AGRONOMIC RESEARCH

PROVIDING ANSWERS
in an exacting context

Before solutions can be developed and made available, however, ecosystemic functions, economic profitability and agronomic feasibility must first be assessed.

Meeting everyone's requirements, from farmers to consumers, is the ambitious objective motivating the research sector. The complexity and constant evolution of agrosystems are both an obstacle to be overcome and a source of many potential solutions.

Food security issues and the desire to better manage our planet have considerably altered the agricultural production context over the last few years.

The latter has evolved from a range of constraints, some resulting from decisions (restrictions on plant protection products, reduction in irrigation volumes with more uncertain timings), others from imponderable factors (climate change) or finally from quasi-foreseeable circumstances (price volatility, rising energy costs). A consensus was established to design cropping systems that combine four main objectives:

- lowering reliance on chemical inputs,
- reducing environmental impacts, and even making a positive contribution to ecological challenges,
- enhancing resilience in the face of global change,
- ensuring high production levels, perfect quality and good economic efficiency.

Meeting those objectives involves increasing production per hectare in order to help meet global food needs as well as demand from domestic or close export markets that are showing strong structural growth (organic products, protein crops, bio-sourced processed products, etc.).

Those objectives also entail seeking environmental excellence in response to strong expectations from society, customers and producers themselves, who are as keen to protect their living environment and their health as they are to satisfy consumers.

The strategy will be to optimise existing systems, which is effective in the short term (varietal choice, technical optimisation of practices, crop management, etc.), while also looking for innovative cropping systems, or even a complete departure from current systems. This will require ongoing assessment of the progress achieved, based on the new knowledge and innovations that will be offered to producers, including the assessment of ecosystemic functions, cost effectiveness, as well as agronomic feasibility, in order to estimate how likely the proposed solutions are to succeed or fail.

To achieve those objectives, all the technical action levers available must be combined, including chemical inputs, as part of a progress generation process.

Some performance targets involve going beyond the farm gates. Some benefits will only come to light and be sustainable if practices change at production area level, as part of a concerted effort by the producers, including improving water quality, quantitative management, and functional biodiversity based on biological control agents, or the sustainable management of varietal resistance.

Four pathways to open

Increasing yields or, at the very least, stabilising them is therefore one of the first areas of work to pursue. The aim is primarily to develop varieties that are adapted to limiting factors, such as pests and climate change (heat tolerant wheat and cold tolerant maize). At the same time, it is essential to establish cropping systems aiming to lift the ceiling on yields, reduce risks and utilise variability, including by choosing varieties with stages occurring at more propitious times during the season and at different times within a farming business, which works in tandem with a wider variety of cropping techniques.

The second area of work focusses on achieving savings, once again through genetic advances (tolerant varieties, efficiency, low levels of nitrogen input, etc.), as well as through optimisation of crop operations (decision support tools, reduction in machinery cost) and cropping practices that maximise margins, with, for instance, the introduction of legumes (previous crop, cover or companion crops, green covers, etc.) and the use of residual organic or innovative products (with lower emissions, more efficient).

In response to increased variability from one year and one place to the next, a third area of work involves considering this as an opportunity, i.e. seeking greater cost effectiveness ("premium" or local markets, or new uses).

The last area of work also involves capitalising on the multifunctional nature of agriculture, and paying farmers for services other than their produce (carbon storage in the soil and in plants, biodiversity, etc.).

In order to choose the action levers that will help meet those challenges, we must first know how effective they are in various situations, by creating frames of reference based on field trials, data collection and modelling.

Favouring very early species in the rotation may make it possible to achieve two harvests in three years (biomass, grain), such as spring wheat followed by a cover crop.

Multiple performance through genetics

The genetic action lever plays and will continue to play a central and pivotal role in the process of increasing production while having a positive impact on the environment. In order to fully utilise genetic advances, various means of action must be combined:

- accompanying the utilisation of characteristics of tolerance or resistance to biotic (pests, etc.) or abiotic (weather, etc.) stress with evasive strategies,
- adapting cropping techniques to ensure those characteristics can be fully expressed, while seeking new benefits from specific genetic traits,
- in view of the level of variability from one year to the next, focussing more on stabilising plant behaviour, and offering varietal combinations, or "varietal blends", that help to mitigate the impact of fairly unpredictable and detrimental limiting factors.

Those combinations can also be useful to meet the markets' qualitative specifications, through post harvest grain mixing.

This means seeking complementarity and adopting a transdisciplinary approach (ecophysiology, genetics, pathology, agronomy, economy) that may include not creating a dichotomy between genetic pyramiding and varietal bundles, nor between genetic nitrogen efficiency and the use of companion plants (peas, alfalfa, etc.).

To fully utilise genetics, a combination of technological, agronomic and agroecological innovation must be implemented.

And for research to be operational, it must involve a variety of players and focus in equal measures on each key stage of successful plant breeding: varietal development, agronomic advice, and implementation by farmers. It is then essential for varietal advice to embrace innovation, and, for example, to promote the combination of varieties that minimise the impact of an array of weather events.

Improving nitrogen management by maximising its efficiency

Adjusting nitrogen input rates on the basis of potential yield and revising them throughout the season remains the main issue regarding fertilisation. Avoiding early nitrogen surplus, triggering a specific input of 20 kg/ha where this is justified and will be utilised, or varying inputs according to the soil and weather conditions are only some of the issues that mathematical models integrated into decision support tools can help to resolve. Those models are improved year on year and becoming ever more precise. A new approach is also being developed: dynamic management using a nitrogen nutrition indicator, unrelated to yield, without measuring residual nitrogen, but designed to maximise input efficiency regardless of the field's potential. Work is also being carried out to integrate seasonal (3 months) weather forecasts into the models, as well as data from field sensors (continuous data stream regarding the soil and the plants). In addition, although this is more empirical, a double density strip sown in a field is a simple visual indicator that helps to decide whether to trigger the first nitrogen input a week after this strip starts yellowing. This discolouration could be detected remotely through sensors.

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2018