGHT STRESS

Martin Thalheimer
Soil, Fertilisation and Irrigation Working Group

One of the major challenges for the future posed by climate change is to make more efficient use of increasingly scarce water resources in order to continue to meet the demands of agricultural production whilst also doing justice to the needs of nature, industry and private households. One of the traditional approaches to achieving this goal is to use soil moisture sensors. In the case of plants with deep roots, however, such instruments come up against the limits of their capacities, as they are mainly only able to provide an insight into the water supply situation in the upper soil layers. However, in such cases sensors attached to plants, such as the "FylloClip" developed by Laimburg Research Centre, might provide an expedient solution.

LEAF STOMATA AS SENSITIVE INDICATORS OF WATER SUPPLY

The leaf stomata of a plant are its points of contact with the surrounding air and control the uptake of CO_2 as well as the release of water vapour. A plant with an adequate water supply opens its stomata when exposed to the sun until darkness falls, thus enabling transpiration to occur. In drought conditions, however, the stomata close earlier in the course of the day in order to prevent excessive water loss. This behaviour can be used as a valuable indicator of incipient drought stress.

Fig. 3: "FylloClip" in the apple plantations at Laimburg Research Centre

Fig. 1: The new leaf sensor should offer especially interesting potential uses in viticulture.

Fig. 2: Some initial positive results have also been obtained with sweet chestnuts.

A SIMPLE MEASURING PRINCIPLE PROVIDES CONTINUOUS INSIGHTS

The newly developed sensor is attached to the leaf of a plant like a paper clip (Fig. 1). When water vapour escapes through the stomata, it condenses into small water droplets on the disc located on the underside of the leaf, which are registered by the sensor. At the same time, on the top surface of the leaf, the solar radiation is also measured. Conclusions can then be drawn about the supply of water to the plant by comparing the solar radiation with the transpiration over the course of the day: if the two lines remain parallel throughout the day, this indicates that the water supply to the plant is sufficient, whereas if transpiration drops off at an early stage this might indicate incipient drought stress.

CONCLUSION AND OUTLOOK

The new "FylloClip" leaf sensor has already been tested in potted plants as well as in the open. So far, the tests, which have been carried out on a variety of plants, have returned largely positive results. There has been interest in this development from winegrowers in particular but initial experience points to beneficial applications of this economical measurement principle for other perennial crops such as sweet chestnuts too.

BENEFICIAL INSECTS FOR THE BIOLOGICAL REGULATION OF THE SPOTTED WING DROSOPHILA

Silvia Schmidt, Peter Neulichedl, Martina Melchiori
Biological Plant Protection Methods Working Group

The spotted wing drosophila, *Drosophila suzukii*, was detected for the first time in South Tyrol in 2010. Since then, *D. suzukii* has become a major pest for cherry and soft fruit growers. Combating it is difficult and is predominantly reliant on insecticide treatments and expensive protective netting. In South East Asia, the area of origin of the spotted wing drosophila, this pest is controlled by parasitoid species. Two species of ichneumon wasps, which parasitise the larvae of the spotted wing drosophila, achieve the highest parasitisation rates; these are *Leptopilina japonica* and *Ganaspis brasiliensis*. The introduction of exotic predators in the dispersion areas of the spotted wing drosophila would be welcomed with a view to achieving natural regulation of the pest over the long term. Releasing a small number of individuals in a targeted manner should enable this beneficial insect to reproduce and spread locally where conditions are favourable.

MASS BREEDING AND RELEASES

In August 2021, after reviewing a risk analysis, the Environment Ministry approved targeted releases of *G. brasiliensis* for the first time and subsequently also for 2022 and 2023. The beneficial insect was bred at Laimburg Research Centre for release in South Tyrol (Fig. 1). Each year, 200 individuals were released three times per season in each of seven suitable locations at different altitudes ranging from 200 to 1,200 metres above sea level in natural landscapes that bordered the orchards (Fig. 2). Before and after the releases, samples of fruit infested by spotted wing drosophila were taken and analysed in the laboratory to check for the hatching of parasitoids and the identified *Drosophila* species. The results were passed each year to the Ministry of Agriculture and the Environment.

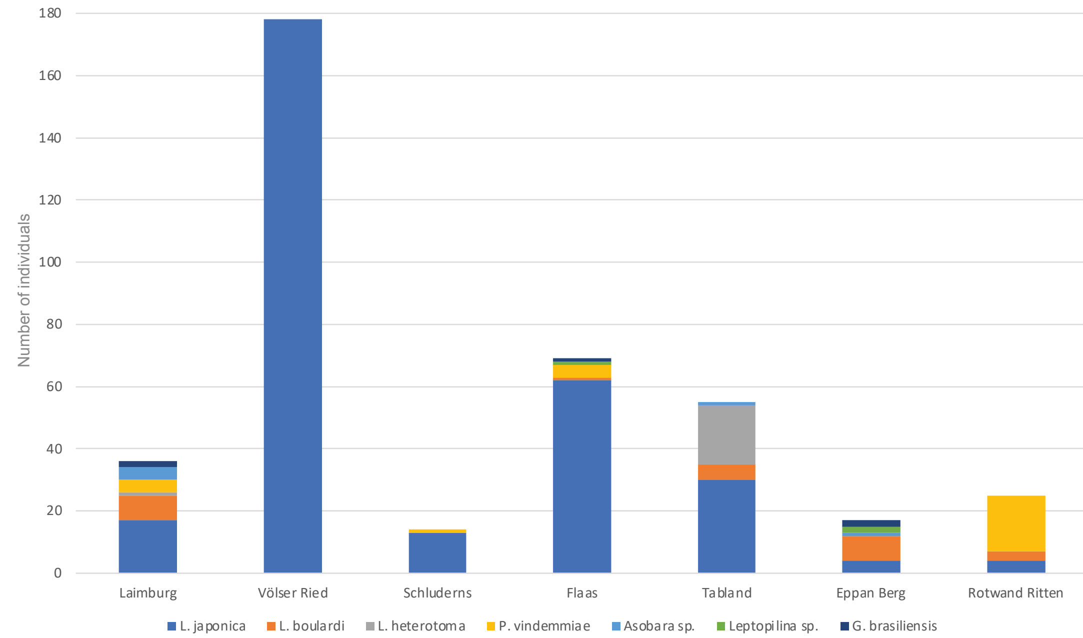


Fig. 3: Species of beneficial insects surveyed in the seven locations in 2022

SPECIES OF ICHNEUMON WASPS, COLONISATION AND PARASITISATION RATES

Seven different species of ichneumon wasps were identified in the fruit samples, including the two exotic predators, *G. brasiliensis* and surprisingly also *L. japonica*. *G. brasiliensis* is very specific and only attacks *D. suzukii*. Some individual exotic predators were found again in five release sites in the valley and up to an altitude of 1200 metres. Only once, however, was it possible to detect overwintering individuals of this species, and only in the valley location. L. japonica prefers to parasitise *D. suzukii* but is also able to reproduce on fruit flies such as *D. melanogaster*. This species was found again in all locations (Fig. 3) and over the three years showed rising rates of parasitisation of up to 20% in 2023. The other ichneumon wasps (*L. heterotoma*, *L. boulardi*, *Asobara sp.*, *Pachycrepoideus vindemmiae* and *Trichopria drosophilae*) are generalists, which is why their potential for controlling the pest is low.

Fig. 1: Breeding the beneficial insect, *Ganaspis brasiliensis*, at Laimburg Research Centre

Fig. 2: *G. brasiliensis* being released

CONCLUSION AND OUTLOOK

The study showed that *L. japonica* continues to spread throughout the region and that the species only recently deployed, *G. brasiliensis*, is already showing colonisation potential. The releases and their monitoring via fruit samples continue. Specific studies regarding their ability to overwinter are ongoing. This means that the prerequisites for curbing the population of drosophila in future are in place.

CITRUS FLATID PLANTHOPPER *(METCALFA PRUINOSA)* BECOMING MORE PREVALENT IN SOUTH TYROL'S APPLE PLANTATIONS

Stefanie Fischnaller, Angelika Gruber, Manfred Wolf
Entomology Working Group

The Citrus flatid planthopper, *Metcalfa pruinosa*, originates in North America and was first discovered in Europe in 1979 (Fig. 1). It infests over 300 different hosts, predominantly woody plants, such as the apple. By sucking on the phloem they weaken the plants, which leads to distorted leaves. The wax and honeydew excreted by the insects can be colonised by sooty moulds, which results in reduced quality in wine and fruit growing. Moreover, *M. pruinosa* can transmit the bacterium *Pseudomonas syringae pv. actinidiae* and is associated with various phytoplasmoses. Due to their mobility, the broad range of host plants and the waxy excretions to protect their young, it is difficult to combat the citrus flatid planthopper with conventional plant protection methods. In Europe, natural predators have proven to have little effect in newly colonised areas. In 1987, *Neodryinus typhlocybae*, a natural predator from the American areas of origin, was introduced to Italy as a form of biological control. After successful use in different regions of Italy, including South Tyrol, controlled release methods were also used in other European countries.

STATUS QUO IN SOUTH TYROL

Studies of planthoppers in the apple plantations in South Tyrol between 2014 and 2016 showed that the Citrus flatid planthopper only appeared sporadically in the orchards studied in comparison with other species. However, most recently, in some areas an increase in population density on apples has been observed, particularly in the peripheral zones. For this reason, in 2023 initial preliminary studies were conducted in some local apple plantations, in order to collect up-to-date information on host plants and record initial data on parasitisation.

REPRODUCTION HOSTS AND PARASITISATION RATES

In July 2023, shoots were collected from several different plants and examined in the laboratory for colonisation with nymphs and their possible parasitisation (Fig. 2). Of the 911 shoots examined, 28% were colonised by *M. pruinosa*, however only 1% of the nymphs showed parasitisation. Apple shoots that were removed in three different locations, showed a colonisation of between 11% and 47% with a low parasitisation rate. In autumn, additional plant samples were examined from the Bassa Atesina region.

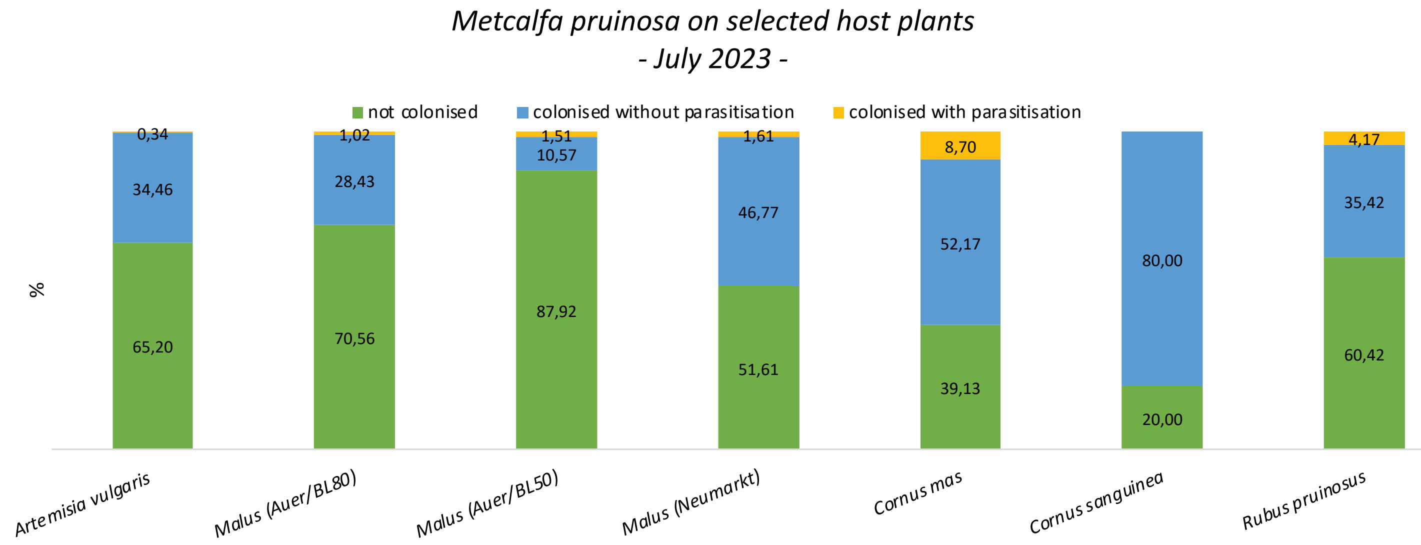


Fig. 2: Colonisation of selected plant species by nymphs of *Metcalfa pruinosa* and their parasitisation rates in summer 2023

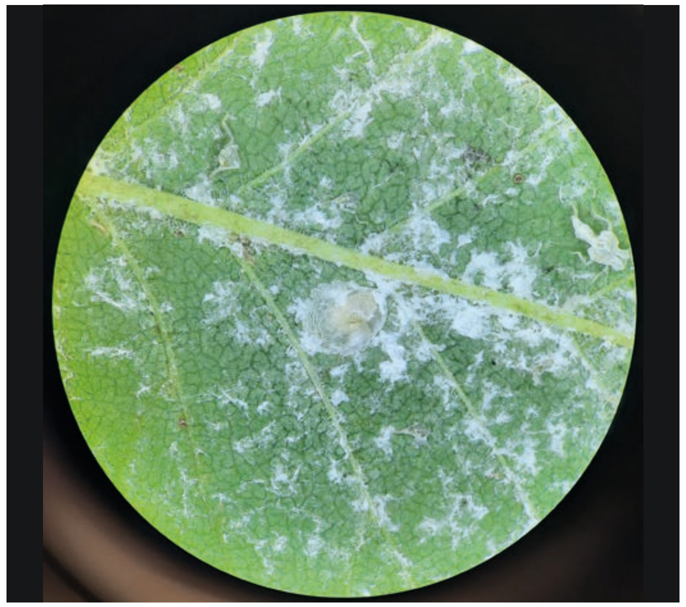


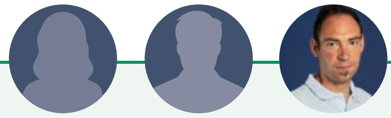
Fig. 3: Parasitised nymphs of *Metcalfa pruinosa*

An increased number of nymphs on plants of the genus *Carpinus, Ailanthus, Faxinus, Ilmus, Cornus, Viburnum* and *Malus* were found. At this time, parasitised nymphs were found particularly on *Acer, Ulmus* and *Cornus*. However, no parasitised nymphs were detected on apple trees.

CONCLUSION AND OUTLOOK

Changes in abiotic factors such as climate and cultivation influence the population dynamics of pests and their natural predators. Species that previously were considered to be "exceptional pests" may appear more frequently in future and lead to reduced quality in agricultural products. Local studies of the biology, spread and vigour of *Metcalfa pruinosa* form the basis of targeted management. Targeted studies based on these initial surveys are planned for the coming years.

CONTAINING THE PROLIFERATION OF TOBACCO RING SPOT VIRUS IN QUARANTINE



Yazmid Reyes Domínguez, Andreas Gallmetzer, Christian Springeth
Laboratory of Virology and Diagnostics

The Laboratory of Virology and Diagnostics is responsible for diagnosing plant diseases that are caused by bacteria, viruses, viroids, phytoplasmas and fungi. Over the course of 2023, more than 3,500 samples from different sources were analysed, including samples from the Regional Plant Protection Service of the Province of Bolzano, from fruit cooperatives and grower organisations, from the South Tyrolean Advisory Council for Fruit and Grape Growing and from private entities. In addition, samples of propagation material used in fruit, grape, vegetable and ornamental plant cultivation as well as from various Laimburg Research Centre research projects were analysed.

PRESENCE OF A NEW PATHOGEN DETECTED IN GRAPES: *ROESLERIA SUBTERRANEA*

In April 2023, the emergence of vines (*Vitis vinifera* cv. Lagrein) with atrophied, truncated internodes, yellow leaves and secondary roots that had died back was observed in the district of Bolzano. There were also some vines that had completely died off. Microbiological and molecular biological investigations showed that *Roesleria subterranea*, the pathogen responsible for grapevine root rot, was present in South Tyrol for the first time. The fungus *Roesleria subterranea* is considered to be a primary pathogen in vines and can cause enormous economic damage, as it is able to survive in a broad range of ecoclimatic conditions.

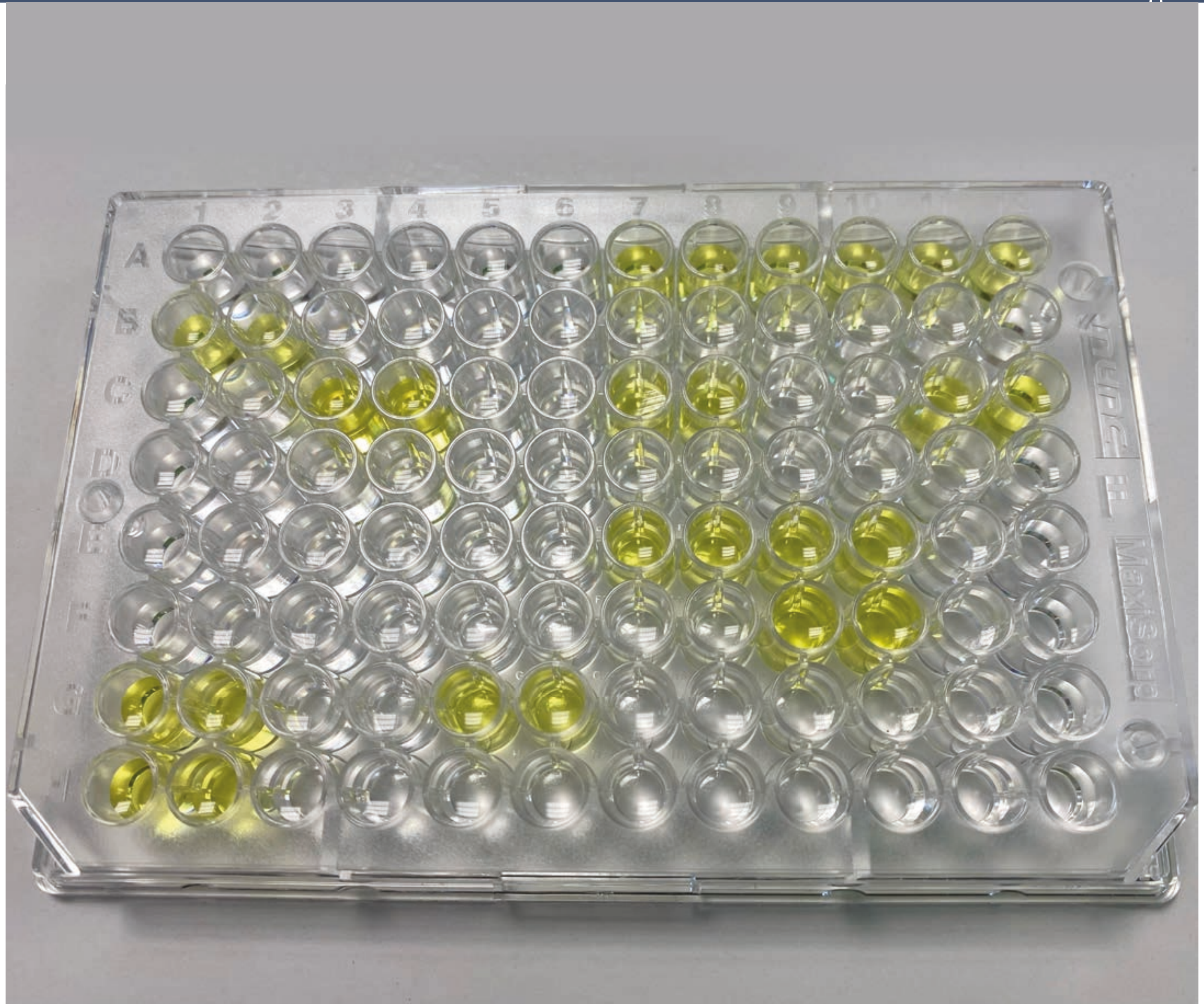


Fig. 1: ELISA plate. An ELISA (enzyme-linked immunoabsorbent assay) test is a process whereby the presence of certain molecules in a test substance can be demonstrated by colour changes. Here, viruses that infect plants were shown to be present.

FIRST EVIDENCE OF TOBACCO RING SPOT VIRUS (TRSV) IN APPLES

One important task of the Laboratory of Virology and Diagnostics is to conduct phytosanitary tests on apple tree propagation material: in accordance with Directive (EU) 2016/2031 concerning measures to protect against plant pests, all imported plants must enter quarantine and be tested for the main pathogens before they are permitted to be traded for propagation purposes.
As a result, in November 2021, an apple graft imported from North America for propagation purposes was tested for the presence of various latent apple viruses and viroids, with all analyses returning negative results.
As required by law, after being imported, the refined mother plant was held in quarantine until May 2023 and during the entire period showed no symptoms of disease. As part of the second routine phytosanitary inspection, this apple plant from the parent plant greenhouse at Laimburg Research Centre tested positive for tobacco ring spot virus TRSV. A comparison of the genetic information of the virus with an international database showed a 97.9% match with the "Budblight" TRSV isolate. After TRSV was definitively identified, the infected parent plant was destroyed.
This prevented possible impacts on propagation and marketing and the spread of the virus was contained. This highlights the importance of preventative measures and rapid reactions to control the spread of plant diseases.

NUCLEAR MAGNETIC RESONANCE SPECTROSCOPY: A POWERFUL TECHNOLOGY FOR PROVING THE AUTHENTICITY OF HAYMILK

Alberto Ceccon
Laboratory of NMR Spectroscopy

In recent years, nuclear magnetic resonance spectroscopy (NMR) has become established as one of the most powerful and fastest technologies for testing natural products and foodstuffs, as by observing the behaviour of nuclei in a magnetic field it is possible to obtain detailed information about the molecular structure of the compounds being tested. This enables the authenticity, typicality and origin of products to be determined. NMR technology makes it possible to resolve spectra of complex mixtures in order to identify "molecular markers". In turn this allows the origin of the compound being tested to be determined. In the production of haymilk, an important product for the South Tyrolean dairy sector, cyclopropane fatty acids (CPFA) are important molecular markers. This is because evidence of these molecules can only be found in the milk of cows fed on silage, but not in haymilk. Consequently, optimising analytical methods with which the presence of CPFA can be proved, is of critical importance for uncovering possible irregularities in the production of haymilk.

DIGITAL FINGERPRINT OF CPFA USING NMR

The ^{1}H-NMR spectrum of dihydrosterculic acid (DHSA), one of the two CPFAs proven to be found in silage milk is shown in Fig. 1. Each signal in the spectrum can be assigned to a specific proton (^{1}H), that makes up DHSA (see structural formula in Fig. 1) as a result of which the ^{1}H-NMR spectrum is a true fingerprint of the molecule. What makes the CPFA compound class into a very powerful molecular marker in NMR spectroscopy is the characteristic signal position of one of the protons ($^{1}H^{c}$) that belongs to the cyclopropane ring (red excerpt in Fig. 1A). Even in complex matrices (e.g. the fat components of milk), in which many signals overlap one another, the position of this $^{1}H^{c}$ signal is clear. Nevertheless, the signal intensity of a single proton is extremely low and detection is still a challenge (Fig. 1B).

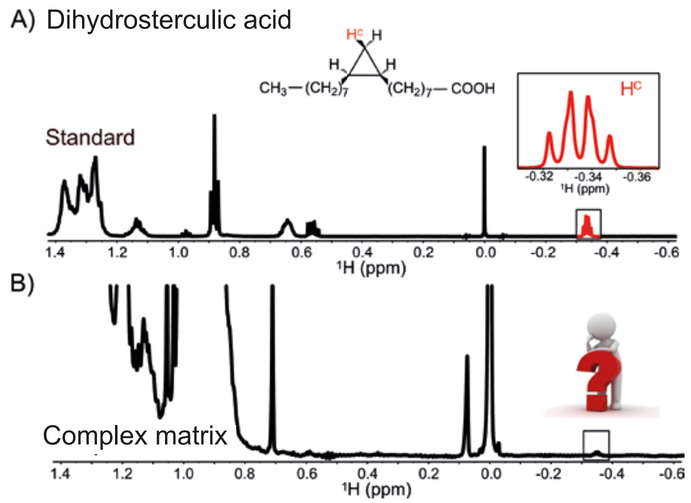


Fig. 1: ^{1}H-NMR spectra recorded from (A) DHSA (standard) and (B) a fat fraction of commercial milk (not haymilk, complex matrix). The characteristic signal ($^{1}H^{C}$) of DHSA is highlighted in red in the upper spectrum and marked in both spectra.

STRATEGY FOR IMPROVING THE ABILITY TO DETECT CPFA

Using a simple technical trick known as "decoupling" during the acquisition of the NMR signal, the signal of $^{1}H^{c}$ can be amplified, thus significantly increasing the detection threshold of DHSA. In Fig. 2, if the signals corresponding to the $^{1}H^{c}$ of DHSA, that were recorded without decoupling (highlighted in black) and with it (highlighted in red) are compared, the effect of decoupling becomes particularly apparent. While decoupling leads to an approximate doubling of the signal in the spectra recorded using the DHSA standard, in the case of the spectra recorded in milk (where the DHSA content is lower) the use of decoupling is a necessary prerequisite for detecting the DHSA signal, which otherwise would fall below the detection threshold.

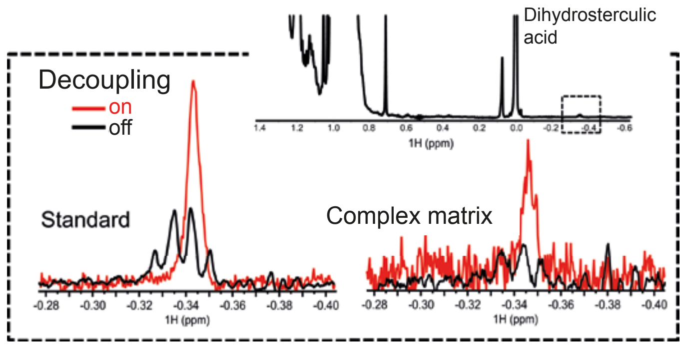


Fig. 2: Comparison of NMR spectra recorded without decoupling (in black) and with it (in red), which illustrates the potential of NMR technology. Only the section of the spectrum that corresponds to the $^{1}H^{C}$ signal is shown in each case: left DHSA standard and right complex matrix (milk fat fraction).

CONCLUSION AND OUTLOOK

The development of measuring techniques that are able to strengthen the signal corresponding to the molecular markers is of fundamental interest for the certification of foodstuffs. This study shows that NMR spectroscopy can be extremely useful for the authentication of South Tyrolean products.

PNEUMATIC DEFOLIATION INCREASES THE ANTHOCYANIN CONTENT OF THE ROSY GLOW/PINK LADY® VARIETY OF APPLES

Daniela Hey, Peter Robatscher
Laboratory of Flavours and Metabolites

Christian Andergassen
Fruit Physiology Working Group

Pneumatic defoliation is a new mechanical technique for reducing the amount of leaves on apple trees in order to increase the proportion of the red body colour on apples such as Rosy Glow (Pink Lady®) (Fig. 1). Trials conducted in the field show that the use of pneumatic defoliation just before the harvest in combination with pruning to enhance exposure to light that is carried out as standard is extremely efficient, considerably enhances fruit colouring, and at the same time does not have a lasting impact on the productivity of the orchard.

DETERMINING THE ANTHOCYANIN CONTENT OF APPLE SKIN

Anthocyanins are compounds that are responsible for the red colouring of fruit, berries and vegetables. For example, blackberries obtain their typical dark red colouring due to their high anthocyanin content. To determine the effects and the efficiency of pneumatic defoliation on the increase in the red colour desired by customers in Rosy Glow apples, the quantity of anthocyanins in the apple peel was measured in the laboratory using a photospectrometric method (Fig. 2). For this purpose, fruits were sampled that either had not been treated or where the trees had been pruned to enhance light exposure followed by pneumatic defoliation two weeks before the harvest.

Fig. 1: Rosy Glow apple trees following pruning to enhance exposure to light and pneumatic defoliation (left) and without treatment (right)

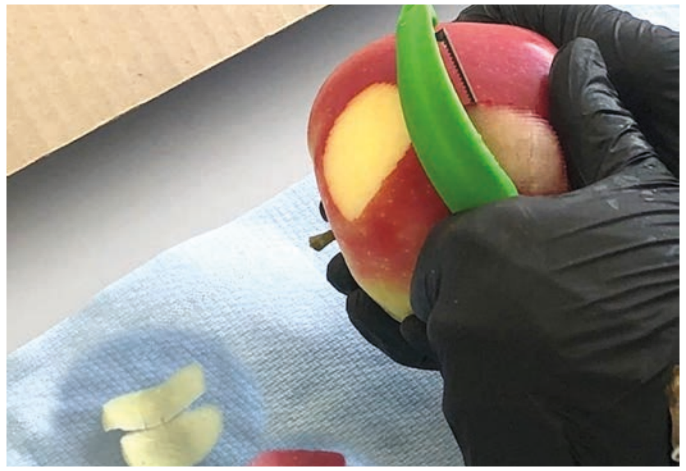


Fig. 2: Testing of anthocyanin content in apple skin

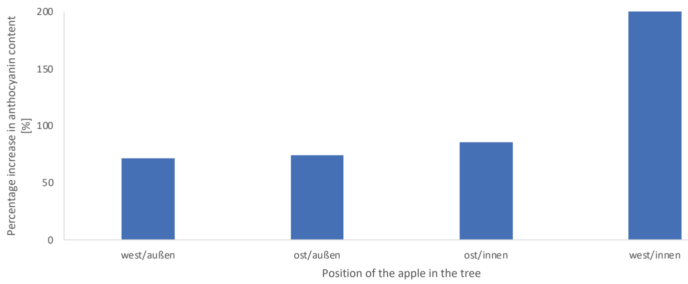


Fig. 3: Increase in anthocyanin content in apple skin following pneumatic defoliation and pruning for light exposure in comparison with fruit from untreated trees

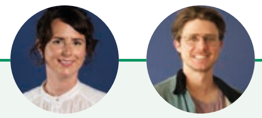
EFFECT OF PNEUMATIC DEFOLIATION ON ANTHOCYANIN CONTENT

The analysis of the anthocyanin content in the skin of the apples showed that pneumatic defoliation in combination with pruning to enhance light exposure is a very effective method of increasing the red colour in Rosy Glow apples. Depending on the position of the fruit in the tree (east side, west side, inside, outside) the level of impact of defoliation varied. For example, the largest increase in anthocyanin content was detected in fruits on the inside of the tree, which normally are shielded by the leaves (Fig. 3). The fruit on the west side of the tree also featured considerably better colouring as a result of the treatment, which is probably due to the fact that they were already exposed to less sunlight at the end of October when the control trial was harvested.

CONCLUSION AND OUTLOOK

The increase in anthocyanins in the skins of apples from defoliated trees confirms that pneumatic defoliation just before the harvest in combination with pruning to enhance exposure to light considerably enhances the colouring of the skins of Rosy Glow apples. Further studies will consider the longer-term effects of this treatment on the productivity of the orchard and on the nutrient cycle of treated trees.

SPECTRAL ANALYSIS OF LEAVES TO IDENTIFY PLANT DISEASES BASED ON THE EXAMPLE OF APPLE PROLIFERATION



Katrin Janik, Cameron Cullinan
Functional Genomics Working Group

Combating pests and plant diseases is a vital aspect of agricultural production. However, plant protection can have negative effects on the environment. An important goal for the future is to minimize these side-effects and only use chemical plant protection where absolutely necessary. The basic prerequisite for such precision measures is the early detection of a disease, or in other words, identifying when the plant is subjected to stress. This is because the earlier a disease is discovered, the less plant protection will be needed. A promising approach for early and efficient detection is the use of what are known as hyperspectral sensors or spectroradiometers.

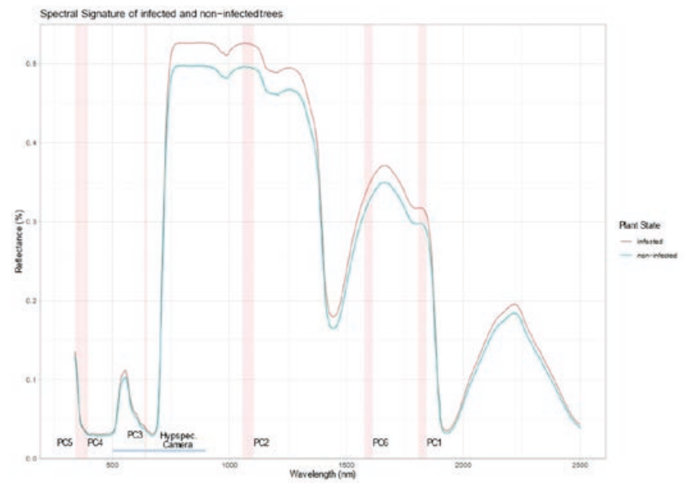


Fig. 1: Spectral leaf profile of a tree suffering from apple proliferation (red line) in comparison with a leaf from an uninfected tree (blue line)

ANALYSIS OF THE SPECTRAL REFLECTION PATTERN OF DISEASED APPLE TREES

Hyperspectral sensors and spectroradiometers measure the electromagnetic waves that are reflected by leaves, for example. We are already familiar with these electromagnetic waves from everyday life since visible light, infrared waves, microwaves and radio waves are all part of the electromagnetic spectrum. If plants are subjected to stress, for example due to disease, this can lead to a change in the way that electromagnetic radiation is reflected, or to put it another way, to a change in the spectral profile of the leaves. This can be measured, enabling stress to be detected at an early stage.

INITIAL PROMISING RESULTS IN THE EARLY DETECTION OF TREES SUFFERING FROM APPLE PROLIFERATION

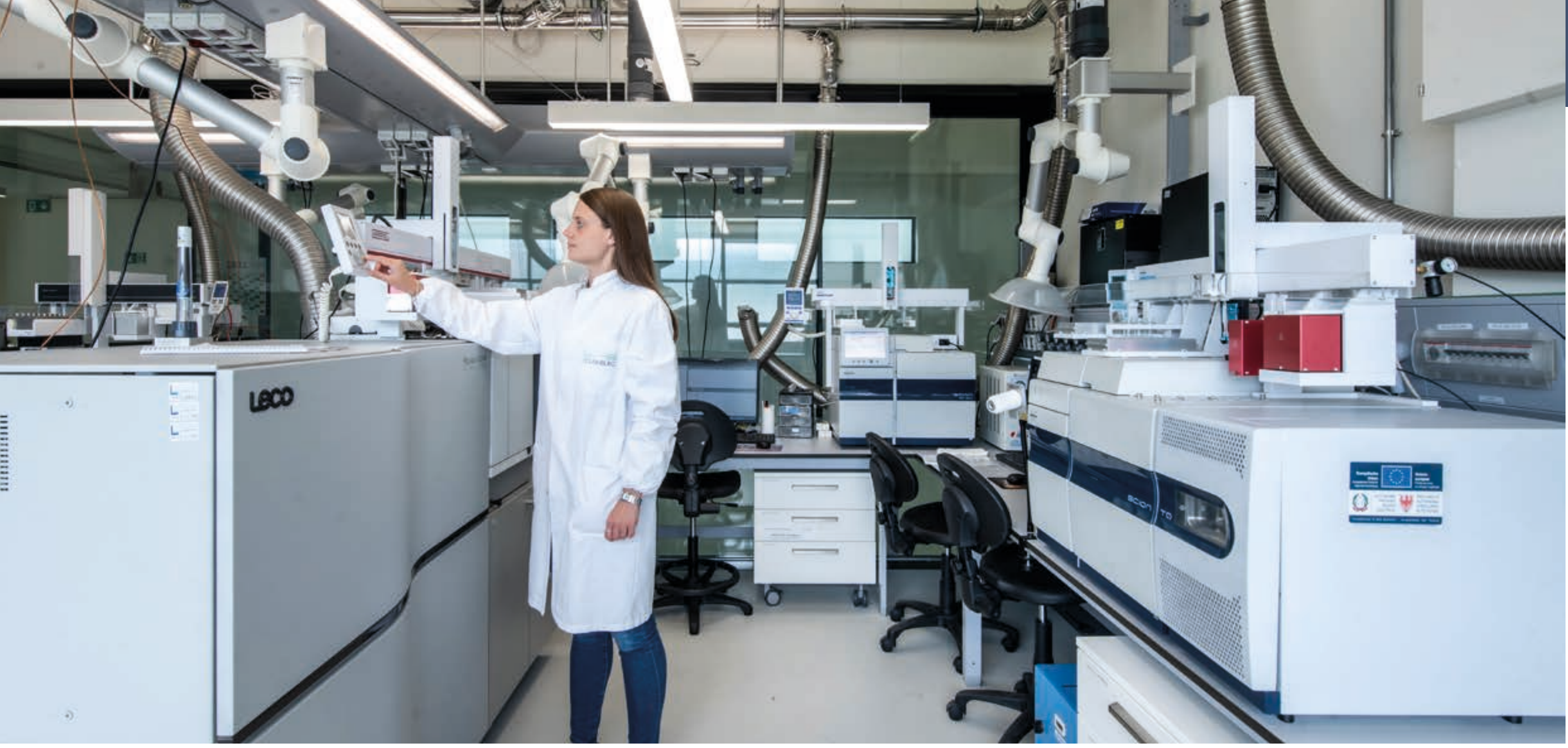
A project at Laimburg Research Centre is specifically concerned with the early detection of trees suffering from apple proliferation disease using spectral analysis. The research has returned promising results, with field trials showing that with the help of spectral analysis, it is possible to distinguish between healthy and infected trees. This technology could have many advantages in practice, as diseased trees can be detected early on before any visible symptoms appear. This would be a quick and cost-effective method of being able to remove diseased trees from orchards before carrier insects have to be targeted with pesticides.

Fig. 2: Assessment of apple proliferation symptoms in an apple orchard

Fig. 3: Collecting spectral leaf profiles in an apple tree

CONCLUSION AND OUTLOOK

Although the initial results are promising, further research efforts and above all many measurements are needed before this method can be used. Agriculture is becoming ever more complex and climate change in particular entails many new challenges and stress situations. New technologies can make an important contribution to meeting to these challenges.



NEW FOOD PROTOTYPES MADE FROM AGRICULTURAL BY-PRODUCTS TO REDUCE THE RISK OF THE EMERGENCE OF METABOLIC SYNDROME

Martina Magni, Andrea Pichler, Peter Robatscher
Laboratory of Flavours and Metabolites

The REALiSM project, which was conducted in collaboration with the South Tyrolean company, Dr. Schär, saw the development of new foodstuffs that could minimise the risk of the emergence of metabolic syndrome. Metabolic syndrome is linked to a significant increase in the development of cardiovascular complications and type 2 diabetes. The most important features of the formulations developed were the use of functional ingredients derived mainly from by-products from South Tyrol's agricultural and food processing industries that are rich in nutraceuticals, have a high beta-glucan content due to the use of oats and that are highly palatable.

Fig. 3: Prototypes developed during the project: Grissini, biscuits and focaccia with the addition of by-products from apple processing and Lagrein pomace, which are rich in antioxidants, as well as oats that are rich in beta-glucans

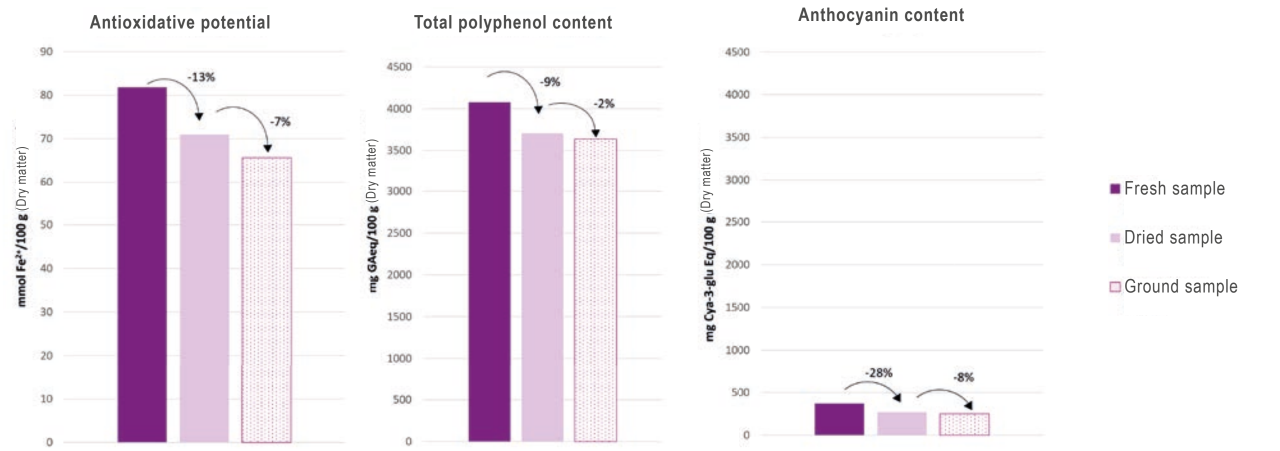


Fig. 1: Change in the antioxidative potential, the total polyphenol content and the anthocyanins subject to the methods used (drying, milling) for Lagrein pomace

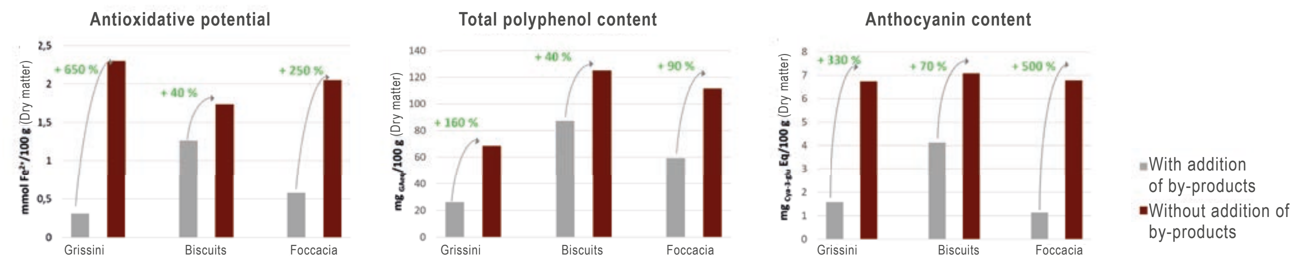


Fig. 2: Change in the antioxidative potential, the total polyphenol content and the anthocyanins in food prototypes with and without the addition of by-products

SELECTION OF RAW MATERIALS AND TECHNOLOGICAL METHODS

In collaboration with local companies and the "Arable Crops and Aromatic Plants" working group from Laimburg Research Centre, raw ingredients were identified that are abundant in nutraceuticals. The change in the concentrations of nutraceuticals during the various processing steps (drying and milling) was monitored in order to select gentle conditions. The nutraceuticals examined were antioxidants such as polyphenols from grapes, apples and oats, essential fatty acids from grape seeds and oats, and fibre such as beta-glucans contained in oats. As it is known from scientific studies that the molecular weight of beta-glucans is pivotal for their ability to reduce the glycemic peak after eating, both the content and the molecular weight distribution of the available beta-glucans were determined. The analysis, which was carried out using liquid chromatography, made it possible to identify the oat varieties with the highest content of beta-glucans with high molecular weights and thus those with a greater positive impact on health.

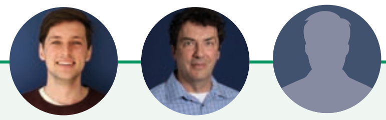
FORMULATION OF FOOD PROTOTYPES

The nutritional profile of the product prototypes was established in collaboration with the Nutrition Service department of Dr. Schär. To meet the requirements of the European Food Safety Authority (EFSA), every prototype must contain grape and apple by-products, have at least one gram of beta-glucans from oats per portion, provide omega-6 and omega-3 fatty acids that are contained in the grape seeds or linseed, and not contain any added sugar. In accordance with these guidelines, the researchers from the R&D department at Dr. Schär formulated prototypes of grissini, biscuits and focaccia and evaluated their antioxidative profile (Fig. 3).

CONCLUSION AND OUTLOOK

Optimising the processes used on the raw materials made it possible to preserve the nutraceuticals to the greatest extent possible through to the production of food prototypes. The functionality of the prototypes was ultimately analysed using in-vitro models that simulate the gut microbiome, and their appearance and taste were validated by sensory analyses and consumer tests.

REFERENCE VALUES FOR PASTURE MANAGEMENT IN SOUTH TYROL USING THE CONTINUOUS GRAZING SYSTEM



Markus Gatterer, Giovanni Peratoner, Christoph Wedmann
Grassland Farming Working Group

Pasture management can make a contribution to the efficient feeding of livestock for milk production in South Tyrol. Continuous grazing is an intensive form of grazing with which, over the vegetation period, an average plant height of 5 to 6 cm is maintained. The objective is the continuous provision of high quality food with a low labour requirement and minimal feed losses. To this end, the size of the grazing area must be continuously adapted to the growth of the grass, which alters with the season and weather conditions. This form of pasture grazing is being explored in the "System Comparison" project run by Laimburg Research Centre and the Free University of Bolzano at the "Mair am Hof" farm of the Provincial Property Agency in Teodone. The continuous grazing system is practised successfully in the alpine area but is uncommon in South Tyrol.

RECORDING OF GRAZING PARAMETERS

In the "System Comparison" project, compartmentalised (or enclosed) continuous grazing pasture is used, where the total area is subdivided into three enclosures that are repeatedly grazed at short intervals. The pasture planning depends on the plant height in the individual enclosures. For this reason, the plant height is measured at 75 random points using a herbometer every week (Fig. 1). In each enclosure there is, in addition, a fenced-in area, in which every two weeks half is mown, in order to quantify the changes in grass growth over time.

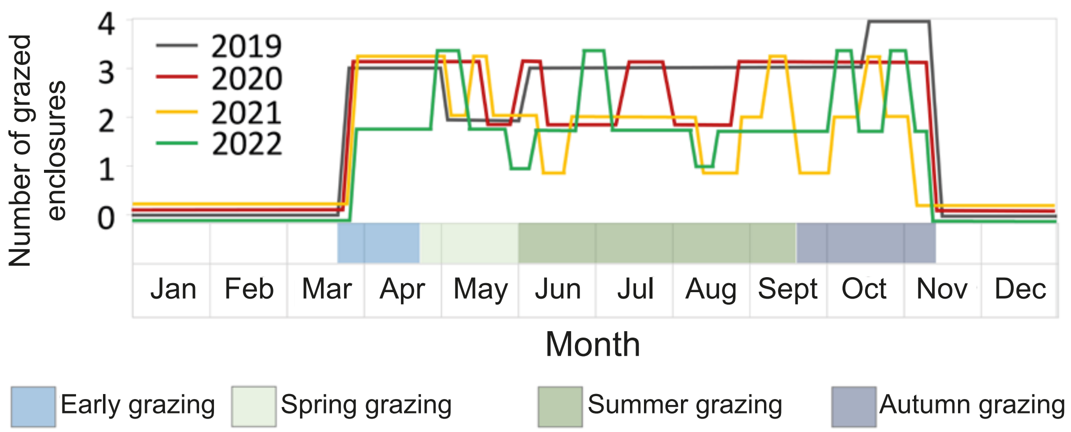


Fig. 2: Grazing phases and number of grazed enclosures

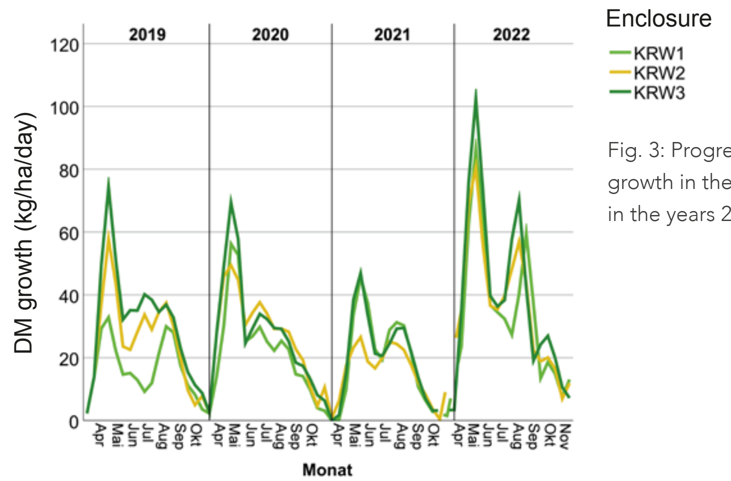


Fig. 3: Progression of pasture growth in the three enclosures in the years 2019 to 2022

RESULTS

The grazing period in Teodone runs from the end of March until the end of October. The grass growth determines the number of enclosures offered to the animals for grazing every week. For this reason, the number of enclosures used does not follow a strict pattern (Fig. 2). For example, in 2019 and 2020, usually three enclosures were grazed, whilst in 2021 and 2022, it was often the case that for long periods only two were grazed. The progression of grass growth differed by year and enclosure (Fig. 3). The highest growth rates (approx. 90 kg dry mass per hectare per day) were observed from the end of April to the beginning of May in 2022. In the preceding years too, the highest growth rates were achieved within this time frame, with growth being at its lowest in 2021 (approx. 40 kg/ha/day). After this, growth decreased rapidly in all years, and remained relatively constant until the end of the summer grazing season. In 2021 and 2022 growth increased again at the end of the summer.

CONCLUSION

For the first time, the trial produced reference values for the practice of continuous grazing in South Tyrol. The results show that growth can vary strongly both during the grazing period and also between individual years. Continuously adjusting the grazing area in a timely manner is therefore an essential element of good management.

WHICH VARIETY OF PEPPERMINT HAS THE BEST CHARACTERISTICS?

Manuel Pramsohler, Alessia Castellan, Angelika Ruele
Arable Crops and Aromatic Plants Working Group

Herb cultivation is among the niche areas in South Tyrol's mountain agriculture and may be an interesting alternative for some farms. One of the species of herb most commonly grown in South Tyrol is peppermint. The yield and quality of the final product as well as its adaptability to environmental conditions can vary greatly between the different peppermint varieties. For this reason, the choice of suitable varieties can play a decisive role in the success of cultivation.

PEPPERMINT CHARACTERISTICS

Peppermint (*Mentha x piperita L.*), a hybrid of spearmint (*Mentha spicata L.*) and water mint (*Mentha aquatica L.*), is a perennial herbal plant. It belongs to the labiate family, whose members are known to have high concentrations of essential oils. Peppermint leaves can contain up to 5% essential oil. The main components of peppermint essential oil are menthol and menthone. The quantity and composition of the essential oils vary considerably depending on the type, harvest time, location and climatic conditions. Currently, the "Multimentha" variety is most commonly grown, which has become increasingly popular due to its resistance to the fungal disease, mint rust (*Puccinia menthae*).

Year	Prunings	Multimentha	Proserpina	Agnes
2021	1	4,3	3,6	4,3
2021	2	3,6	3,0	4,0
2022	1	2,2	2,3	2,4
2022	2	4,0	3,7	4,0
2022	3	3,6	3,8	3,6
2023	1	3,0	3,1	2,9
2023	2	3,8	4,2	3,9
2023	3	3,5	3,0	3,1

Tab. 1: Essential oil content (%) of the three varieties tested, "Multimentha", "Proserpina" and "Agnes" (three years, eight harvesting dates). In each case, a mixed sample from the four replicates was analysed

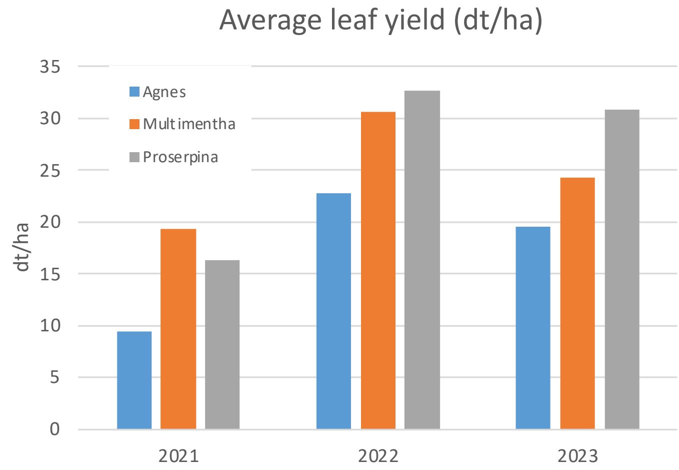


Fig. 2: Average leaf yield (dry weight) of the three varieties tested

Fig. 1: Harvesting peppermint at the Gachhof trial site. © Laimburg Research Centre/Ivo Corrà

THREE-YEAR VARIETY TESTING

As part of a three-year field test (2021-2023), the well-established "Multimentha" variety was compared with two varieties of peppermint selected in Bavaria ("Agnes" and "Proserpina"). The trial was conducted at the state-run Gachhof herb garden (Fig. 1) in Labers/Merano (620 m.a.s.l.). During the year of planting, two harvest prunings were carried out, whilst in the subsequent years there were three pruning dates each year. After each pruning, the harvested crop was dried out carefully in a dryer at a maximum of 35° C. Over the course of the three years, various agronomic parameters such as plant height, fresh and dry weight, leaf yield and leaf share were recorded. In addition, the essential oil content and its main components were also analysed.

CONCLUSION AND OUTLOOK

Between the three varieties tested there were significant differences in yield; the highest yields were achieved in the second year after planting in each case (Fig. 2). The "Proserpina" and "Multimentha" varieties yielded more highly than the "Agnes" variety. In terms of the essential oil contents, with up to 4.3% (Tab. 1), very high values were achieved, which indicates a high quality. As expected, there were large differences between the pruning dates. And as far as the content of the most important components in the oil were concerned, that is menthol and menthone, there were clear differences between the harvest dates. These differences will be investigated more closely in follow-up projects.

INFLUENCE OF STORAGE TECHNOLOGIES ON SOOTY MOULD ETC. IN APPLES

Angelo Zanella, Ines Ebner
Storage and Post-Harvest Biology Working Group

Yazmid Reyes Dominguez
Laboratory of Virology and Diagnostics

Sabine Öttl
Phytopathology Working Group

Epiphytic fungi, which manifest with symptoms such as sooty mould or sooty blotch (Fig. 1), can cause significant losses of fruit in storage. Contamination occurs outdoors, but in many cases it has not yet been possible to find a satisfactory defence against this complex of different types of fungi in the orchard. The fungi may form clearly visible patches of hyphae on the fruit while it is still on the tree or only multiply during storage (Fig. 2).

CAN THE DEVELOPMENT OF EPIPHYTIC FUNGI IN STORAGE BE SLOWED DOWN?

It is known that whilst conventionally altering the atmosphere during storage in CA-ULO (controlled atmosphere with ultra-low oxygen content) may not substantially prevent the development of these micro-organisms, it can delay it. For this reason, to begin with the study examined the impact of the normally very high air humidity in storage cells containing the susceptible Cripps Pink/Pink Lady® variety. In addition, the effect of an ionised atmosphere was also investigated in a practical trial. To do so, air ionisers were installed in a cool cell belonging to the BioSüdtirol Cooperative (Lana, Italy) in collaboration with Isolcell (Laives, Italy), with which the air molecules were electrostatically charged at high voltage. Furthermore, in cooperation with the Agroscope Research Institute in Conthey (Switzerland), the effect of a storage atmosphere enriched with low ozone concentrations was also investigated.

Fig. 1: Various symptoms of sooty mould etc.

Fig. 2: The effect of different storage factors was investigated in the trial storehouse.

WHICH STORAGE FACTORS REDUCE EPIPHYTIC DAMAGE?

After only a very short storage time, reducing the air humidity showed a positive effect. This trend also continued during longer-term storage in CA-ULO conditions. In this context, the negative side-effect of a higher loss of weight must be taken into consideration. The ionisation of the atmosphere showed a certain amount of potential for reducing symptoms, and in other cases to altering the spectrum of species of fungus involved: instead of a coating of sooty mould, in the ionised atmosphere predominantly white haze was observed. Treatment with ozone was able to suppress the development of the symptom to a greater extent, with this effect being maintained long after the treatment. This was not the case with ionisation.

CONCLUSION AND OUTLOOK

The microbiological and molecular biological analysis of the micro-organisms present on the apple skin showed that a high proportion of ubiquitous fungi are formed, which are fostered by increased humidity during storage. A considerable reduction was achieved with ozone, whilst air ionisation tended to lead to changes in the range of species. However, both methods exhibited a greasiness of the skin to varying extents as a side effect, the causes of which must be more closely examined. Moreover, numerous questions regarding the implementation of the test results on a practical scale still remain.

TEMPEH MADE FROM WHOLE PULSES GROWN IN SOUTH TYROL

Lorenza Conterno, Noemi Tocci, Hannah Mayr, Letizia Bernardi
Fermentation and Distillation Working Group

Daniel Ortler, Manuel Pramsohler
Arable Crops and Aromatic Plants Working Group

Christof Sanoll
Laboratory for Wine and Beverage Analysis

Tempeh is a product made from fermented pulses, originally from soybeans, which is considered to be a sustainable, economical and healthy source of protein, vitamins and bioactive compounds. Tempeh represents a valuable source of protein and is thus an interesting alternative to meat. With the traditional way of making tempeh, the beans are skinned first, which generates food waste and requires a significant amount of time. The aim of this project was to develop a tempeh production process using whole pulses that is characterised by a reduction in food wastage and the use of locally-produced pulses.

PREPARATION OF TEMPEH

The following base products were tested for the production of tempeh: the garden pea (*Pisum sativum*), white lupin (*Lupinus albus*), blue lupin (*Lupinus augustifolius*) and broad bean (*Vicia faba*). For the test, the products made with whole pulses were compared with those made from skinned pulses (Fig. 1). For the transformation into tempeh, spores of the fungus *Rhizopus oligosporus* were inoculated, the growth of which was monitored visually. Cold storage, pasteurisation and sterilisation were tested as post-production processes. Finally, the amino acid composition was analysed in the laboratory.

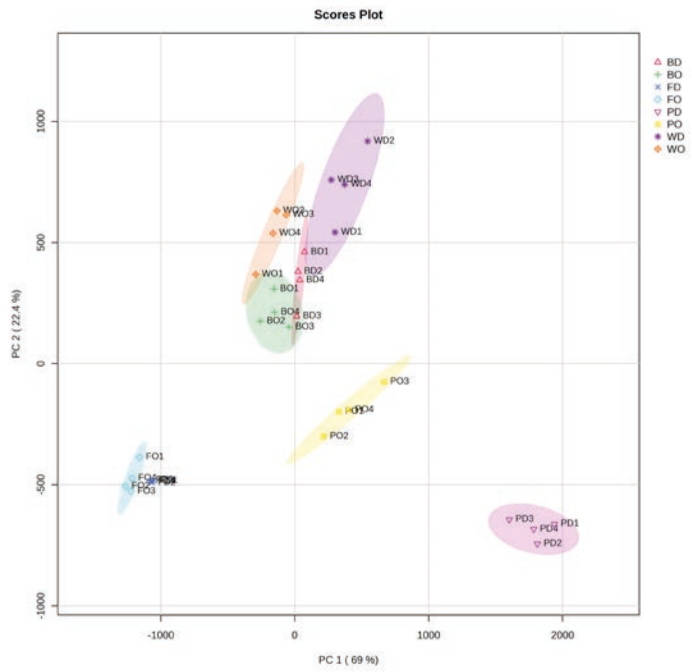


Fig. 2: Main component analysis for the 36 measured amino acids in fresh tempeh, produced using different pulse varieties. P: Garden pea (*Pisum sativum*), W: White lupin (*Lupinus albus*), B: Blue lupin (*Lupinus augustifolius*) and F. Broad bean (*Vicia faba*). D: made of skinned pulses; O: made of whole pulses

THE AMINO ACID COMPOSITION OF TEMPEH

The amino acid analysis enabled the content of 36 amino acids to be measured and showed that tempeh made from whole pulses featured a lower free amino acid content in comparison with skinned tempeh (Fig. 2). This suggests lower fungal protease activity and is probably attributable to the presence of the seed coat. Among the pulses tested, *garden peas* featured the highest quantity of amino acids and the lowest quantity of skin waste, which indicates that it may be a suitable pulse for the production of whole tempeh. During the fermentation process, an increase in the total amino acid content was observed in all samples as well as an increase in specific metabolites, which were only detected in the fermented products. Moreover, the analysis showed that pasteurisation and sterilisation could prevent a further splitting of the proteins by fungal enzymes and thus stabilise the product.

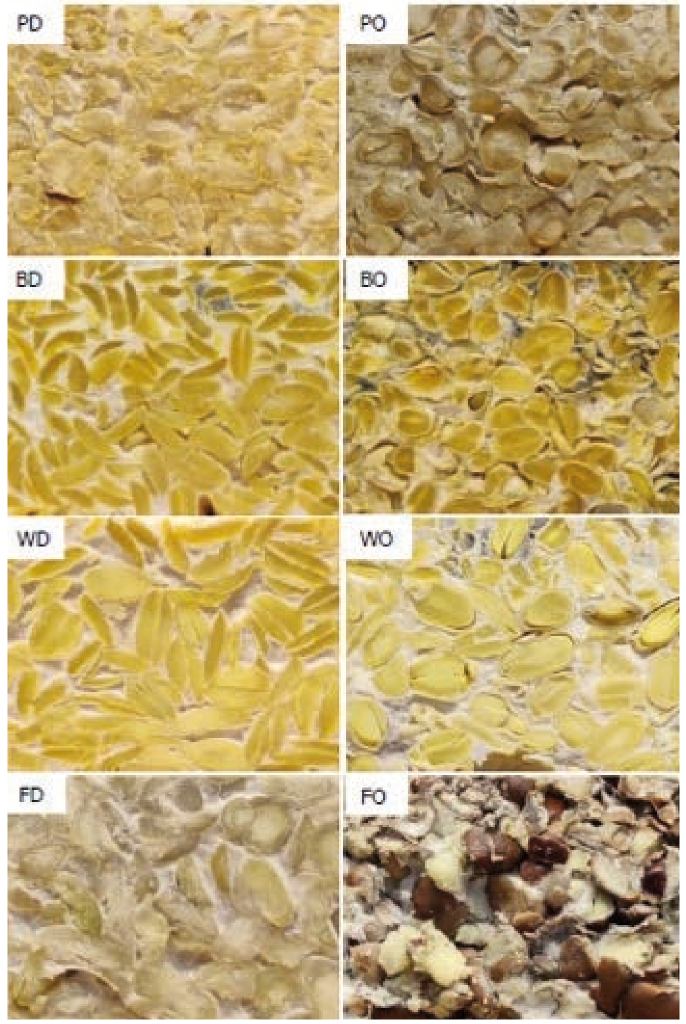


Fig. 1: Samples of fresh tempeh in cross section. P: Garden pea (*Pisum sativum*), W: White lupin (*Lupinus albus*), B: Blue lupin (*Lupinus augustifolius*) and F. Broad bean (*Vicia faba*). D: made of skinned pulses; O: made of whole pulses

CONCLUSION AND OUTLOOK

The results of this study show that tempeh can be manufactured from all four pulse varieties that are suitable for cultivation in South Tyrol. With some of these varieties it is also possible to use whole pulses and thus reduce the amount of wastage. Pasteurisation was shown to be an effective preservation method. To confirm the shelf life of the product, however, suitable shelf life testing must be conducted.

SPRAYING AS A SUSTAINABLE ALTERNATIVE TO IMMERSION IN THE TREATMENT OF APPLE SLICES

Flavia Bianchi, Noreen Faller, Elena Venir
Fruit and Vegetable Processing Working Group

The production of fresh cut apples requires the product to be immersed in solutions containing antioxidants in order to prevent browning due to oxidation. This technology has microbiological, economic and ecological limits, as repeated immersion cycles lead both to an increase in microbial load as well as a reduction in the concentration of the effective ingredient in the solution. In addition, there are large quantities of liquid that have to be disposed of. To reduce the environmental impact and costs, more sustainable application methods need to be considered. In this laboratory-scale test study, the antioxidative effectiveness of immersion and spraying technologies were compared for Golden Delicious apples.

COMPARISON OF METHODS

The apples were immersed for 5 minutes in a solution containing salts and ascorbic acid or sprayed with laboratory equipment. 12, 16, 20 and 24 spray applications of single and double concentration solutions were tested (Fig. 1A). Afterwards, the treated apples were stored for 99 hours at 4 °C. The absorption of ascorbic acid by the treated apples was measured. The colour development over the period was analysed using a colorimeter and visually (dark spots). The differences in lightness, colour saturation, shade and overall colouring (ΔE*) were calculated.

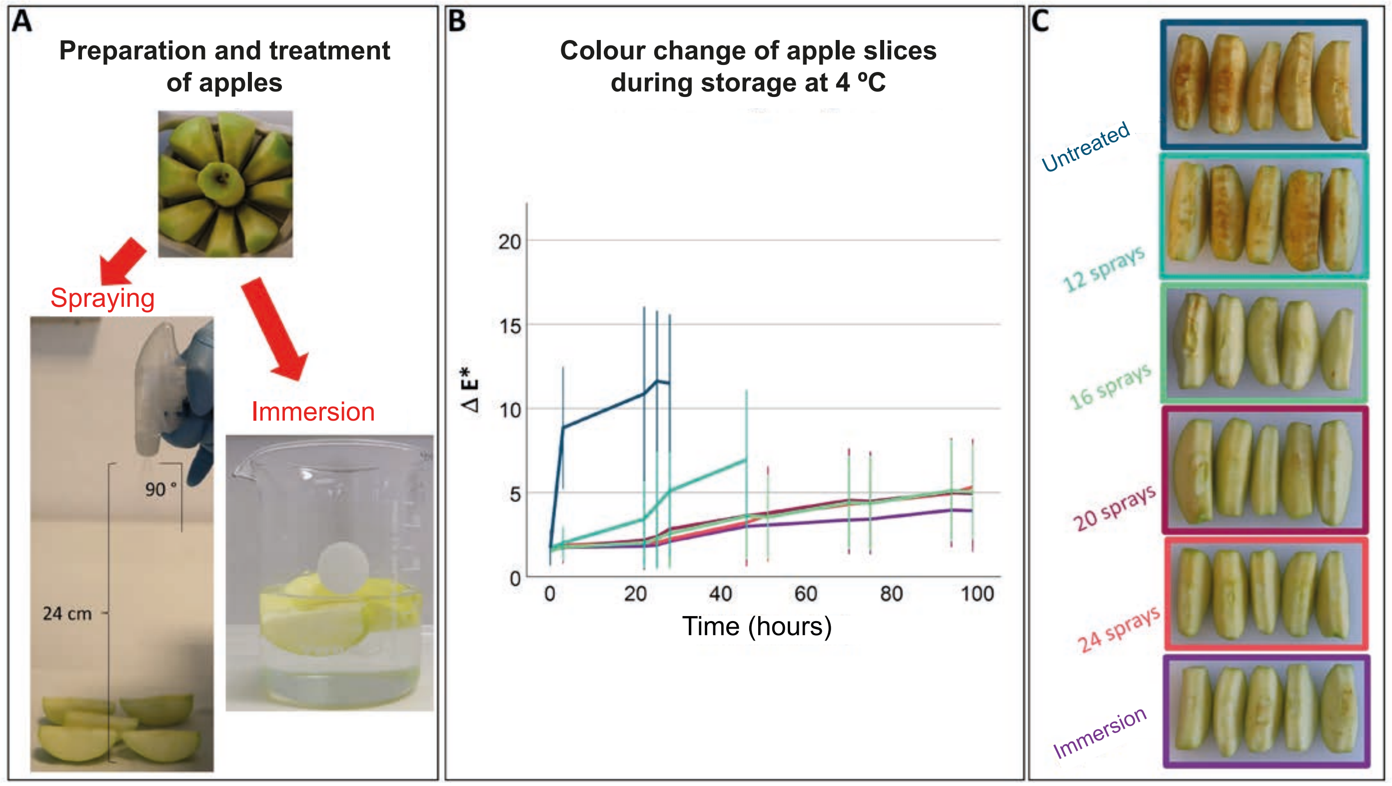


Fig. 1: (A) Method of sample treatment. (B) Total colour difference (ΔE*) over 99 hours. (C) Photo of apples at the last time of sampling (24 hours in the case of untreated apples; 45 hours where sprayed 12 times; 99 hours where sprayed 16, 20 and 24 times; 99 hours where immersed)

ANTIOXIDATIVE EFFECTIVENESS OF THE DIFFERENT METHODS

Up to a storage time of 50 hours (approx. 2 days) both treatments showed comparable levels of effectiveness, with the exception of the spraying regime where only 12 sprays were applied, which was ineffective. At the end of the storage period (99 hours), the immersion treatment tended to evince a slight advantage over the spray treatment, which, however, produced similar results (Fig. 1B). Optically too (dark spots), apples that had been sprayed with 16 or more sprays did not differ from the apples that had been treated by immersion (Fig. 1C). This result seems not to be attributable solely to the quantity of ascorbic acid absorbed, since the immersed segments did not show a higher concentration that those that had been sprayed (Fig. 2). It therefore follows that the distribution of antioxidant plays just a great a role as its concentration. It can be assumed that, in comparison with spraying, immersion facilitates the capillary distribution of the dissolved substances in the apple tissue. It is assumed that this lower distribution may be compensated for by adjusting the concentration of dissolved substances and the spraying technique.

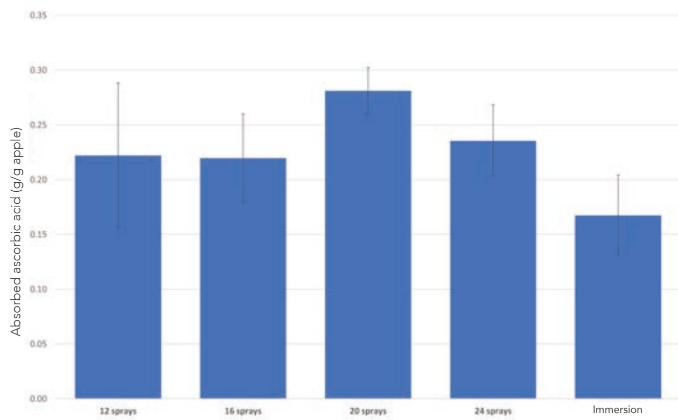


Fig. 2: Quantity (average value ± SD) of ascorbic acid absorbed by immersed and sprayed apples.

CONCLUSION AND OUTLOOK

Under the particular circumstances tested in this study, spraying was just as effective a preventative method against the apples turning brown as immersion. Spraying the surface with antioxidants may possibly have several advantages: contamination is prevented, no excess solution is produced and the titre of the antioxidant solution remains constant over time. Further studies will be needed to optimise the procedure and evaluate the potential for scalability to industrial level.

PROFILES

BARBARA RAIFER

I studied Agriculture at the University of Natural Resources and Life Sciences in Vienna and since 1995 have been Head of the Research Area Viticulture at Laimburg Research Centre. In cooperation with stakeholders, my role is to identify the research questions that need to be examined in order to provide the best possible support to viticulture in South Tyrol. Together with the employees of Laimburg Research Centre, these questions are developed into trial projects, implemented and the results put into practice.
I believe that my work is useful, as viticulture represents the livelihood of many people, either directly or indirectly. Today in particular, as a result of climate change, new solutions are needed in order to be able to continue to produce good quality in changed conditions. It is certainly never monotonous or boring. Instead, I find that there is plenty of scope to shape my own work, attend conferences or partner institutes at home and abroad and build suitable cooperations.

MATTIA TABARELLI

I studied at the University of Padua, obtaining a Bachelor's degree in Biology and a Master's degree in Evolutionary Biology. As I wanted to remain in research, I studied for a doctorate in Agricultural Sciences and Biotechnology at the University of Udine with a project that was co-financed by the Fondazione E. Mach and Laimburg Research Centre. After obtaining my doctorate in 2021, I was delighted to be able to take up the opportunity of continuing my work in the Functional Genomics Working Group at Laimburg Research Centre, thus exploring the work undertaken during my doctoral studies in greater depth.
The main focus of the working group is on a phytoplasma known as apple proliferation disease, and I am particularly interested in the aspects of interaction between plant and pathogen at protein level.
Research means constantly seeking answers to new questions and solutions to new problems. It is a task that requires non-stop concentration, but it is the unpredictability and constant mental challenge that make this work so fascinating for me.

SARA NICLI

I studied for my Bachelor's degree in Landscape Planning and Landscape Architecture at the University of Natural Resources and Life Sciences in Vienna and then completed a Master's degree in Environmental Management of Mountain Areas at the Free University of Bolzano.
Since 2022, I have worked in the in the Research Area Horticulture the "Nature in the Garden" project. As part of this project, I advise South Tyrolean local authorities about how they can design and maintain their public green spaces to be ecologically, economically and socially more sustainable, paying particular attention to biodiversity, adaptation to climate change and tree maintenance. At the same time I am responsible for looking after the associated website naturimgarten.laimburg.it and conduct guided tours of our show gardens. In addition, I have the opportunity, thanks to our test site, to gain an insight into the creation of indigenous flower meadows.
I particularly value the daily contact with nature and people, the variety of work tasks and being able to research practical solutions for the green spaces of the future.

HELGA PRIGHEL

I have a degree in Economics and Business (old system) from the University of Trento and my professional experience so far has always been focused on contact with different types of customers and users with differing needs.
This is an aspect that still plays a central role in my activities at Laimburg Research Centre today. Since 2018 I have been a member of the Human Resources Working Group and am primarily concerned with the selection processes for the Research Centre, which aim to award fixed-term and permanent employment contracts. Alongside the purely administrative and bureaucratic tasks, a large part of my daily work is devoted to contact with people from both outside (applicants/candidates) and within the Research Centre. This is something that I particularly enjoy, as it makes it possible to create and maintain a working environment that is based on respect, cooperation and transparency with my colleagues, which, in my opinion is extremely important for the sustainability of the organisation.

ELISA MARIA VANZO

I studied Molecular Biology at the University of Innsbruck and Lund University in Sweden. Afterwards I obtained my doctorate at the University of Freiburg and completed a certificate programme in Applied Sensory and Consumer Science at the University of California in Davis.
Since 2021 I have led the Sensory Science Working Group at Laimburg Research Centre. Sensory Science uses the human senses as a measuring tool to detect change in the quality of foods. With the help of trained tasters, a standardised tasting laboratory and statistical design and evaluation of experiments, the influence of ingredients, storage and of new, innovative processing methods on sensory product profiles can be measured.
The exciting thing about my work is the variety of the tasks, from training tasters through to the scientific planning and evaluation of the tests. Naturally, the possibility of getting to know South Tyrolean products and product innovations is a particular attraction too.

ANGELO ZANELLA

I am the head of the Institute for Mountain Agriculture and Food Technology as well as the Storage and Postharvest Biology Working Group at Laimburg Research Centre. In addition, I also lecture at the Free University of Bolzano.
In Bolzano I was able to enjoy an education that introduced me to both the Italian and the German cultural spheres. My studies in Biology at university in Austria (PhD) led me to specialise in microbial physiology, especially biohydrometallurgical processes.
My current areas of research focus are in the field of advanced postharvest technologies for the prevention of harvest losses and for increasing the quality of agricultural produce, including the effects on postharvest physiology, disease prevention and on innovations in quality assessment.
The nice thing about my work is that I am able to actively participate in national and international projects dealing with critical issues at the point where new technologies intersect.

SCIENTIFIC PUBLICATIONS

Thalheimer M. (2022). A leaf-mounted capacitance sensor for continuous monitoring of foliar transpiration and solar irradiance as an indicator of plant water status. Journal of Agricultural Engineering, DOI: 10.4081/jae.2022.1477.

Mora-Vargas A., Kelderer M. (2022). An Overview of Pest and Disease Occurrence in Organic Pome Fruit Orchards in Europe and on the Implementation of Practices for Their Control. Agriculture, Special Issue Innovative Strategies in Organic Farming Systems (12), 2136.

Tomada S., Agati G., Serni E., Michelini S., Lazazzara V., Pedri U., Sanoll C., Matteazzi A., Robatscher P., Haas F. (2022). Non-destructive fluorescence sensing for assessing microclimate, site and defoliation effects on flavonol dynamics and sugar prediction in Pinot blanc grapes. PLoS One 17 (8), 0273166, DOI: 10.1371/journal.pone.0273166.

Soppelsa S., Gasser M., Zago M. (2023). Optimizing Planting Density in Alpine Mountain Strawberry Cultivation in Martell Valley, Italy. Agronomy 13 (5), 1422, DOI: 10.3390/agronomy13051422.

Guerra W., Manfrini L. (2023). Automatisierte Apfelernte. Gartenbauprofi 111 (11), 10-12.

Deltedesco, Evi, and Sabine Oettl. "First report of Preharvest Decay caused by Colletotrichum chrysophilum on apples in Italy (South Tyrol)." plant disease 107.3 (2023): 967.

Falagiarda M., Bortolini S., Schmidt S. (2023). Marmorierte Baumwanze: Evaluierung der dreijährigen Freisetzungen von Trissolcus japonicus. Obstbau Weinbau - Fachmagazin des Südtiroler Beratungsringes 60 (4), 15-18

Spitaler U., Cossu C. S., Delle Donne L., Bianchi F., Rehermann G., Eisenstecken D., Castellan I., Duménil C., Angeli S., Robatscher P., Becher P. G., Koschier E. H., Schmidt S. (2022). Field and greenhouse application of an attract-and-kill formulation based on the yeast Hanseniaspora uvarum and the insecticide spinosad to control Drosophila suzukii in grapes. Pest Management Science 78 (3), 1287-1295, DOI: 10.1002/ps.6748

Prechsl, U.E., Rizzoli, W., Marschall, K. et al. Fungicide-free management of Alternaria leaf blotch and fruit spot on apple indicates Alternaria spp. as secondary colonizer. Sci Rep 13, 8431 (2023). https://doi.org/10.1038/s41598-023-35448-2

Rizzoli W., Acler A., Facchini T., Caset D. (2022). Versuche zur Bekämpfung der Blutlaus. Obstbau Weinbau - Fachmagazin des Südtiroler Beratungsringes 59 (3), 25-33.

Mittelberger C., Hause B., Janik K. (2022). The 'Candidatus Phytoplasma mali' effector protein SAP11CaPm interacts with MdTCP16, a class II CYC/TB1 transcription factor that is highly expressed during phytoplasma infection. PLoS One 17 (12), e0272467, DOI: 10.1371/ journal.pone.0272467.

Letschka T. (2022). Basi genetiche della selezione di resistenze della vite. Frutta e vite - Rivista specializzata del Centro di Consulenza 46 (5), 16-19.

Avesani S., Lazazzara V., Robatscher P., Oberhuber M., Perazzolli M. (2023). Volatile linalool activates grapevine resistance against downy mildew with changes in the leaf metabolome. Current Plant Biology (35-36), 100298, Published online: 25.09.2023, DOI: 10.1016/j.cpb.2023.100298.

Bacher F., Robatscher P., Tagliavini M., Aguzzoni A., Tirler W. (2022). In welchen Vinschger Obstwiesen wurden die Äpfel gepflückt? VIP Blick (8), 24-25.

Eltemur D., Robatscher P., Oberhuber M., Scampicchio M., Ceccon A. (2023). Applications of Solution NMR Spectroscopy in Quality Assessment and Authentication of Bovine Milk. Foods 12 (17), 3240, DOI: 10.3390/foods12173240.

Castelli M., Peratoner G., Pasolli L., Molisse G., Dovas A., Sicher G., Crespi A., Rossi M., Alasawedah M. H., Soini E., Monsorno R., Notarnicola C. (2023). Insuring Alpine Grasslands against Drought-Related Yield Losses Using Sentinel-2 Satellite Data. Remote Sensing 15 (14), 3542, Published online: 14.07.2023, DOI: 10.3390/rs15143542.

Pramsohler M., Gallmetzer A., Castellan A., Neulichedl P., Waldboth B., Reyes Domínguez Y. (2022). First record of Donus intermedius (Coleoptera: Curculionoidae) as a pest on Melissa officinalis in South Tyrol and its identification by molecular methods. Laimburg Journal 4, DOI: 10.23796/LJ/2022.003.

Bianchi F., Gamper G., Lozano L., Simoncini N., Virgili R., Spada L., Venir E. (2022). A simple and portable method for on-line texture measurement of Italian "Speck Alto Adige". Meat Science 190, 108891, DOI: 10.1016/j.meatsci.2022.108831.

Casciano F., Mayr H., Nissen L., Putti A., Zoli F., Gianotti A., Conterno L. (2022). Red Beetroot Fermentation with Different Microbial Consortia to Develop Foods with Improved Aromatic Features. Foods 11 (19), 3055, DOI: 10.3390/foods11193055.

Populin F., Vittani L., Zanella A., Stürz S., Folie I., Khomenko I., Biasioli F., Scholz M., Masuero D., Vrhovsek U., Busatto N., Costa F. (2023). Transcriptome and metabolic survey disclose the mode of action of static and dynamic low oxygen postharvest storage strategies to prevent the onset of superficial scald disorder in fruit of 'Granny Smith' apple cultivar. Postharvest Biology and Technology 205, 112492, DOI: 10.1016/j.postharvbio.2023.112492.

LAIMBURG JOURNAL

Research for Practice LAIMBURG JOURNAL

Since February of 2019,
Laimburg Research Centre has been publishing
its own Open-Access online periodical:
The Laimburg Journal.

OPEN ACCESS

This portal is freely accessible and available at no cost. Its objective is to promote knowledge transfer and to disseminate professional know-how in the areas of agriculture and food sciences and all related fields. The journal publishes sound specialist information in the form of original studies and reports on various agricultural topics relevant for South Tyrol. The journal's target group comprises professionals from the fields of research, industry, politics and teaching, as well as interested laypersons.

Is there a connection between extreme weather events and the occurrence of Berry Shrivel?

Biodiversity survey in medicinal and aromatic plant fields

KULTIVAS: Feasibility study of a variety-location model for apple cultivation

Starting an invasion: A five-year monitoring programme of *Halyomorpha halys* (Hemiptera: Pentatomidae) in South Tyrol (Northern Italy)

LAIMBURG RESEARCH CENTRE ONLINE

The institution's website, **www.laimburg.it**, contains information about organisational structures, research and experimental activities, third-party projects and events.

It is possible to visit the premises, laboratories and trial fields as well as the central building and different external sites throughout South Tyrol virtually via the **virtual 3D tour**. Details of this can be obtained from the various info points.

The project website, **lido.laimburg.it**, provides information on the **LIDO - Laimburg Integrated Digital Orchard outdoor laboratory**.

The project website, **naturimgarten.laimburg.it**, contains information about the **„Nature in the Garden"** initiative, which promotes the ecological design and maintenance of gardens and green spaces.

The most recent version of the **Laimburg Report**, which you are currently reading, is published on the **report.laimburg.it** website.

webGRAS is a web application for quickly and easily assessing the potential quality of fodder free of charge. The development of the application was financed by the European Union and the Autonomous Province of Bolzano.

WebGIS-VEGEMONT is an information system that sets out the suitability of agricultural areas for the cultivation of eight different vegetable and strawberry varieties as well as providing an estimate of the potential harvesting period. The development of the application was financed by the European Union and the Autonomous Province of Bolzano.

POMOSANO contains a catalogue of more than 70 different apple varieties with navigable information and details via a search engine. In addition, the website contains detailed information on the allergenicity of individual apple varieties. The results were obtained as part of the "AppleCare" project, which was financed by the European Regional Development Fund and Interreg V-A-Italy-Austria 2014-2020.

The **Laimburg Meteo App meteo.laimburg.it** is an app that provides weather data and graphical representation of this data from the weather station at the Laimburg site.

THE ROCK CELLAR OPENS ITS DOORS

The site of the Research Centre, which is situated by the historic ruins of Laimburg Castle, is filled with vibrant life, all dedicated to science.

While in the laboratories and experimental facilities of the various departments, experiments are carried out and research conducted into all areas of South Tyrol's agricultural and food processing industries, the province's own wine cellars produce high quality wines that can be tasted in our in-house vinothèque. One place that is not immediately obvious to visitors at first glance is the rock cellar, whose doors are hidden deep in the porphyry rock of the Monte di Mezzo mountain.

WORKING CELLAR AND CEREMONIAL HALL IN ONE

The rock cellar combines a variety of functions. It is a working cellar and bottle store for the provincial winery, and also a ceremonial venue for the province of South Tyrol. Whilst in the barrique cellars the predominantly red, storable reserve wines of the winery's select range, known as the "Manor Selection", mature, the white wine cellar contains wooden barrels up to 38 hl in volume. The white wines from the "Estate Wines" range are matured in the latter. The twelve hectolitre barrel made especially for Laimburg Winery from South Tyrolean oak in which the anniversary Vernatsch, Vernacius solemnis, acquires its special flavour, deserves particular attention.

The centrepiece of the rock cellar, however, is without a doubt the spacious ceremonial hall, which, as an equally historic and sought-after venue, has provided a space for countless events since its grand opening in 1990.

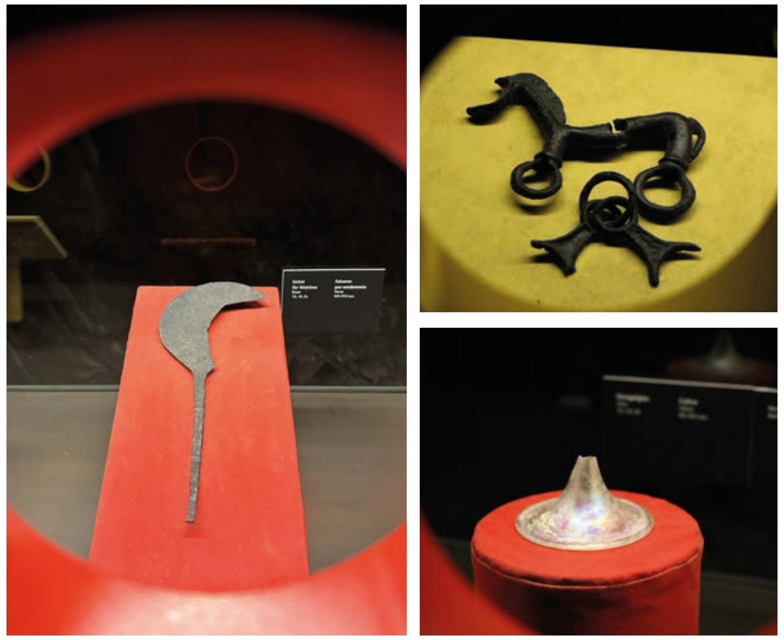


Fig. 4: Among other things, some historic finds are exhibited in the rock cellar.

AT THE HEART OF THE MOUNTAIN WITH ALL OF OUR SENSES

The rock cellar is a place where the senses can run wild, permeated with the aroma of the wines as they mature in the barrels and adorned with special art, culture and architecture. A visit to the rock cellar will live long in the memory of anyone who has been here, and they will also feel a strong desire to share their experience with others.

The visitor numbers bear witness to this keen interest. In the last two years, a total of 20,245 guests from all over the world have visited the "cellar in the rock" and got to know about rarities in the wine archive or marvelled at the archaeological artefacts found all around Laimburg during their tour through the volcanic rock of the Monte di Mezzo. During 164 receptions that took place in 2022 and 2023 in the approx. 300 m^2 ceremonial hall, political delegations and internationally renowned scientists have been welcomed, successful athletes honoured, and diplomas and degree certificates awarded. And, of course, a lot of wines have been tasted during the 253 guided wine tastings.

Fig. 1: The entrance to the rock cellar with a view of the two wine muses by Guido Anton Muss

Fig. 3: In the centre, the barrel made from South Tyrolean oak in which the Vernacius solemnis wine is maturing

EDUCATING VISITORS ABOUT OUR WINE CULTURE

With each of the total of 268 guided tours for which the rock cellar has opened its doors over the past two years, a piece of South Tyrolean wine culture has been passed on to guests. This has ranged from the Rhaetian roots of wine production, today's diverse wine growing in South Tyrol and the experimental work at the Research Centre, to the special kind of conviviality and hospitality that is characteristic of the tastings.

Name of wine	Award 2023	Awarding institution
Vernacius Solemnis	Le 4 Viti	Vitae - la guida vini 2024
Elyond - Gw.Riserva	5 grappoli	Bibenda 2024
Vernacius Solemnis	Miglior Lago di Calaro DOC	Winesurf-guida vini 2023-2024
Elyond - Gw.Riserva	Tra i 12 migliori vini bianchi d`Italia	Winesurf-guida vini 2023-2024
Elyond - Gw.Riserva	The Winehunter Award	The Winehunter Award
Sass Roà- CS.Riserva	The Winehunter Award	The Winehunter Award
Musis	The Winehunter Award	The Winehunter Award
Col de Rèy Riserva	The Winehunter Award	The Winehunter Award
Oyèll -S.Riserva	The Winehunter Award	The Winehunter Award
Saphir- S.passito	The Winehunter Award	The Winehunter Award
Rosenmuskateller passito	The Winehunter Award	The Winehunter Award
Barbagòl	3. migliro vino rosso	Luca Maroni- Annuario dei migliori vini italiani
Sass Roà- CS.Riserva	The Winehunter Award	The Winehunter Award
Rosenmuskateller passito	3 Stelle Oroq	guida Veronelli

HIGHLIGHTS

2022

24.03.2022

The Gender Equality Plan (GEP) of Laimburg Research Centre was published with a range of concrete measures for bringing about equality between the sexes

09.05.2022

Girls in Science at Laimburg Research Centre – inspiring female school students to consider careers in agricultural and food processing research

27.05.2022

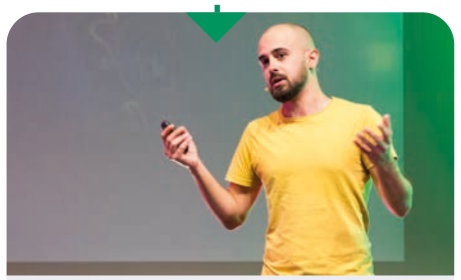
Laimburg Research Centre, The Free University of Bolzano, the South Tyrolean Advisory Council for Fruit and Grape Growing and the Felderer Terra Laboratory organised the first South Tyrolean Soil Symposium: Healthy Soils as the Foundation for Successful Agriculture

19.07.2022

The Show Garden at Laimburg Research Centre is the first garden in South Tyrol to obtain the "Nature in the Garden" certification - an initiative for the sustainable design and maintenance of gardens and green spaces

26.10.2022

The "LIDO - Laimburg Integrated Digital Orchard" opened. LIDO is the South Tyrolean outdoor digital laboratory for fruit and grape growing with the aim of advancing digitalisation and robotics in agriculture



28.10.2022

Two researchers from Laimburg Research Centre win at the Science Slam South Tyrol: Mattia Tabarelli and Christian Öhlmann

02.11.2022

First female Head of Institute at Laimburg Research Centre: Sabine Öttl takes over the Institute for Plant Health

14.11.2022

"Green Genetic Engineering" information event: a discussion of hybridisation, mutagenesis, traditional genetic engineering and genome editing

2023

15.05.2023

Inauguration of the Laboratory of NMR Spectroscopy with Nobel Prize for Chemistry winner, Professor Kurt Wüthrich. The focus of the new laboratory is on characterising agricultural and food products.

18.05.2023

Inauguration of the Laboratory for Sensory Science for objectively describing the sensory characteristics of foods using teams of professional tasters.

15.11.2023

Information event on the topic of Invasive Neophytes: non-native species of plants that are proliferating in South Tyrol and which could endanger local plant species

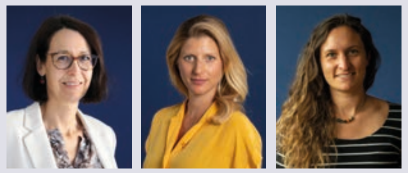
22.11.2023

Brown marmorated stink bug information event: 15 projects, 37 papers and 67 presentations and poster contributions since 2016 for improved management of this invasive insect pest.

COLOPHON

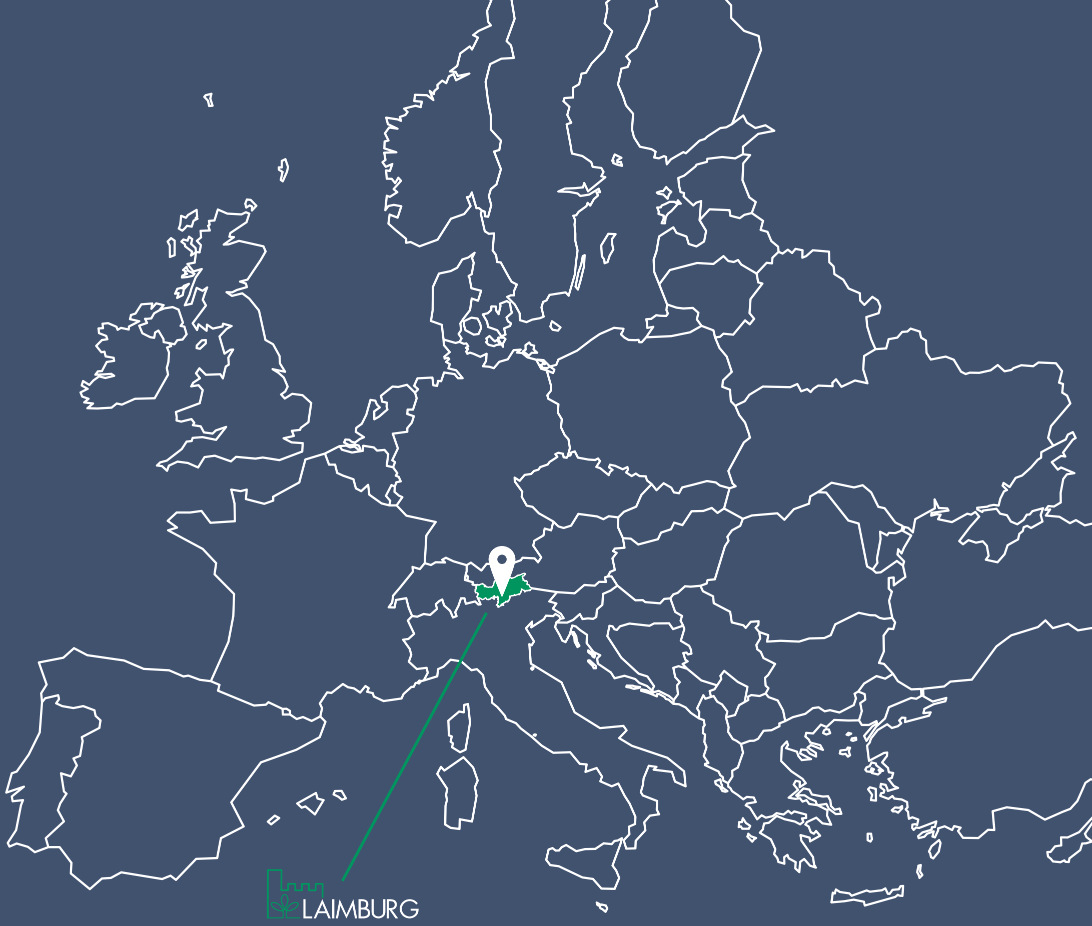
Photo credits
Laimburg Research Centre/Ivo Corrà
Laimburg Research Centre/Andreas Tauber
Laimburg Research Centre/agnese martinelli/ david montagna
NOI Techpark/Ivo Corrà
NOI Techpark/Fanni Fazeka

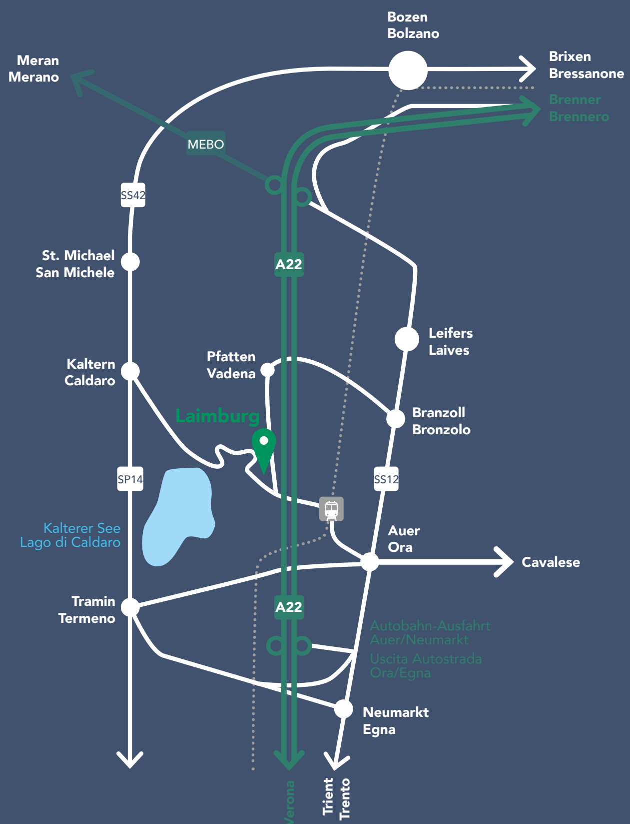
Editing
Jennifer Berger, Julia Rizzo, Johanna Höller



Graphic design
Conceptart Werbeagentur | www.concept-art.it

Print
Longo SpA





www.concept-art.it

Versuchszentrum
Centro di Sperimentazione
Research Centre
LAIMBURG
NATURE & SCIENCE: HAND IN HAND

Laimburg 6 Vadena, 39040 Ora, Italy
versuchszentrum@laimburg.it
+39 0471 969 500 | **www.laimburg.it**