ARVALIS'S WORK

2019/2020 IN 24 EXAMPLES

ACTIVITY REPORT

ARVALIS - Institut du végétal is an applied research organisation for farmers, specialising in arable crops and their markets. Its work focusses on cereals, maize, sorghum, potatoes, forage crops, flax and tobacco. The Institute's mission is to find effective agronomic, economic, environmental and plant health solutions. It then communicates to farmers, to help them adapt and face current challenges such as climate change, societal expectations, commercial requirements and international competition. Over 400 colleagues staff 27 sites throughout France, working in experimental fields and laboratories to evaluate innovations, and disseminate them to farmers through various communication platforms (meetings, training sessions, trade fairs, technical publications, the Internet, etc.). Its research work focusses on agronomy, economy, knowledge of plants, modelling, biotechnology, crop management and protection, agro-ecology, precision farming, agri-equipment, digital applications, harvest and storage, quality, and markets for the agricultural products that are within its remit.

ARVALIS'S ROADMAP TO 2025

Arvalis's Board has produced the new roadmap that will steer the Institute to 2025. Its 2021-2025 corporate plan will include this set of strategic guidelines. In the autumn of 2019, Arvalis's comprehensive survey of the various parties with whom it interacts (the usual stakeholders, as well as NGOs, industry and academic research players, policy makers, etc.), produced a whole host of information on the way they perceive the Institute, its strengths, areas of improvement, and what missions it is tasked with. This review, considered alongside an overview of the main changes in agriculture in relation to climate change and societal demands, served as the basis for the roadmap that was approved at the beginning of 2020. *"Now we aim to convert this into a corporate plan that will highlight challenges and produce indicators by the end of the operational conversion period spanning the second half of 2020"*, explains Norbert Benamou, Arvalis's CEO. *"The lockdown and the COVID crisis forced us to focus on operational matters linked to this unprecedented situation and have slowed down this process. But progress is still being made and considerations have taken into account the impact of the coronavirus. We should manage to stay on track and see this new corporate plan become operational on 1 July 2021 as expected."*
"We are taking into account over 30 years of changes in agriculture. Our new roadmap clearly goes beyond yields per hectare, which used to be the key objective, to favour economic profitability based on agro-ecology with multi-performing systems, including a lesser use of synthetic inputs and lower consumption of resources through integrated and systemic solutions", points out Philippe Gate, the Institute's Scientific Director.

The full activity report is available online at www.arvalisinstitutduvegetal.fr (in French)

ARVALIS Institut du végétal

PRODUCING FOOD IN SUFFICIENT QUANTITY

With the intensification of hazards, decision-support tools take on their full meaning.

AGMIP: PLANNING FOR THE UNPREDICTABLE?

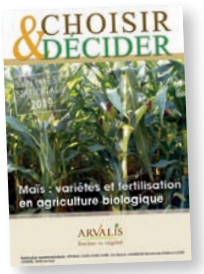
No two years are the same. And yet, farmers must be able to rely on dependable decision support tools to help them make the best possible choices on their farms. The greater the volume of data used by digital tools is, the better the models' accuracy will be. This is at the core of AgMIP, an international collaboration Arvalis is involved in alongside Inrae. It includes the work being carried out by a PhD student to analyse what occurred in 2016, which was a disastrous year for cereals. No model had predicted, or managed to explain, the yield losses caused by a combination of diseases and climatic stress. It is therefore important to go forward collectively, in order to properly take into consideration this type of isolated and poorly documented incident, as climate change will increase the occurrence of rare and violent weather events.

POTATOES JOIN THE "HIGH THROUGHPUT" CLUB

Alphi® is a kind of scanner that analyzes potato varieties.

High throughput phenotyping is an imaging technique used to study plants without destroying them, by sensing the characteristics that can be observed, such as size, shape, anatomy, chlorophyll content… It is very useful to improve varietal selection and to determine which varieties are best suited to cope with climate change. Over the last few years, Arvalis has been designing *Alphi®*, a light high-throughput phenotyping frame equipped with numerous sensors. It works very well for cereals and is currently being tested on potatoes.

ORGANIC MAIZE: COPING WITH INCREASING DEMAND



Rain, drought, temperatures, soil nature: each region has its own strengths and weaknesses, and maize varieties must be chosen accordingly. This is why the variety assessment network for organic grain maize is so valuable. The number of varieties available for organic crops has increased over the last few years and several partners have decided to pool their resources in the South of France as well as in Alsace. Arvalis and its partners have carried out a total of 11 trials to screen the varieties that are available. The Institute, who is leading the network, summarised the findings and published this in January in the brochure *Choisir & Décider, Maïs : variétés et fertilisation en agriculture biologique (Choosing & Deciding, Maize: varieties and fertilisation in organic farming)*. It gives producers the information they need to make a choice before the next planting season: harvest dates, yield, consistency of performance, varietal resistance to diseases and pests found in the area, etc.

KERNZA: AN ANCIENT PLANT TO HELP OUR PLANET'S FUTURE

© O. Duchêne

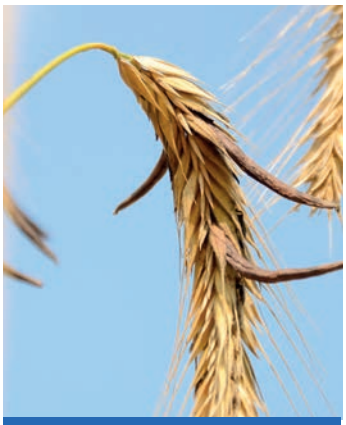
On the right, kernza is a plant that never leaves the ground bare.

For us, cereals are crops sown and harvested in synchronicity with the seasons. However, some ancient varieties, like Kernza *(Thinopyrum intermedium)*, are not annual but perennial plants. Several research teams in France, Belgium and North America, including Isara in Lyon, Arvalis's partner in the Cerpet project, are studying this ancient plant to determine whether it could be grown on a large scale. If that is the case, it could help diversify rotations. As trials started in 2018 at three Arvalis research stations as well as on several producers' farms have shown, it will take time. But the concept of using ancient plants to produce food and provide soil cover all year round is appealing. In other words, it is a case of digging into our planet's past to offer disruptive innovation!

IN BRIEF

- 44% of wheat varieties grown in France present a good resistance to septoria, a very concerning disease. This percentage is three times higher than ten years ago. Genetics offers serious scope for reducing fungicide use.
- *Ideotype Sud* compares bread wheat and durum wheat varieties on sites with a hot and dry climate, in the South of France, in Portugal and, this year for the first time, in Italy. The objective: to select varieties suited to the constraints encountered in those regions, which are in the vanguard of climate change and prefigure what may happen in other areas.
- The free online tool *Choix des variétés de blé tendre* (Choosing bread wheat varieties) has been used over 27,000 times since its launch a year ago. It collects all the data produced by varietal trials. It enables each farmer to reach the best compromise for his or her own farm.
- Based on the same concept as energy-saving certificates, plant protection product-saving certificates add value at the time of their registration to the varieties that deliver the best performance. For potatoes, *Alix* for example, scores highly for this characteristic, with +7 on a scale of 1 to 9.

PRESERVING AND ENHANCING **QUALITIES**



Cereal ears contaminated with ergot.

ERGOT NO MORE

Do you know what historians specialising in the Middle Ages mean by "Saint Anthony's Fire"? It is a disease caused by ergot. This fungus gets established in cereal crops and produces dangerously toxic substances. To control it, Arvalis is leading an action plan involving 100 grain storage organisations, cooperatives and traders. A 4:50-minute video was produced to explain to farmers and agricultural advisors how to manage this risk.

To see the video (in French), click on the following link : Arvalis-TV

A SMART TROUGH CLOSE TO THOSE SNOUTS

Piglets live in groups to ensure their well-being. It is a statutory obligation that applies equally to livestock farmers and research stations involved in testing the best animal feeds. It is therefore difficult to monitor the exact impact of this or that ration on each individual animal's growth. So Arvalis has modernised its Villerable facilities by putting in place a more advanced, and more ethical set-up, designed and developed with Asserva. Named *Porc'Inn* (for *Porcelets Innovation*), it is a smart trough, unique in France, that automatically weighs, to the nearest gram, each piglet's intake. This equipment also improves and simplifies the technicians' working conditions, as they now handle fewer feed bags and fewer animals. With the RFID piglet chip identification system, scientists can not only monitor the piglets' intake, but also how many times they feed each day. This information is crucial to understanding the animals' behaviour.

Piglet consumption is measured to the nearest gram.

100% of the potato sprout inhibitors registered in France are evaluated by Arvalis.

NO SPROUTS, NO RESIDUE

When a potato sprouts, it loses its organoleptic and nutritional qualities. For around four decades, and until last year, the potato sector therefore used C.I.P.C. (chlorpropham) to suppress sprouting during storage and ensure consumers could enjoy eating potatoes all year. However, in 2019, the European Commission chose not to renew the licence for C.I.P.C. The previous year, Arvalis had launched a study of buildings where that product had been used, to determine whether the potatoes that will be stored in them in the future may get contaminated. This initiative was taken up by the other potato-producing countries in Europe, in order to provide decision makers with quantified technical support. A common maximum residue limit (MRL) must be determined for all EU countries.

FRENCH PROTEINS FOR BOVINES

Yellow peas are high in protein, and increasingly popular for human consumption. Their extraction from the seed generates two wet by-products: pea pulp and pea solubles, which, once mixed produce "pea cream", which is generally fed to pigs. Arvalis has just shown that it is also suitable for young bovines. The latter need rations that are high in energy, often supplied by forage maize with additional protein-rich raw materials such as oilseed cake or protein plant cake. Besides the volatile price of those materials, some of them are in competition with feedstuffs for human consumption. Arvalis was able to demonstrate that pea cream can indeed be used in rations for young bovines, and can comprise up to 25% of the ration's dry matter without penalising their growth.

IN BRIEF

A biological weapon in silos

Arvalis is testing biological control techniques on its Grain Industry ("Métiers du Grain") platform, which is a unique facility in Europe. Its aim is to guarantee the quality of cereals stored without chemicals. This year, it was the turn of micro-insects belonging to the bee family and bearing the sweet name of *Lariophagus*, to show how effective they are for treating storage facilities. They lay their own eggs inside weevil eggs and that way, eradicate them from silos.

A hip app

After harvest, cereals are kept either on farms, or in grain storage organisations' silos. In both cases, they must be ventilated to cool them down and preserve them. Arvalis offers two free online apps, one for storage organisations (Venti-LIS® diagnostic), and the other for farmers (Venti-LIS® agri), to help all of them to optimise ventilation.

HEALTHY PLANTS

By biting plants, aphids can transmit viruses to cereals, such as "barley yellow dwarf virus".

EACH TO THEIR OWN VIRUS

Cereals also have viruses to contend with. Those are often transmitted by aphids. For the past ten years or so, Arvalis has been working on risk assessment (determining the weather conditions that encourage the arrival of aphids), direct control (by testing new biocontrol products) as well as indirect control methods. Establishing flowering plants close-by may keep pests out of crops. Alongside its partners that include Inrae, Geves and some seed companies, the Institute is also studying how cereals are able to defend themselves. For the past two years, wheat varieties have been tested in relation to viral diseases transmitted by aphids in the autumn. The 2019 results show that losses associated with the most serious of those diseases, BYDV, are twice as great in some cases as in others (from 1.4 to 2.9t/ha), with an overall average yield around 7t/ha in France. Some new varieties can sometimes show a reduction in expressed symptoms. It is hoped that, like for winter barley, tolerant varieties can be developed.

DOWN WITH DRIFTING

To deliver to crops the cure that they require as precisely as possible, sprayers are equipped with anti-drift nozzles that reduce droplet dispersion into the environment. Out of all those tested by Arvalis in trials certified by the French Ministry of Agriculture, air injection nozzles are the most effective. The best ones reduce spray drift by up to 90% while maintaining treatment efficacy.

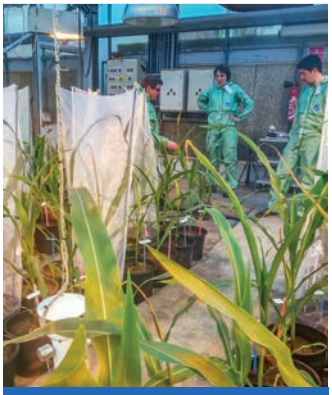
HOW TO DO WITHOUT GLYPHOSATE?

Over the past three cropping seasons, Arvalis has been carrying out multiple trials to identify and evaluate alternatives to glyphosate. The Institute is also identifying the impasses caused by its ban. Over 7,000 farmers answered the agricultural technical institutes' online survey on what they are doing and what they would like to know in that respect. Its action plan also includes training on alternatives to glyphosate.

Wireworm larvae can cause serious damage in fields and gardens.

HOW TO FOOL A PEST...

A pest can be deceived. That is the idea behind bait plants that Arvalis has been putting forward over the past three years to protect maize from wireworms, and this method is gaining momentum. This Coleoptera's larvae destroy the roots of many vegetable crops, as well as maize. When sown at the same time as the latter, bait plants act as a lure to reduce the damage caused by the pests to the crop, which is particularly fragile if attacked between emergence and the 6-8 leaf stage. The best bait seems to be a mixture of wheat and maize. The best positioning then needs to be determined. Bait plants must be close enough to the crop to protect it, without competing with it.



Tests in a confined environment in the experimental greenhouses of the Montardon station near Pau.

HOW TO INTRODUCE PEST PARASITES

Mediterranean corn borers, from the Noctuidae family, are maize pests. Inrae is carrying out trials aiming to control their attacks with another insect originating from Africa, a little parasitic wasp *(Cotesia glomerata)* that disrupts them. For this purpose, scientists have chosen Arvalis's secure greenhouse in Montardon (southwestern France), since it has been approved for this type of trial. They must indeed check that the new insects do not have any harmful impact before they are introduced into the environment.

PRECISION IS KEY, TO INPUT JUST WHAT IS NEEDED

Technician comparing ammonia emissions between different cropping practices.

HUNTING DOWN PARTICLES

The French plan to reduce the emission of pollutants into the atmosphere refers to the good fertilisation practice guide published by Ademe, the French Environment and Energy Management Agency. It is indeed absolutely crucial to reduce the ammonia volatilisation that can occur during fertiliser spreading, as that ammonia can generate fine particles if mixed with pollutants produced by transport, domestic heating or industry. Arvalis has been working on air quality and ammonia volatilisation for the past ten years, either on its own or with partners such as Inrae. This has led to gaining a better understanding of this phenomenon. Among other functions, the Volat'NH3 tool helps to estimate nitrogen flow volatilisation in the field. Ademe used this body of research work to draw up summary data sheets intended for agricultural advice organisations and decision makers.

50 LISTED FERTILISERS

Farmers sometimes find it difficult to choose the best fertiliser for their crops. The market is constantly evolving with new technologies coming on stream and new input types becoming available. Arvalis has therefore given free access on its website to 50 data sheets describing nitrogen fertilisers, and their performance for different crops (wheat, maize, potatoes and spring barley).

WHEN WASTE BECOMES FERTILISER

Arvalis is one of ten partners involved in the European ReNu2Farm programme to find ways of adding value to food waste, slurry and manure in fields. Those products contain nutrients that can be used as fertiliser. But that means knowing all about them and how and when to best use them for this type of circular economy to be really successful.

Only 5% of the agricultural land is irrigated in France.

THIRSTY WORK

Crops' needs for water vary depending on the variety, its earliness, and the soil's capacity to store water. By integrating all this data, as well as weather monitoring information, decision support tools (DSTs) help farmers manage irrigation according to the crop's maximum evapotranspiration (ETM). However, those models only work if sufficient water is available. But water resources are increasingly often limited, either because reserves are structurally insufficient for the block that is being irrigated, or because the winter groundwater recharge was incomplete, or when the overall volume permitted for the farm is too low. When this resource is limited, the farmer will try even harder to better utilise each available drop. This explains the appeal of a prototype under study at Arvalis to establish a provisional grain maize irrigation schedule, based on the season's particular conditions and the amounts applied over the previous 20 years.

IN BRIEF

- The Comifer association has been publishing good fertilisation practice guides for over 40 years. It organises a biennial conference like the one that took place in Dijon in November 2019. Arvalis was involved in organising it, but also took the opportunity to present its own trials.
- In order to make it accessible to a wider public, Arvalis is modernising the penetrometry technique used to determine the structure and physical fertility of a soil. Indeed, plants find it difficult to root in a compacted soil.

SUSTAINABILITY HAPPENS NOW

The ground beetle is a slug predator and wireworm, among others.

ARENA: BEETLES IN THE RING

Controlling aphids and slugs: a gardener's dream… shared by arable farmers! For the past three years (2017 to 2020), a large group of scientists, lecturers and agricultural advisors have been studying how to biologically control those pests. They went as far as filming the intimate life of beetles, itemising their diet and monitoring their intake of pests to see how much this valuable biological control agent was able to consume. They also reviewed the types of landscapes in which aphid predators are most at home. The Arena project was then able to produce tools to help assess the hosting potential of a field plot and its surrounding area for those biological control agents. The same tool also analyses the impact of agricultural practices.

FINDING ECONOMIC MOTIVATION

The *Leviers de compétitivité des exploitations en région Centre Val de Loire* (Solutions available to farmers in Central France to ensure competitiveness) project led by the Chambre Régionale d'Agriculture has the financial backing of the Conseil Régional, Cap'Filières 2017-2021. In conjunction with numerous partners, Arvalis established the farms' current performance diagnosis, then identified solutions to help them regain a competitive edge. The third phase of the project starts with the implementation of those solutions.

YES TO ANAEROBIC DIGESTION, WHERE IT IS SUSTAINABLE

Energy catch crops and their transformation into biogas illustrates one of the positive contributions of agriculture to ecological transition.

Arvalis's work on energy catch crops (cover crops used to produce energy) was utilised in the *Méthanisation agricole: quel cadre de durabilité pour cette filière? (Agricultural digesters: how sustainable is that sector?)* report produced as a result of a year-long study by the NGO WWF France and the energy supplier GRDF. The two parties brought together the technical institutes, relevant institutions, agricultural industry and biogas sector representatives, as well as community groups. Together, they reflected on the right conditions to ensure the sustainability of agricultural anaerobic digestion.

UNLOCKING ORGANIC FARMING

Arvalis has been running a programme of organic farming activities for several years. The Institute identifies farmers' requirements, including through its national Organic Farming Commission. In 2019, it also took an inventory of all the work already carried out to add value to it and determine which R&D activities should be developed. This formed a good basis for communicating both at the agricultural technical institutes' seminar organised by Acta in October 2019, and in the "Organic Village" area of the Culturales® event organised by Arvalis in Poitiers. It covers a multitude of topics: resistance to climate change, food security, food quality and safety quality, mechanisation, crop rotation, preservation and storage, varietal selection, weed control, robotics, disease and pest control, soil management, etc.

IN BRIEF

- Arable crops have one of the greatest carbon storage potentials in France. In 2019, that fact led producers and their technical institutes to commit to developing the "low carbon label" method to be submitted to the French Ministry of ecological transition in autumn 2020.
- With the financial support of Ademe (Agency for ecological transition), the *Gest'Im+* project has led to the updating of the methodological reference framework for estimating the environmental impacts of agricultural activities on climate change, non-renewable energy consumption and air quality. It was based on a census of the references produced since the publication of the first *Gest'Im* guide in 2010.

AGRICULTURE DARES TO GO DIGITAL

BORDERLESS BOVINES

This cow is connected... Thanks to its GPS necklace, the breeder can determine its grazing areas and get rid of fences.

The Norwegian company Nofence has developed and sells a virtual fence system for farm animals. Each animal wears a GPS collar that helps to manage its grazing from a smartphone. Arvalis began testing this system in autumn 2019 on its Digiferme® in Saint-Hilaire-en-Woëvre (Lorraine, North Eastern France). The aim is to remove the need for physical fences. During the spring of 2020, the project was extended to three other Digifermes that are now testing the application on dairy cows, beef cattle and sheep. In those trials, the Digifermes examine various aspects, such as the impact that using Nofence can have on the animals, including their behaviour and their growth.

A BOOST FOR GREEN SHOOTS

Innovation is gaining momentum thanks to Unigrains (an investment fund specialising in agriculture and the food industry) and Arvalis, who created Unilis Agtech in January 2020. It will support the young and innovative agro-tech companies whose bids were successful. Its main distinctive characteristic is to provide both technical backing, since it supports the R&D programme, as well as financial.

PRECISION WEATHER FORECASTING

Connected weather station. It records the parameters more frequently and sends the data remotely to the end user.

With the increasing affordability of this type of equipment, more and more farmers are acquiring connected weather stations to monitor the forecast for their own fields. Météoprec (as in "precision weather forecasting" in French) is a three-year research programme aiming to build a network of such connected stations, as the greater the amount of data there is, the more accurate the models will be. The project will not only check that their data is still relevant, but will also use their weather forecasts in decision support tools for farmers. This should deliver benefits in a variety of fields, from forecasting risks from diseases and pests to the state of cultivated soils.

MULTIPASS LOOKS AFTER THE DATA

With the advent of digital technologies, farms are producing large amounts of data. Those are a valuable resource to help agriculture meet environmental, economic and societal performance challenges. However, farmers quite naturally have questions regarding their use and the potential risks linked to disseminating them. Based on the FNSEA/JA (National Federation of Farmers Unions/French Young Farmers) charter on the use of agricultural data, Arvalis and its partners wish to demonstrate the value and feasibility of a global management system for farmers' consents. This project, named *Multipass*, brings solutions to allay farmers' concerns regarding control over their data and transparency of the ways they are used. Consents are stored in secure tools. They can be withdrawn. Whether a valid consent is in place can be checked before a third party uses the data.

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Member of: acta LES INSTITUTS TECHNIQUES AGRICOLES, Plant2Pro, Partenaire technique ACTIA

In partnership with organisations from the different sectors (Intercéréales, GNIS, FNPSMS, CNIPT, GIPT, CIPALIN, FNAMS, FNPT) and with the financial involvement of the Compte d'Affectation Spécial pour le Développement Agricole et Rural (special fund for agricultural and rural development) managed by the French Department of Agriculture and Food.

IN BRIEF

- A conference to present the results of the first three years on the Saint-Hilaire-en-Woëvre Digiferme® should have taken place in a room of 200 people on 17 March. Covid-19 put paid to that. Instead, four webinars were organised between 27 and 30 April. They were very successful! Over 1000 people attended one of those four sessions.
- Arvalis has signed a partnership with Photonics Bretagne to roll out agri-photonics, i.e. technologies involving light in agriculture. In practice, this means that field imaging using fibre optic helps to collect real-time information on the health of a plant.
- Arvalis and Inrae have issued an international data challenge to count wheat ears by analysing images (deep learning). An international image bank was made available to teams all over the world. The winning team is Vietnamese, followed by American and Slovenian teams.

In every farmer there is a citizen who watches over.

The farmer wants to improve the quality of his production, ensure food needs, progress in agro-ecology, change his farming practices... and make a living from his profession. And the citizen within him has environmental and health requirements. The action of ARVALIS - Institut du végétal is to find the means to reconcile the requirements of the farmer and those of the citizen.

Find the evidence on **www.action-arvalis.fr**

ARVALIS
Institut du végétal

The farmer. The citizen. The action.

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Liliane et compagnie