AN ADAPTABLE APPROACH by nature

Choosing the right solutions first requires an initial agronomic diagnosis and a performance assessment based on multiple criteria.

The implementation of agro-ecological principles, provided they are adapted to each specific situation, helps solve the limitations of certain production systems. Innovations born of research work will in turn create an exponential number of tools.

Average yields have been stagnating over the past 20 years for many species. Performance is increasingly variable, whereas demand keeps growing, both in quantitative and qualitative terms.

Certain factors may explain this phenomenon, including climate change (crops subjected to greater stress and unpredictable weather). In addition, crop management is affected by new economic, regulatory and societal constraints such as price volatility, qualitative requirements, and a reduction in plant protection product and synthetic fertiliser use.

"Producing more and better", as part of cropping systems that consume less synthetic inputs and better manage natural resources, is becoming not only a major objective but a priority. An agro-ecological approach helps to rise to this challenge, provided certain principles are applied, including managing multiple performance, activating various action levers, adopting an approach that can evolve, and working on an appropriate spatial scale.

Getting more out of crop ecosystems, while respecting and enhancing the way they work is not only a necessity, justified by an increasing world population, scarcity of resources and the environmental impact of agricultural activity, but it is also a realistic objective.

High performance agro-ecology

Solutions must be developed in a holistic context. The notion of multiple performance (agronomic, economic, environmental and societal) is therefore becoming a crucial one. A solution must not under any circumstances improve one of the performance components if this is to the detriment of another, and it risks affecting sustainability and/or profitability.

In agro-ecology, agronomic and biological action levers must be complemented by those derived from genetics as well as by new inputs. Cropping practices must be analysed at field and farm level. Decision support tools are becoming essential in order to adjust applications and to ensure they are appropriate.

In some cases, it can be difficult to find alternative solutions to synthetic inputs, or they are only partially effective, carry more risks or are too expensive. Agro-ecological solutions must therefore be designed as part of an approach able to evolve, to gradually integrate new research findings.

The agro-ecological approach involves looking at a much more varied and wider area, beyond the boundary of the cropped parcel. This is the case when using biological control agents to push down aggressor populations. It also applies to the logistical management of residual organic products (livestock farming effluents…) as well as to improving the sustainability of engineered resistance to diseases.
However, creating favourable conditions to optimise natural regulators can be time-consuming because of the processes involved, such as controlling erosion, reducing pest and weed populations, or finding better ways of utilising mineral nutrients in the soil.

Combining various techniques

This is why the solutions offered as part of an agro-ecological approach are based on reference data built up over many years, including by the technical institutes.
There are numerous action levers and they can now be ranked based on their effectiveness and the type of agro-ecological effect: lesser dependence on synthetic inputs, lesser consumption of inputs, resistance, efficiency (better results with use of equal amounts of resources), substitution (partial replacement of a synthetic input with natural processes), avoidance strategy (risk mitigation), resilience (adaptation capability to obtain a level of performance that is hardly affected by disruptions impacting on the system)... For instance, in the case of fertilisation, the aim is to find natural sources to partially replace synthetic inputs, as well as to improve uptake and bioavailability of nutrients, and to use effective products with precision application techniques and management tools. More generally, the aim of solutions that take into account all cropping practices and soil preservation is to make farms less dependant on synthetic inputs and water.

From diagnosis to proposals

There is no nationwide “agro-ecological recipe”. The transition towards agro-ecology starts with determining strengths and constraints on a regional scale at the very least. This diagnosis is essential to identify opportunities, and therefore the array of solutions suited to each specific context. A hierarchy of factors that limit production (deficient root establishment, compromised access to nutrients, etc.) or are environmentally harmful (erosion, nitrate leakage, diminished biological activity in the soil. etc.) is established for a given soil/cropping system/climate combination.

This expert assessment requires knowledge and skill to analyse an environment in the broad sense of the term (soil and climate, production systems involved, crop succession and practices, and markets). It can be carried out at regional, local, farm or even field level *(insert)*.

Stimulating mycorrhiza activity is one of the possible ways being studied to improve plant nutrition efficiency.

« Getting more out of crop ecosystems, while respecting and enhancing the way they work is a realistic objective. »

Organising varieties at production area level is one of the ways of ensuring the longevity of disease resistance.

Promising research

Various combinations of potentially innovative agro-ecological action levers are being tested on the field level, as part of the SYPPRE project’s prospective platforms led by ARVALIS, Terres Inovia and ITB *(1)*. Assessed in five different environments, those innovative species successions and practices help to acquire reference data, in association with local experts and farmers. For the past two years, ARVALIS has also been supporting a network of farmers growing wheat and maize under permanent cover, to evaluate the benefits of their practices. This requires full understanding of the way those systems work, in order to propose cover crops that are appropriate for the cash crop of the rotation. At the moment, the most satisfactory results, although they probably cannot be generalised yet, show that yield levels can be maintained while reducing nitrogen input by 50 kg/ha, with an increase in protein content.
As far as crop protection is concerned, biological control products such as plant natural defence stimulators, and biological control agents, are likely sources of progress. Trap plants have been identified. They release kairomone molecules that affect the behaviour of predators. Likewise, allelopathic plants inhibit weed germination and fungus development. Advances made by research in genetics, molecular biology and biochemistry, applied to plants and soil as well as to bio-aggressors and biological control agents, will help speed up innovation.

Very significant development potential

As regards to fertilisation, an innovative possibility consists in improving the extraction of nutrients essential for the plant. This involves stimulating the activity of mycorrhiza, whose strands absorb nutrients, as well as encouraging the development of certain micro-organisms in the soil, such as actinomycetes, which affect the bio-availability of major nutrients.

Innovative methodology

Agro-ecology relies on various action levers, which are often only partially effective and therefore need to be combined. The choice of solutions must also be consistent at all the different levels, from the production area to the field, and take into account local issues and challenges. This has led to the development of diagnostic tools such as “Cassiopée” or the one offered by the Ministry of Agriculture (www.diagagroeco.org), designed by ACTA. At field level, ARVALIS has developed an innovative diagnosis protocol. It includes measuring all the parameters influencing yield (disease, water reserves, nitrogen nutrition index, soil, etc.). By comparing actual and expected yields (estimated depending on the context, the season and the practices used), it is possible to identify limiting factors and evaluate improvement potential, and therefore to identify useful action levers. The combined use of this tool with the Systerre® software that evaluates cropping system performance based on several criteria, will eventually constitute an effective solution for assessing practices and ensuring their constant improvement.

From a genetic point of view, a better knowledge of meteorological, parasitic and nutritional stresses in different environments will help choose more appropriate species and varieties, depending on their physiological characteristics.
An approach encompassing a whole production area and focusing on spatial organisation of varieties based on current knowledge of disease resistance genes and information on the disease strains present in that area, will ensure the longevity of existing engineered resistance.
There is further research to be done on soil. A recent discovery has highlighted interactions between plant roots and micro-organisms in the soil. Those interactions, which differ between varieties, are opening up very interesting agro-ecological possibilities concerning various types of stress. All those techniques and tools, produced by a variety of complementary disciplines, enhance the way crop ecosystems work.

(1) Systèmes de Production Performants et Respectueux de l’Environnement (efficient and environmentally-friendly production systems).

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