AgroSCOPE

Annual Report 2016

Agroscope good food, healthy environment

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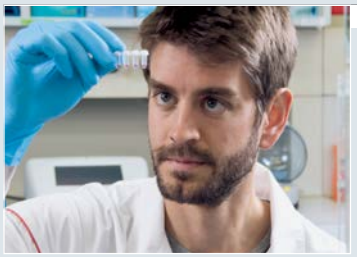
Quarantine pest or harmless insect? Today, we can find out in two hours instead of two days.



Plants

Sustainability

Food

Livestock

Mission Statement

Swiss Research for Agriculture, Nutrition and the Environment

Agroscope, the Swiss Federal Centre of Excellence for Research in the Agriculture and Food Sector, is affiliated with the Federal Office for Agriculture (FOAG). Agroscope is strategically managed by the Agroscope Council, whilst the Agroscope Executive Board is responsible for its operative management.

Vision

Agroscope makes an important contribution to a sustainable agriculture and food sector as well as to an intact environment, thereby contributing to an improved quality of life.

Aim and Purpose

Agroscope researches along the entire value chain of the agriculture and food sector for a competitive and multifunctional agricultural sector, for high-quality food for a healthy diet, and for an intact environment. Our focus is on research and development for the benefit of the agriculture and food sector; the provision of decision-making bases for federal-authority legislation; enforcement tasks within the framework of the legal provisions in the service of agriculture and the general public; and knowledge exchange and technology transfer with practitioners, agricultural extension, industry, science, the teaching sector and the public.

Innovations for Practice

"Everything should be made as simple as possible, but no simpler" Nobel prize winner Albert Einstein was meant to have said. Much the same applies for solutions to current challenges in the agriculture and food sector: what is needed here are methods that are as simple and practical as possible, which make a positive impact whilst respecting the environment, going easy on the wallet and staying within the time budget. But an innovative method is worthless if it is not put into practice.

The cover story, 'Stopping Pathogens at the Terminal', describes the successful implementation of just such a method. In the perishable goods hall at Zurich airport, fruit, cut flowers and much more piles up. These goods can harbour harmful insects that have not yet been detected in Switzerland, and which could cause major harvest losses. Previously, identifying these pests would take two days – too long for perishable goods. Agroscope experts have developed a method enabling the on-site plant-protection inspector to achieve the same result within two hours.

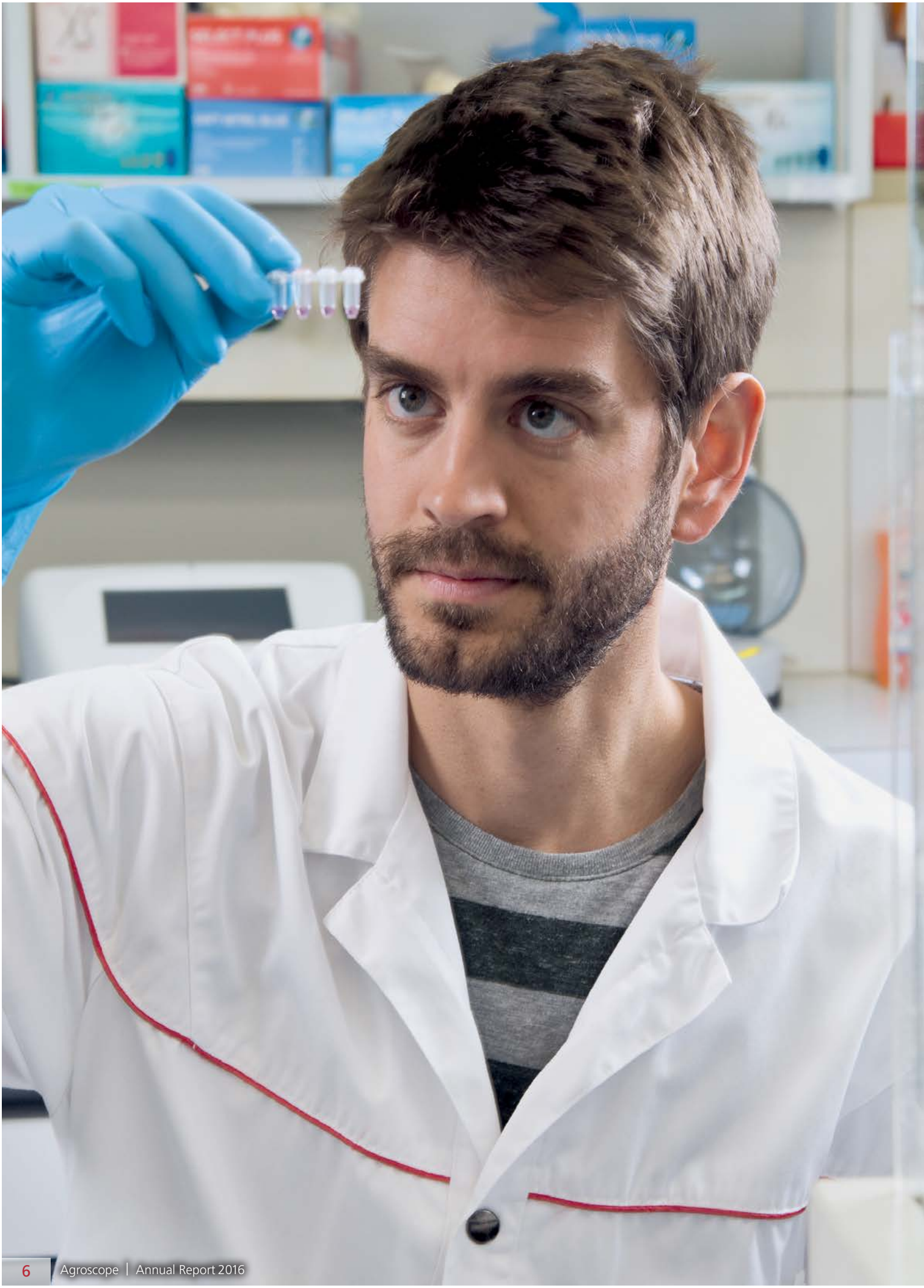
The article 'The Road to Digital Farming' shows how modern information technologies are used to control agricultural machinery more precisely, to improve pest forecasting, and to set robots on the hunt for weeds.

Read how Agroscope researchers help prevent antibiotic-resistant bacteria on food in the article 'Antibiotic-Resistant Bacteria on Salad Plants?'.

Nowadays, soya is imported *inter alia* to fatten pigs. The article 'Fattening Pigs without Soya' demonstrates how a simple discovery can blossom into a major innovation.

Thus, when innovations for practice are needed that are simple, fit-for-purpose and effective, Agroscope is the right port of call – because we are already dealing with tomorrow's issues, today.

Michael Gysi
Head of Agroscope



Stopping Pathogens at the Terminal

In the perishable goods hall of an airport, the waiting time for inspection must be short. But when suspicious organisms are found in the freight, they must be identified in order to keep quarantine organisms out of Switzerland. Thanks to a method optimised for use in practice, this now takes just two hours instead of two days.

"Time is money" – this quotation from Benjamin Franklin, the American inventor and statesman, is particularly true in the perishable goods hall of an airport. There, newly arrived goods from the four corners of the earth pile up – fruit, vegetables, cut flowers and much more.

One person who tests these goods at Zurich airport for pathogens is Hanspeter Diem, a plant-protection inspector at the Swiss Federal Plant Protection Service SPPS. In a suspected case, he must determine whether quarantine organisms are present. These organisms must be stopped at Customs, as the majority of them are not yet present in Switzerland, and could cause damage in the agricultural, horticultural or forestry sector.

Often, however, Diem finds only insect eggs or larval stages that cannot be unequivocally identified by eye. Such samples must be genetically analysed, and are sent to Agroscope's central laboratory. "Previously, we waited two days for an answer" explained Diem. Although two days is good from the laboratory perspective, space in the airport hall is limited; what's more, perishable goods can't afford to be kept waiting. Hence, the need for a quicker method.

Simon Blaser worked on the new method and shortened the waiting time for perishable goods at the airport.

2011 – First flight attempts

It was with just such a method that Andreas Bühlmann travelled to the airport in 2011. A PhD student, he was researching a quick method for identifying harmful organisms by means of a genetic fingerprint – similar to a paternity test. During filming of the programme 'Einstein' for Swiss television, he gave an on-the-spot demonstration of the LAMP (= loop-mediated isothermal amplification) method – a process for chemically amplifying DNA at a constant temperature.

If the plant-protection inspector discovers a suspicious insect, he places two of the creatures in two separate test-tubes with an extraction solution. The solution is heated,

releasing the DNA. Two control test-tubes, each containing one specimen of the quarantine organism in question, also form part of the testing kit. The four tubes are inserted in a detection device that is smaller than a shoe box. There, the sample is heated to 65 degrees Celsius. At this temperature, a DNA polymerase makes copies of specific sections of the genome.

After no more than two hours, the results are visible: if DNA sections were amplified which only match the control quarantine organism, the results are positive, and the tested insect is indeed a quarantine organism.

2015 – Clearance for take-off

In 2011, i.e. still in the same year, the method was presented at an Inspectors' Workshop of the European and Mediterranean Plant Protection Organization EPPO in Padua, Italy. One of the participants was Andreas von Felten, Diem's boss and the person responsible for plant-protection inspections in Switzerland. With London Heathrow also poised to launch such a system, von Felten realised at once that Bühlmann's method had a future.

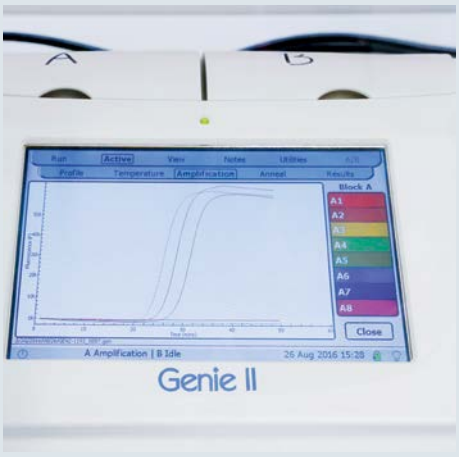
Andreas von Felten got in touch with Jürg Frey, Bühlmann's supervisor at Agroscope. Von Felten and Frey agreed that the innovation potential was there, but the method's successful implementation in practice was critically dependent on the training of the people who would be working with it. This task was assumed now by Simon Blaser, after Andreas Bühlmann had finished his PhD.

For Blaser, introducing the LAMP method at the airport meant on-the-spot training of specialist staff, and overcoming problems. He introduced an extraction method even simpler than the original one, and added dye to all of the reagents to make them clearly visible, thereby reducing the risk of mistakes. Blaser succeeded in his task.

2016 – Optimum altitude reached

From 2015 to 2016, 59 samples were tested both at the airport and in the Agroscope laboratory. All results detecting a quarantine pest were positive both on-site and in the lab. Thanks to the quick decision, the importer would now still have time to organise a replacement delivery.

However, around two per cent of the negative test results were false negatives. This means that in two out of every hundred imports, a quarantine pest would have entered the country undetected. That's why to this day, negative results are still examined in the Agroscope laboratory, and the relevant testing kits are being refined. Agroscope now provides kits for identifying several fruit flies of the genus *Bactrocera*, as well as for *Thrips palmi, Bemisia tabaci* and three *Liriomyza* species (*L. sativae, L. trifolii* and *L. huidobrensis*). Hanspeter Diem would like to see testing kits for additional insects, as well as for fungal diseases on citrus fruits.



Smooth cruising and a new destination

Jürg Frey, the actual father of the use of this method, has been identifying agriculturally important organisms by means of genetic barcodes since 1995 – because, provided that it is solidly validated, genetic identification is quicker and more reliable than classic morphological identification.

Jürg Frey worked on LAMP methods *inter alia* as part of the EU projects QBOL and Q-Detect, after which he continued to refine the LAMP system described above. At present, the system used at Zurich airport is the most advanced in the world.

But Jürg Frey is already working on the next step: "The future belongs to sequence-based diagnostics. With LAMP, you see, we can only tell whether the sample is type A or not." In other words, each quarantine organism needs a validated test of its own. "The aim is actually a system that tells us which species the sample belongs to" says Jürg Frey, placing a little box on the table – a nanopore sequencing device the size of a large pocket knife. "The biggest problem is still the preparation of the sample – the process is too complicated at the moment, but we'll solve that too…" ■

Wood Shavings Increase Shelf Life of Fruit and Veg

Unadulterated wood shavings can be a sustainable alternative to synthetic packing materials in trade and retail. Laboratory tests conducted by Agroscope have shown that wood shavings can lead to growth inhibition and a reduced survival rate for certain bacteria and fungi. These effects could not be detected for all microorganisms or test conditions, however. In practical trials, wood shavings contributed to an improved shelf life for apples, strawberries and tomatoes.

Resource-Efficient Disinfection Method

Worldwide, there is a great demand for alternatives to chemical and thermal disinfection processes. 'ebeam' technology is based on low-energy electrons with an antimicrobial effect. Compared to conventional methods, it is resource-efficient: no water use, reduced energy requirement, no problems with chemical residues. Agroscope is testing this technology for the sanitation of seeds and seeding material for sprout production.

Stable Microbial Diversity in the Soil

There is enormous species diversity in the soil, and different land-use types and sites harbour different microbial communities. This is shown by the recording of the state of agricultural soils in the reference measurement network of the Swiss Soil Monitoring Network (NABO) by means of biological parameters (NABObio). Over four years, the microbial communities of the thirty NABObio sites on field and grassland and in the forest proved to be relatively stable.

Social Boxes Foster Contact with Stall Neighbours

Special individual boxes allowed stallions at the Swiss National Stud to interact with one another without the occurrence of serious injuries. Thanks to the vertical bars, they were able to play, feed or rest together. This new type of box wall therefore represents an enrichment for horses housed on their own. A solution for preventing skin abrasions caused by bumping the head against the vertical bars must still be found, possibly by cushioning the metal.

Foulbrood Identification Method Accredited

European and American foulbrood are serious bee diseases and are therefore notifiable animal diseases. A method recently developed by Agroscope now makes it possible to simultaneously identify a specific DNA sequence for both pathogens. The method has been authorised. Agroscope's Centre for Bee Research is a reference laboratory, and can thus support authorities and recognised laboratories with diagnosis.

High Rainfall Yields Good Resistance Data

Agroscope is currently studying eight cisgenic potato lines with resistance genes against potato late blight in a field trial on the Protected Site. Frequent, heavy rainfalls in 2016 favoured the development of this plant disease, which facilitated data collection. The result was clear: two of the resistance genes used proved to be completely effective against late blight, whilst two other resistance genes afforded partial protection to the plants.

Molecular Detection of Potato Viruses

Every year, as part of the process of certifying potato plants intended for Swiss producers, Agroscope inspects around 300,000 tubers to ensure that they are free from viral diseases. Since 2016, this is done via quantitative reverse transcription polymerase chain reaction (real-time RT-PCR) right after the harvest. This method allows results to be obtained more quickly, and dispenses with the use of toxic and environmentally hazardous substances. It also offers the means to check each stage of the analysis, and can be adapted to screen for other types of microorganisms likely to affect the quality of the potato plants.

'Insect Monitoring' Tool Available Online

Since spring 2016, the flight curves of the main pests in orchards and vineyards are available free of charge at www.agrometeo.ch. Developed by Agroscope, 'Insect Monitoring' allows users to view the activity of an observed pest in space and time, facilitating an overview of the pest situation within a region, canton, or part of the country. This new tool enables an even more targeted and sustainable approach to pest control.

The Road to Digital Farming

We have long since become accustomed to new technologies changing our lives. Smartphone applications, satellite navigation, online retailing and cybergaming are just a few of the key words illustrating this fact. A similar change is now also underway in agriculture, with so-called smart farming or agriculture 4.0.

Developments which better define agricultural systems and allow for more precise management are summarised under the terms 'agriculture 4.0' or 'smart farming'. The primary aims of these systems are resource efficiency, emission-, cost- and workload reduction, and the improvement of product quality. As in the private sphere, technologies used in farming are highly diverse, ranging from simple individual applications all the way to complex internet-linked systems.

Today, satellite positioning systems mean that agricultural machinery can be steered to centimetre accuracy. It is thus possible to traffic fields exclusively on fixed tramlines, which remain in the same place year after year. Such technologies – known as 'controlled traffic farming' (CTF) – can minimise the negative effects of soil compaction. The aims are a loose soil structure, and hence adequate water infiltration even after heavy precipitation, as well as improved rootability of the soils. A trial demonstrated the potential of CTF in Switzerland. Currently, attempts are underway to implement this system in practice.

Targeted plant protection

Sensor technologies are suitable for refining forecasting systems that calculate the development of pests and diseases in advance. These include e.g. the pest forecasting tool for fruit production (SOPRA), the risk assessment of Fusarium infestation in cereals (FusaProg), and the warning and forecasting system for controlling potato late blight (PhytoPRE). In this way, targeted plant protection is encouraged and unnecessary treatments avoided. In future, these classic forecasting systems will be expanded by new technologies.

Matthias Hatt calibrating the tramlines for controlled traffic farming (CTF).

Smart farming is also in demand in connection with irrigation systems. Around half of the apple orchards in Switzerland are irrigated. Automatic irrigation systems that also take soil moisture and plant parameters into account are still in their infancy, however. Relevant trials are currently underway in the Valais region, among other places.

Virtual fences could allow us to check the health and feeding activity of cows.

Improving animal monitoring

Among dairy cattle, fertility and metabolic disorders are common. In future, precise monitoring of the animals should allow us to keep a close watch on their state of health. An example of such a monitoring system is Rumiwatch. In cooperation with the industry, Agroscope is currently refining this monitoring system with a view to it supporting farmers in this task in future.

Sensors can also simplify grazing. The intention is to improve the energy efficiency of positioning systems through the use of new

technologies that can transmit data over large distances using as little transmission capacity as possible. In addition, it should also be possible in future to deliberately influence the radius of movement of cows through 'virtual fences', and to monitor their health and feeding activity.

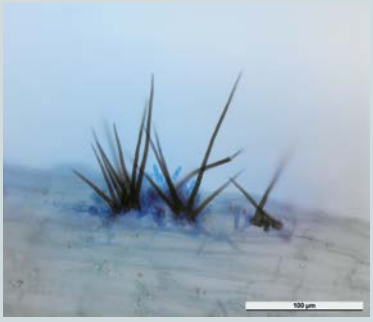
Robots for controlling dock plants

Smart farming also offers new possibilities for organic agriculture. The development of the hot-water method for controlling dock weeds opens the way for the automated control of these plants without pesticides. It's now a question of also tackling the demanding task of automated identification. A new prototype is expected to be built in the near future as part of an EU project.

Applications in a wide range of fields show that there are numerous opportunities for optimising production processes in agriculture. The aim is to manufacture products of even higher quality that can be produced both efficiently and with minimal adverse impact on the environment ■

Useful Microbes for Vegetable Production

Harmful soil-borne organisms are a growing problem in outdoor vegetable production. Such insect pests and diseases could be controlled with the help of microbial antagonists. Both the use of new organisms and the inclusion of microbes in cultivation systems are being tested and optimised. These alternative methods will catch on in practice if they are technically easy to implement. The aim of the Agroscope work is eco-friendly plant protection in vegetable production.



Influencing the Quality and Ripening of Cheese

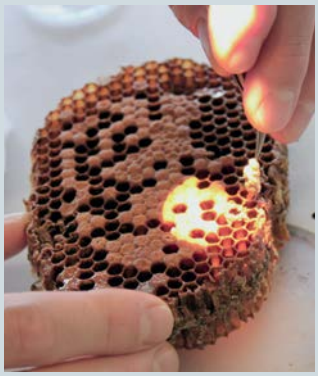
The arginine-deiminase (ADI) pathway, in which arginine is broken down into ornithine, ammonia and CO_2, can be found in various lactic acid bacteria. A number of Agroscope studies point to the fact that the pathway is an important source of CO_2- and eye formation, as well as of flavour formation and ripening in cheeses. In cheese trials with ornithine-forming cultures, the latter have been shown to substantially influence ripening and quality of the cheese.

Pests and Beneficials: A Reference Work

The second volume of the *La Vigne* collection brings together current research and summarises the knowledge acquired over the course of the last few decades. "Our approach is based on the famous book *La défense des plantes cultivées*, published in 1909, and whose successive versions have supported generations of professionals" explains Olivier Viret. This new work shows that all research conducted nowadays allows farmers to dispense with insecticides and acaricides in the majority of cases. An invaluable guide for integrated pest control.

Varroa Treatment in Mild Winters

Warm winter weather may mean that the queen bee continues to lay eggs, reducing the effectiveness of the winter treatment against Varroa. Our experiments showed Varroa to have a significant presence in the brood cells. Thus, even in mild winters the broodless colony should be treated with oxalic acid. If necessary, the winter brood must be destroyed. Alternatively, the queen can be confined for 25 days. This will prevent her from laying eggs, and the broodless colony can then be treated.



Antibiotic-Resistant Bacteria on Salad Plants?

Antibiotics are increasingly losing their medical effect. This is down to an increase in antibiotic-resistant bacteria occurring not only in humans and animals, but also on foodstuffs. Agroscope is investigating how antibiotic resistance can be transferred to plant-based food.

Vegetable foodstuffs such as fresh salads are subject to numerous risks of contamination with undesirable microbes during production. Bacteria can, for instance, be transferred to the plants via organic fertilisers, the soil, animals, or irrigation water. Consumers ingest numerous bacteria by eating fresh raw products. Most of these bacteria are harmless, or even useful, for humans. Others, however, are undesirable, such as disease-causing salmonellae, enterohaemorrhagic *E. coli* (EHEC) and listeria, as well as all the antibiotic-resistant bacteria.

Antibiotic-resistant bacteria are of course widespread in the environment. In recent decades, however, their numbers have multiplied owing to the increased clinical use of antibiotics. Increasingly, so-called multi-resistant bacteria, which are impervious to three or more classes of antibiotics, can also be found in the environment.

Focus on Irrigation

As part of the Agroscope Research Programme REDYMO, scientists are therefore investigating how antibiotic-resistant bacteria come to be present on salad plants, devoting particular attention to the antibiotic-resistant gut bacteria *E. coli* and enterococci, both of which serve as faecal indicators. Special focus is placed on irrigation water. After sampling plants and irrigation water, resistant bacteria are cultured in the laboratory on nutrient media with various antibiotic additives. Afterwards, the resistance of the isolated bacteria to up to 32 clinically important antibiotics is determined. Several multiresistant *E. coli* strains have so far been identified in this way.

Maria Stergiou and David Drissner collect samples of young salad plants.

Confirming Suspicions

To determine whether irrigation water contributed to the appearance of resistant gut bacteria on plants, bacterial isolates from water and plant samples with the same antibiotic resistance pattern underwent genetic analysis in the form of multi-locus sequence typing (MLST). This method is used to determine the origin of the bacteria, e.g in order to identify the responsible foodstuff in the case of a foodborne disease outbreak. These analyses have demonstrated that the irrigation water represents a source of contamination with antibiotic-resistant *E. coli* on plants.

The use of antibiotics has caused an increase in the numbers of antibiotic-resistant bacteria.

Avoidance Measures

Agroscope experts conducted this study in partnership with the industry, specialist agencies and commercial farms. The occurrence of *E. coli* and enterococci in the irrigation water is investigated in various Swiss growing regions on salad plants, from cultivation through to the harvest product and processed cut salads.

Based on this, measures for avoiding contamination of fresh and cut salads were summarised for vegetable growers in an Agroscope factsheet. This factsheet will be published in 2017.

Research Continues

Further studies are to be launched as part of the National Strategy for Antibiotic Resistance (StAR) and the Swiss National Science Foundation (SNSF)-financed National Research Programme 'Antimicrobial Resistance' (NRP72). The aim: to investigate additional

contamination sources, such as the soil, or organic fertilisers used in agriculture.

Since early 2017, Agroscope experts have been researching what resistances and bacteria from the soil, water or fertilisers are transferred to salad plants up to harvest, to what extent this occurs, and which resistances survive and reach humans. This should allow recommendations to be developed for agricultural practitioners, for monitoring programmes and for official guidelines. In this way, Agroscope hopes to contribute to a reduction in antibiotic resistance in the environment and agriculture, as well as to reduced transfer to the food chain ■

Dairy Products: Zero-Defect Raw-Milk Cheese

The potential contamination of Swiss cheese with *Listeria monocytogenes* and coagulase-positive Staphylococci was researched as part of the National Investigation Plan for Milk and Dairy Products. In the time period studied, all industrially manufactured cheeses had zero defects. It was also shown that it is quite possible to manufacture raw-milk cheeses without a higher risk of contamination with *L. monocytogenes* or coagulase-positive Staphylococci.

Recommended Varieties of Forage Plants

"The principle that only the best varieties are good enough is especially true for ley farming" explains Daniel Suter of the Forage Production and Grassland Systems Research Group. Leafy, high-yielding persistent plants are desirable for forage production. The *List of Recommended Varieties of Forage Plants* contains all of the varieties that comparative variety trials conducted in Switzerland have proven to be the best. The List is also the basis for clover/grass mixtures with an AGFF (Swiss Grassland Society) quality mark.

Drosophila suzukii: Feeling the Heat

The year 2016 was marked by a high pest population. Damage was reported on cherries, mainly in plots without protective nets. In small fruits, the implemented prevention and protection strategies limited damage. Autumn raspberries and blackberries remain difficult to protect, however. Sizable losses were recorded for apricots. In vineyards, a few sensitive grape varieties were attacked. It seems that grapes are not a preferred host plant of the spotted-wing drosophila.

Using Sensors to Counter Ruminal Acidosis

Subacute ruminal acidosis is a common disease of high-performance cows. Recording pH profile in the rumen would be helpful for the early detection of incipient ruminal acidosis. According to an Agroscope study, the reticulum measurements of the available sensors deviate significantly from the pH in the rumen. Moreover, the useful life of these sensors – also called 'pH boli' – is just 150 days, and hence does not cover a full lactation, or the productive life of a cow.

Fattening Pigs without Soya

If Switzerland were to focus on fattening pigs that can get by on less protein, the country could save an amount of crude protein equivalent to the amount of soya imported to feed pigs.

Every year, around 75,000 tonnes of soya as a protein source, most of it produced abroad, winds up in the feed troughs of Swiss pigs. These soya imports are controversial owing to their long transport routes from South America, and the clearing of old-growth forest for farmland.

Whilst examining the feed standards for pigs, Agroscope researchers made a surprising discovery: there are pigs that deliver the same performance on less protein. Around thirty per cent of the animals show entirely normal growth with an underprovision of protein. What's more, they excrete less nitrogen, thereby reducing environmental pollution.

Adapting pig type to feed

With targeted breeding of the more efficient pigs, a significant percentage of soya imports could be spared. Agroscope researcher Peter Stoll is even convinced that it would allow Switzerland to dispense completely with soybean imports for fattening pigs. This would lead to a reduction in the cost of feed, and to domestic or alternative protein sources having a better chance. In concrete terms, it would bring about an annual savings of CHF 18 million and lower excretion levels of 5300 tonnes of nitrogen in Swiss pig production. As Peter Stoll explains: "All in all, a rethink of pig breeding – namely, adapting genotype to feed – would substantially increase the sustainability of pig production over the longer term."

Some piglets achieve similar meat yields to conventionally fed animals, even without soya in their diet.

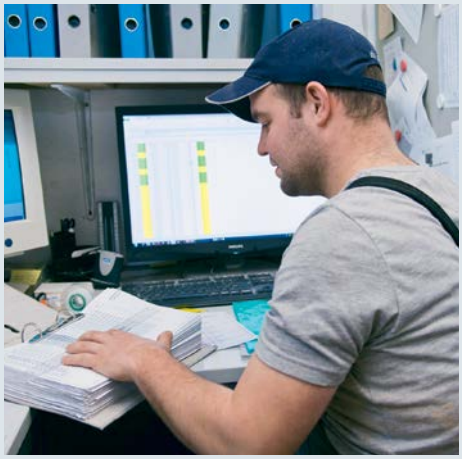
Less protein, no losses

And what about animal health and meat quality? "The pigs in our research project that showed normal growth when undersupplied with protein were even better off, since underprovision meant that they received a needs-based feeding for their type" says Peter Stoll. As regards meat quality, Agroscope is currently conducting a further project. Peter Stoll sums up the situation thus: "The overarching objective of pig breeding must be the selection of animals that forfeit nothing in terms of health, daily weight gain, meat quality or fertility when fed less protein."

Pigs that didn't need soya could save Swiss producers CHF 18 million per year.

Bringing the industry on board

These findings are especially valuable for pigs fed an organic diet, since they excrete more nitrogen than those on conventional fattening farms. This is because organic pig producers dispense with synthetic amino acids in the feed, which raises the amount of nitrogen in the pig's excreta. A joint research project with the Research Institute of Organic Agriculture (FIBL), the School of Agricultural, Forest and Food Sciences (HAFL) and the Service Centre for Pig Production (SUISAG) is currently being developed with the support of the Federal Office for Agriculture (FOAG).



The aim of this project is to determine the rations that enable fattening pigs to be fed a diet of 100% organic feedstuffs, allow ecological factors to be taken into account, and yield a meat quality that fulfils the expectations of consumers.

Raising a more efficient pig

This project also includes a module in which SUISAG tests whether the feedstuffs – low-nitrogen or conventional – have an influence on which pigs are selected for further breeding. Is it always the same genotypes, or are there different ones?

For Agroscope and its research partners, practical cooperation with SUISAG is extremely valuable, since the latter's access to animals from throughout Switzerland contributes to the creation of a wide gene pool. These are ideal conditions for large-scale trials for determining how to achieve more-efficient breeding lines of fattening pigs. One day, producers will be able to rely on fattening pigs that get by on less protein, and will therefore be able to reduce soya imports ■

Significance of Cheese Defects Caused by Bacteria

Cheese defects caused by propionic acid bacteria include brown spots in the curd, atypical eye formation, cracks, and flavour defects. Even with Emmentaler, where the milk is inoculated with propionic acid bacteria, wild strains from the raw milk can cause damage by leading to secondary fermentation. A recent issue of Agroscope Transfer sheds light on the characteristics of propionic acid bacteria, and discusses the cheese defects caused by it in a variety-specific manner.

New Guidelines for Fertiliser Application

The 'Principles of Agricultural Crop Fertilisation in Switzerland' (PRIF) are primarily a tool for agricultural advisers, but also serve to help farmers with practical questions concerning the fertilisation of agricultural crops. In addition, the PRIF guidelines are used by researchers, political decision-makers and for legal enforcement. Agroscope worked on a new edition of the guidelines for 2017. For the first time, fertilisation data for field crops, forage crops and special crops are presented in a complete work in modular form.

Early Detection of Lameness in Cows

Painful hoof and limb ailments adversely affect the well-being of animals and lead to economic losses. The current study therefore compares the behaviour of healthy and slightly lame dairy cows in loose housing on twenty Swiss commercial farms. The aim is to identify differences that can be used for an early, automated detection of lameness, thereby contributing to the prevention of serious ailments.

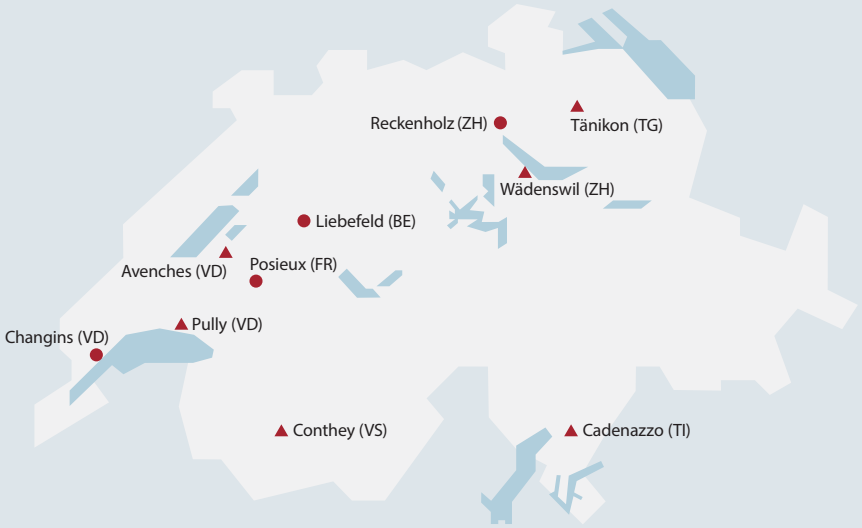
New Sampling of Accounting Data

Since 2016, Agroscope's agricultural income has been determined on the basis of a random sampling. From a certain size onwards, any farm can now be asked to make its accounts available, on a voluntary basis and in an anonymised form, to the Farm Accountancy Data Network. This approach leads to a significant improvement in the representativeness of the sample, compared to the previous, non-random selection of the farms.

State Accounts 2016

Statement of Financial Performance	Accounts 2015	Accounts 2016	Divergence 2016/2015	Divergence 2016/2015
	in CHF	in CHF	in CHF	in %
Functional earnings				
Financially impacting	23,116,663	22,479,015	–637,648	–2.8
Non-financially impacting	–606,554	–825,777	–219,223	–36.1
Total revenues	***22,510,109***	***21,653,238***	***–856,871***	***–3.8***
Functional expenditure				
Financially impacting	140,241,926	136,276,490	–3,965,436	–2.8
Non-financially impacting	4,970,696	5,154,620	183,924	3.7
Service accounting between offices	50,740,188	51,126,848	386,660	0.8
Total functional expenditure	***195,952,810***	***192,557,958***	***–3,394,852***	***–1.7***
Statement of Investments				
Investment income	16,979	10,755	–6,224	–36.7
Investment expenditure	5,091,291	4,280,114	–811,177	–15.9
Reserves				
Creation of earmarked reserves	507,000	826,300	319,300	63.0
Use of earmarked reserves	––	380,000	380,000	––
Third-Party Funds				
Acquisition of third-party research funding	15,233,280	14,614,579	–618,701	–4.1

Sites



Key Figures 2016

911 people on average were employed by Agroscope in 2016, based on financially impacting expenditure.

394 of these were women, corresponding to a 43 % share.

65 trainees were employed.

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1217 articles and papers were published during the year under review.

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2155 classes and lectures at universities and technical colleges were given by staff during the past year.

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14.6 million Swiss francs of outside funding were obtained for research by Agroscope in 2016.

Addresses

Agroscope
www.agroscope.ch

Schwarzenburgstrasse 161, 3003 Bern
Tel. +41 (0)58 463 84 18
Fax +41 (0)58 463 82 27

Sites:

Avenches
Swiss National Stud Farm
Les Longs-Prés, Postfach 191, 1580 Avenches
Tel. +41 (0)58 482 61 11

Cadenazzo
Agroscope
A Ramél 18, 6593 Cadenazzo
Tel. +41 (0)58 466 00 30

Changins
Agroscope
Route de Duillier 50, Postfach 1012, 1260 Nyon 1
Tel. +41 (0)58 460 44 44

Conthey
Agroscope
Route des Eterpys 18, 1964 Conthey
Tel. +41 (0)58 481 35 11

Liebefeld
Agroscope
Schwarzenburgstrasse 161, 3003 Bern
Tel. +41 (0)58 463 84 18

Posieux
Agroscope
Rte de la Tioleyre 4, Postfach 64, 1725 Posieux
Tel. +41 (0)58 466 71 11

Pully
Agroscope
Av. de Rochettaz 21, 1009 Pully
Tel. +41 (0)58 460 44 44

Reckenholz
Agroscope
Reckenholzstrasse 191, 8046 Zurich
Tel. +41 (0)58 468 71 11

Tänikon
Agroscope
Tänikon 1, 8356 Ettenhausen
Tel. +41 (0)58 480 31 31

Wädenswil
Agroscope
Schloss 1, Postfach, 8820 Wädenswil
Tel. +41 (0)58 460 61 11

Masthead

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Editorial Board	Carole Enz (Project Manager), Ania Biasio Régis Nyffeler, Ariane Sotoudeh
Contributors	Christian Ahrens, Thomas Anken, Iris Bachmann, Catherine Baroffio, Robert Baur, Sandrine Belcher, Thomas Berger, Lukas Bertschinger, Simon Blaser, Susanne Brunner, Andreas Bühlmann, Joan-Bryce Burla, Jean-Daniel Charrière, Benjamin Dainat, Simone de Montmollin, Hanspeter Diem, Frigga Dohme-Meier, David Drissner, Brice Dupuis, Nadja El Benni, Jürg Frey, Marie-Therese Fröhlich, Andreas Gubler, Christoph Haldemann, Matthias Hatt, Anna Hug, Patrik Kehrli, Willy Kessler, Markus Lips, Matthias Lutz, Andreas Lüscher, Reto Meuli, Thomas Poiger, Walter Richner, Cornelia Sauer, Olivier Schumpp, Sokrat Sinaj, Maria Theresia Stergiou, Peter Stoll, Fredi Strasser, Daniel Suter, Ute Vogler, Andreas von Felten, Beat Wechsler, Daniel Wechsler, Michael Winzeler, Anja Zollinger
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Agroscope Headquarters
Schwarzenburgstrasse 161
3003 Bern

www.agroscope.ch

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