ARVALIS'S WORK 2017/2018 IN 24 EXAMPLES

ACTIVITY REPORT

ARVALIS - Institut du végétal is the applied research organisation for farmers, specialised in arable crops and their markets. Its work focuses on cereals, maize, sorghum, potatoes, forage, flax and tobacco. The Institute's mission is to find effective agronomic, economic, environmental and sanitary solutions, that it can then communicate to farmers, to help them to adapt and face current challenges such as climate change, societal demands, commercial requirements and international competition. Over 400 staff is spread out in 27 sites throughout France, working in experimental fields and laboratories to test and evaluate innovations, and disseminate them to farmers through a variety of communication platforms (meetings, training sessions, professional 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 on the markets for agricultural products.

CREDENTIALS

Arvalis - Institut du végétal's accreditation as a recognised technical agricultural institute has been renewed for a further five years period. This status, which is awarded by the Department of Agriculture and Food following an assessment by national and international experts, recognises the work that has been carried out, as well as the Institute's future ambitions. The assessors highlighted the overall success of the different dimensions that are expected from a technical institute: various quality R&D initiatives, dissemination of knowledge, production of decision support tools, as well as the development of innovative infrastructures, the establishment of numerous partnerships, internal training, European initiatives, etc.
This has strengthened Arvalis' will to fully address the strategic issues that producers and the industry are facing; to keep working in all the areas of performance it pursues (economic, environmental and social); and to further develop partnerships with other French institutes in national networks (ACTA for agricultural institutes, and ACTIA for food research institutes) as well as other French and international R&D players. Agriculture is facing increasingly complex issues that can only be addressed by sharing resources.

Full annual activity report available at www.arvalisinstitutduvegetal.fr

ARVALIS
Institut du végétal

PRODUCING FOOD AND ENOUGH OF IT

Alphi® monitors plant growth depending on their environment

ALPHI®: A FIELD SCANNER

All plants do not react in the same way to their environment. By monitoring varieties very closely, Arvalis is able to identify those that react best. To help with this, **Alphi®** is a kind of metal arch with several sensors that hooks up behind a tractor. This device is used for phenotyping, i.e. to monitor and describe plant growth very precisely depending on weather, nutritional status and stress level such as drought or excess moisture, cold or heat. Technical staff no longer needs to measure with a ruler the surface area of leaves taken from a representative sample of plants in the trial plot! The equipment captures a very high volume of data without destroying the plant, including green fraction, height, light interception, green leaf index and vegetation index.
All the data is processed by an analysis platform designed by INRA and Arvalis in Avignon, and feeds databases, which in turn help to improve the relevance of the decision support tools that are made available to farmers. **Alphi®** was developed with the support of the Institut Carnot Plant2Pro. Arvalis has just acquired the first version of this device. It is now operational for cereal crops, potatoes and flax.

STB16, A SUPERACTIVE GENE…

Wheat variety sensitive to septoria (up), resistant variety (down)

Some plant varieties naturally have genes that make them resistant to some diseases, and treatment against those bioaggressors is therefore not needed. That is exactly what happens with the Stb16 gene, which has just been discovered.
It protects against septoria, a disease caused by a type of fungus called *Zymoseptoria tritici*. Scientists had already identified 21 major "resistance" genes, but Stb16 has the added advantage of protecting the plant at different growth stages (seedlings and adult plants) against a wide range of strains of this fungus.

RÉCOL-TIS®: STAYING AHEAD OF THE GAME

No two years are the same. Depending on whether it is hot or cold, wet or dry throughout the season, but especially at each key stage of its development, the plant will be subjected to stress, or, on the contrary, grow better. Wheat, for example, is quite sensitive to weather conditions at the flowering time. Thanks to the expertise acquired through its trials and by its statisticians, Arvalis has been able to establish wheat crop development models. It can now produce yield and quality forecasts two weeks before harvest. For grain cooperatives and trading companies, having this information in advance of harvest is a real advantage: thanks to Récol-TIS®, which provides this data for their operational area, they are better prepared. This new tool was launched last year and was deployed throughout last season.

IN BRIEF

Since November 2017 Anne-Claire Vial, a farmer from the French department of Drôme (south-eastern France), took over from Christophe Terrain as Arvalis - Institut du végétal's president in November 2017.

Norbert Benamou is Arvalis' new CEO. He succeeded Jacques Mathieu in January 2018.

Funded by *le grand emprunt* ("the big loan", a French government initiative to boost innovation), PhénoField® is a high throughput phenotyping platform based at Arvalis' research station of Beauce-la-Romaine (just south-west of Paris), which identifies wheat and maize varieties that are tolerant to drought.

In 2017-2018, Arvalis assessed **450** cereal maize and sorghum varieties.

PRESERVING AND ENHANCING **QUALITY**

Arvalis developed an indicator to determine whether wheat varieties are able to meet export specifications

SILO TEMPERATURE

In order to preserve the quality of a batch of grain stored in a silo, it is crucial to monitor temperature. A start-up company called Javelot had the idea to produce a new connected temperature probe for farmers to use. But between the idea stage and the end product, you need expertise. That is where Arvalis could help, including via its "Métiers du Grain" (grain industry) platform based at its Boigneville station near Paris. It helped to develop a "real size" probe that led to the production of a marketed one.

SUPPORTING COUNTRY OF ORIGIN: FRANCE

50% of the wheat produced in France is exported: Arvalis' work is therefore naturally connected to this market. The Institute offers a new indicator to determine whether wheat varieties are able to meet export specifications. Based on its own trials, it calculates the probability that a given variety will meet Premium A1 and Superior A2 requirements. The Institute also presents the annual results of the quality survey it carries out jointly with FranceAgriMer during France Export Céréales seminars abroad.
France Export Céréales also relies on its expertise for technical partnerships with North African professional organisations and federations. Finally, the Institute delivers projects on the quality of French cereals and their suitability for processing in buying countries, like China this year for new French malting barley varieties.

QUALITY MONITORING

Each year, Arvalis is involved in FranceAgriMer's cereal quality surveys carried out in the field and at grain storage businesses. The Institute's task includes characterising their bread-making quality, if any, and for durum wheat, its pasta-making quality.

Arvalis also takes part in programmes designed to monitor cereal safety quality, in conjunction with the Hyperion Institute (contaminants and mycotoxins monitoring). It does the same for potatoes in a joint programme with CNIPT. This year, Arvalis and its partners summarised the results of 8 years of sampling. Nearly 1,500 samples were analysed to detect germination inhibitors. This led to the production of a technical memorandum on the use of chlorpropham (CIPC), to provide further arguments to support France's position on the renewal of this active substance's approval.

CONTROLLING INSECTS

There are more and more research works to reduce insecticides

Insects have a nasty habit of settling in grain stocks, that act as a giant pantry for them. Arvalis has tested several methods to control weevils and lesser grain borers (the two main insect pests in stored grain): thorough cleaning and the use of two approved products, one made from diatomaceous earth, and the other from sodium bicarbonate. And it works: cleaning and products fully control insects within two weeks. Interesting prospects are opening up, both for the conventional and the organic sectors.

IN BRIEF

FARMSTAR
PILOTEZ, MODULEZ, OPTIMISEZ

Farmstar for maize is a service dedicated to precision farming for maize crop management. It was created by Arvalis and Airbus.

cnipt Pommes de Terre de France

Arvalis shares its technical expertise with CNIPT regarding the culinary claim "fried" of varieties, which is a useful piece of information for consumers.

Arvalis' **"Observatory"** monitors grain production and markets worldwide. This year, it focussed more particularly on the USA and Russia.

HEALTHY PLANTS

Arvalis participates in writing technical sheets about solutions to limit the use of pesticides

SOUGHT AFTER EXPERTISE

The current regulatory context and its ongoing developments have seen Arvalis' independent expertise in high demand. On 24th January 2018, the French National Assembly's parliamentary mission on crop protection products has consulted the president of Arvalis. This gave her the opportunity to explain the Institute's vision of current and future crop protection. She mentioned that 30% of Arvalis' budget is dedicated to that particular field of research. Following the announcement of the ban of neonicotinoids in cereal seed treatment, Arvalis also made a presentation to ANSES (the French Agency for Food, Environmental and Occupational Health & Safety) on the methodology it uses to assess economic, environmental and social impacts. The Institute carried out the same kind of study on the consequences of a glyphosate ban in arable crops, and identified some situations with no alternative solution, such as the control of common ragweed (*Ambrosia artemisiifolia*). INRA used it as the basis for its "Use of glyphosate and alternatives in French agriculture" report.

TACTICAL MANAGEMENT

Nearly 300 farmers already use **Taméo®**. This decision support tool, launched this year by Arvalis and Météo France, helps them to manage their wheat crops tactically. It provides a weather forecast at individual field level and combines this with its disease models to anticipate disease infection. It forecasts the timing of wheat growth stages and weather conditions to indicate the best meteorological windows for field work. It helps farmers to optimise the use of nitrogen fertiliser as well as crop protection products.

MIMICKING NATURAL MECHANISMS

Biocontrol products are based on natural mechanisms and used as part of an integrated crop protection approach. There are many different types, from macro and micro-organisms, to chemical factors such as pheromones, natural substances and plant defence stimulators… Yet, only about thirty of them are currently approved. Arvalis assesses the efficacy and the directions for use of potential products as well as of some already on the market. It also leads the Elicitra Mixed Technology Network and the Biocontrôle Consortium. The latter was established by public organisations (INRA, CNRS, institutes, etc.) and private companies to speed up the emergence of effective products and determine the best conditions in which to use them.

DOWN WITH WIREWORMS

Wireworm larvae often cause significant damage by boring through seedlings, and yet, farmers have fewer and fewer means of controlling them as the list of approved molecules dwindles. INRA and Arvalis have accumulated an impressive amount of observational data over five years, on weather, agronomic and environmental conditions favourable to their presence in different regions. Thanks to the most advanced statistical methods, the two partners were able to build a wireworm risk forecasting model. This is the first step in helping farmers to get rid of them!

IN BRIEF

ÉTATS GÉNÉRAUX ALIMENTATION

ACTA and ARVALIS presented the Institute's technical reference data to the *Etats Généraux de l'Alimentation* (an assembly of representatives of all the food sector's stakeholders).

Various agricultural sectors asked Arvalis to draw up their "transformation plans" required by the *Etats Généraux de l'Alimentation*.

Vigiculture®, **a tool that stores** millions of observations on bioaggressor attacks each year, has become the main data provider for the French Ministry of Agriculture's Epiphyt database.

PRECISION IS KEY TO INPUT JUST WHAT IS NEEDED

LABSPEC ON THE RADIO

Taking analysis out of the lab and straight to the field: that is Labspec's mission; this portable soil analysis laboratory created by Arvalis fits into a back pack. This innovation caught several media's attention, including France Inter and France 2. Using near-infrared spectrometry technology, it measures 11 nutrients in the soil, so that farmers know exactly what it needs, no more, no less. The reliability of this analysis is ensured by Arvalis' vast soil database. It contains 1200 soil profiles from all over France. This innovation is now marketed by Auréa Agro Sciences under the name Spirit Sol +.

Arvalis has set up a portable soil testing laboratory

WATER WHEN IT IS NEEDED

The decision support tool **Irré-LIS®** is currently being rolled out over 34,000 hectares of cereal, maize and potato crops. This online service calculates a field's water balance, to improve irrigation management. Arvalis also offers solutions to water management challenges at field, irrigation block, farm and production area levels.

CHN: NITROGEN IN REAL TIME

Nowadays, the guiding principles of nitrogen fertilisation are based on calculating a provisional dose, which is then adjusted during the season depending on actual conditions. Arvalis is currently overhauling this method, based on an Arvalis-INRA PhD thesis. The latter is opening the door to real time monitoring of a wheat crop's nitrogen nutrition status. Over the past two years, Arvalis has been assessing the feasibility of using its own CHN model to continuously assess cereals' nitrogen status and integrate this into its nitrogen management tools. Dozens of trials have been established since 2016, with several partners including cooperatives, regional Chambers of Agriculture, trading companies and CETA (agricultural training organisation). Some are funded by regional projects such as the EIP-AGRI Solinazo project in the Centre-Val de Loire region.

THE SOIL UNDER YOUR FEET

Soil is teeming with valuable life. Besides its structure and mineral composition, farmers are increasingly taking into account this biological component of their soil. Sustainably managed cropping systems promote the recycling of nutrients produced by the biological degradation of organic matter, while meeting carbon storage targets to reduce greenhouse gas emissions (4 per 1000 target). However, in order for farmers to be able to optimise both of those functions, they require new data. Two French research projects have been undertaken: Microbioterre (Casdar 2017-2020) and AgroEcoSols (Investissements d'avenir 2018-2021 project). The first one, led by Arvalis, focusses on soil processes linked to carbon and nitrogen cycles. It will offer operational soil analyses. The second one is led by the Auréa Agro Sciences laboratory, an Arvalis subsidiary, in association with INRA and Arvalis for the production of biological activity indicators.

IN BRIEF

fête de la Science

Four Arvalis experimental research stations took part in the 26th Science Week in the middle of October.

Interreg North-West Europe ReNu2Farm

Arvalis is a partner of ReNu2Farm, a European research project on circular economy which aims to increase the use of recycling-derived fertilisers (INTERREG Program).

The Lin'azote project carried out an in-depth study of the nitrogen required by flax. This helps farmers, for instance, to choose the best green manure.

SUSTAINABILITY HAPPENS NOW

17 EUROPEAN COUNTRIES WITH NEFERTITI

Nefertiti is funded by the European Commission's Horizon 2020 programme. With 32 partners and 17 countries involved, this project has created a network of farms and demonstration platforms. What is its purpose? To improve technical knowledge and content sharing in order to promote the innovation uptake, and to encourage connections between the different agricultural players throughout Europe, towards a more competitive and sustainable agriculture. Arvalis is contributing to it with its Digifermes® (digital farming) and Syppre® (innovative cropping systems) works.

The project's team attended the 2018 Culturales®, where it held its first annual meeting. The 80 professionals coming from all around Europe discovered a great example of how to showcase innovation with useful demonstrations for and with the involvement of the agricultural sector.

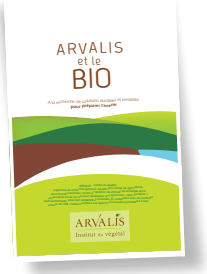
SYPPRE®: TO ADDRESS SOME COMPLICATED ISSUES

How can we help farmers to find the best possible compromise between economic and environmental performance, while meeting societal expectations (reducing crop protection product use and greenhouse gas emissions, trapping carbon in the soil, etc.)? The "Building tomorrow's cropping systems together" Syppre® project is designed to help with this. Between 2017 and 2025, it will test innovative cropping systems on 5 experimental platforms throughout France (in the Picardie, Champagne, Berry, Lauragais and Béarn regions). It is coordinated by three agricultural technical institutes (Arvalis, Institut technique de la betterave and Terres Inovia), and will propose crop successions and cropping techniques derived from both statistical monitoring centres and field observations supplied by local farmer and technical advisor networks. This original project is based on a rigorous scientific approach that will produce methodologies and decision-making rules to transfer built-up knowledge. Syppre® will go beyond local results to work out the transition process for every possible situation.

BIOMASS AND ENERGY TRANSITION

Arvalis studies intermediate crops for energy-supply purposes

Metha5, a group of 5 institutes including Arvalis*, is getting to grips with the issue of available resources for energy production from biomass. The aim is not only to identify the gross volume of crop residue or livestock effluent needed, but also to find ways of maintaining the agronomic potential of the soil into which the straws are returned for instance; it must not be diminished as a trade-off of producing energy. At the end of a research programme supported by ADEME (the French Environment and Energy Management Agency), the five partners launched **ELBA**, an online tool to assess agricultural biomass resources. This helps the players in a given production area to know what energy resources are available at different geographical levels (up to a district), and to establish projects aiming to limit greenhouse gas emissions.



ARVALIS AND THE ORGANIC SECTOR, A LONG-LASTING RELATIONSHIP

Arvalis has built its expertise on several years of experiments in organic arable crops and is basing its communication on tangible results. It takes part in the Tech&Bio trade show and its regional satellite events in the Ile-de-France area around Paris and Centre-Val de Loire region. It has co-organised, with ITAB and Terres Inovia, the first Organic Arable Crop summit. Topics relating to organic farming were also very popular during the 2018 Culturales® show. The event hosted its first organic forum and special displays.
Arvalis was also involved in the *"Des clés pour des systèmes innovants et durables"* scientific conference on sustainable and innovative systems organised with ITAB and ISARA in Lyon on 22nd November 2017.
As for training provision, Arvalis is responding to an increasing demand on various topics, from the agronomic principles behind successful organic arable crops to the storage of organic grain, cover crop management, organic potato crop management and varietal choice for organic milling wheat.

IN BRIEF

- **Arvalis** has developed methodologies to identify the fertilisation practices that most effectively reduce greenhouse gas (GHG, or GES in French) emissions.
- **EGES** is an online service to quickly estimate GHG emissions and therefore compare various technical practices.
- Nearly 40 members of Arvalis' staff are working, directly or indirectly on organic farming.

AGRICULTURE DARES TO GO **DIGITAL**

THIRTEEN DIGIFERMES®

Agriculture provides a plethora of possible applications for digital innovation. Arvalis, in partnership with some other technical institutes including IDELE, ITB, Terres Inovia and the ACTA network, has been assessing them in real conditions since 2016, in order to help farmers choose between them. This is specifically the task of the network of experimental farms with Digifermes® status. In 2018, ten new farms managed by as many new partners were added to the network; they focus on arable crops, viticulture, and beef and pig production. There are thirteen of them now altogether. Each has its own special focus. The Saint-Hilaire-en-Woëvre (in Lorraine, north-eastern France) Digiferme® is concentrating on robotics, drones and agri-equipment for weed control management (including the Oz/Naïo, Ecorobotix, and ElectroHerb Zasso robots), as well as remote sensing for grassland management, and connected tools to avoid hay fermentation. On the Boigneville Digiferme®, near Paris, the European project IoF2020 (Internet of Food and Farm) is implementing field sensor systems developed by the manufacturer Bosch.

THE SMARTPHONE IS IN THE COWSHED

Digital tools can be a solution to reduce the arduousness of work on farms

New digital technologies are increasingly well integrated into livestock farming equipment as well as in research processes. Cattle housed in the new building of the Les Bordes experimental farm (central France) benefit from the best digital technology has to offer from a smartphone; this includes a feeding robot, an automatic hydraulic system to rake out manure, a suspended straw spreader, and scales with a magnetic reader so that staff can monitor the animals' weight safely.
Connected troughs at the Villerable station (central France) also provide more precise information while lightening the employees' workload. The renovations completed there this year have improved the well-being of the animals reared in groups, both on litter (chickens) and slats (pigs).

TRUST AND SHARING

The purpose of the Multipass project, funded by Casdar (Public source of funding for innovation), is to facilitate the flow of information between farmers, businesses and the institutes. This is a complicated issue, and one of the main obstacles to farmers embracing technology, as well as to new tools being developed. Besides the need for interoperability, i.e. data exchange standards, the way software companies use this information also has to be much more transparent, and consent must have been obtained from farmers, who ultimately remain the owners of the data. Multipass will bring this element of trust, through its multiple partner data router that records all those consents. It is compatible with the new charter established by farming professionals.

DEEP LEARNING FORGES AHEAD

Deep Learning's artificial intelligence processes, discovered by the wider public through chess games, or the Go game, that pitch champions against machines, have been applied to the field of plant organ determination. They will be used to build algorithms trained by large databases to recognise the leaves, or the ears in order to speed up data acquisition in field trials. Those tasks, which are painstaking for the Institute's technicians, could therefore be made much easier. A PhD thesis on Deep Learning started in 2018, and the Literal research project was successful in the last round of the Casdar call for projects. It will design a light ergonomic and automated vector for the research staff.

IN BRIEF

- Each year, **Arvalis provides** reference data on bread wheat to FranceAgriMer's Price Forming and Bread Margins Observatory.
- **In order to better utilise** and enhance the societal usefulness of its work, Arvalis has launched its corporate responsibility programme.

Arvalis in **figures**

THE INSTITUTE

400 *staff members, including 186 engineers and 150 technicians*
27 *sites in France*
50% *of its budget is dedicated to R&D*
400 *of its farmers are members of professional steering committees*

REFERENCE DATA ACQUISITION

1,700 *agronomic trials*
7 *PhD thesis*
15 *Master thesis*
175 *collaborative research projects funded*
4 *UMT (mixed technology units) led or jointly led by Arvalis*
13 *RMT (mixed technology networks) with Arvalis*
19 *countries the Institute collaborates with*

TRAINING

400 *training days*
4,000 *people trained*

INFORMATION

120,000 *readers of Arvalis-Terres Inovia infos magazine is sent to*
225,000 *visitors per month on the website*
62,000 *subscribers to the weekly information sheet "Arvalis-Infos"*
13,500 *subscribers to the daily information sheet "Yvoir"*
100 *meetings and national conferences for farmers and technical advisors*
5,600 *pieces of media coverage*
280,000 *views of online videos*
35,000 *followers on social media*

EXPERTISE

720,000 *ha managed with Farmstar*
90,000 *ha of potato crops managed with Miléos® (1400 users)*
34,000 *of cereals, maize and potato crops irrigated with Irré-LIS®*
160,000 *simulations using the free access DSTs online*

ARVALIS SITES AND CUTTING-EDGE EQUIPMENTS

SURFACE AREAS TARGETED

Cereals: *9,071,912 ha – 62,513,000 tonnes*
Maize: *1,356,856 ha of grain – 12,245,502 tonnes*
Ware potatoes: *147,118 ha – 6,079,589 tonnes*
Flax: *97,000 ha – 116,000 tonnes of fibre (*)*
Tobacco: *3,750 ha*
Forage crops: *13,105,000 ha of temporary and permanent grass (**) and 1,401,186 ha of forage maize*

Source Agreste 2018 (*2017 - **1999)

ARVALIS Institut du végétal
3 rue Joseph et Marie Hackin 75016 PARIS - FRANCE
Tél : 00 (33) 1 44 31 10 00
ww.arvalisinstitutduvegetal.fr

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INSTITUT CARNOT Plant2Pro
Partenaire technique ACTIA

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