A SCIENCE STRADDLING
agronomy and ecology

Last autumn, the French Department of Agriculture gave agro-ecology priority, in order to help agricultural production achieve a double goal of economic and ecological performance. But what does this concept entail from a technical point of view?

Agro-ecology invites us to consider the assortment of species or varietal array at farm or production basin level.

Agro-ecology has been given centre-stage in the French government's new agricultural policy, but it is first and foremost a science that proposes to apply ecological principles, i.e. the relationship between living beings and their environment, to the design and management of new production systems.

"Agro-ecology is before all else a science supporting cropping systems**."**

It emerged in parts of the world where farmers have difficulties accessing production factors (fertilisers, plant protection products, water) and/or certain technologies. They therefore concentrate on optimising natural functions and controlling those functions to benefit their production: organic matter dynamics, nutrient cycle, biological activity of the soil, natural pest control mechanisms, resource conservation and recycling (water, nutrients, carbon, seed, etc.) in the cropping environment. Their aim is to maximise the production potential of plants.

A step up from integrated farming

In the context of the French agricultural production, agro-ecology is close to the concept of "integrated farming," which agronomists and producers have been exploring since the beginning of the 21st century. It shares most of its principles: variety of production sectors in the same area, to promote straw for manure exchanges, for example; valuable species diversity within the rotation in order to minimise parasites, or within the cropping programme in order to encourage auxiliaries; and integrated crop protection in order to reduce the risk of accidents and only apply what is strictly necessary in terms of rates.

However, this science is different from integrated farming in so far as it focuses on the need to improve our understanding of biological control mechanisms at different levels: crop, cropping system, and production basin. If they are optimised, enhanced, those mechanisms can support or compensate for expensive production techniques, some of which may also be harmful to the environment. They must also help eliminate factors that are hindering productivity.

The use of products authorised during the pollination period, or limiting applications when pollinators are present, are in line with the principles of agro-ecology.

Encouraging all forms of biodiversity

Agro-ecology promotes all forms of biodiversity (genetic, specific and functional), by identifying the most beneficial combinations in all environmental areas: on the ground, in the air and in the water. With this approach, producers must work in a way that, at the very least, has very little negative impact on biodiversity. They will, for instance, limit the application of plant protection products when pollinators are present, or choose genetics that provide resistance to insects (e.g. soft wheat resistant to gall midges), use antidrift devices, spray only in windless conditions, choose herbicide molecules that are not susceptible to leaching in parcels prone to rapid transfers, or choose to apply them when there is no water flowing through the drainage network, etc.

"Agro-ecology promotes all forms of biodiversity."

Farmers already have a few leads to help them promote and enhance biodiversity, such as growing a diverse range of species and varieties within a production basin, and preserving or establishing agro-ecological infrastructures. The structure of the landscape also seems to have a significant impact on biodiversity. However, the variety of interactions that come into play make it difficult to determine the correlation between the different factors. The multicriteria evaluation of the various levers available to promote this biodiversity is ongoing, based on multiple criteria (figure 1). Farmers sometimes find the cost of such techniques or devices heavy. The lack of guaranteed benefits may also deter some of them.

Enhancement of soil biological fertility

Maintaining or improving the biological fertility of the soil is also a theme of great significance in agro-ecology. The development of tools capable of characterising this biological component remains a core issue however. Work is underway to develop biomolecular indicators. They will help quantify the diversity of microorganism communities (bacteria and fungi) that control the processes that could be promoted by agricultural practices. Some more traditional approaches also help to do this (microbial biomass, organic matter size fractionation, etc.) However, the existing interpretation framework is not precise and exhaustive enough yet to draw up proper cropping system management strategies based on maximising services resulting from this biological component.

A plethora of concepts made clearer

"Conventional systems": the systems most commonly used in a region.
"Intensive" systems: they are essentially based on systematic intervention. Their aim is to maximise production per hectare and/or per manpower unit (MPU), and devise cropping techniques for a cluster of parcels rather than a single field.
"Reasoned" systems: they are based on systematically reasoned interventions on crops, using intervention thresholds, matrices and decision support tools. They aim to improve efficacy for the best part of the crop.
"Integrated" systems: the reasoning takes into consideration the cropping system used, or even the farming system, based on integrated farming principles. Where possible, inputs that cannot be produced by the farm itself are replaced by natural control or regulation processes. The focus is on preventing the risk of disease in parcels, in order to limit the use of plant protection products, as well as on reducing the need for fertilisers.
"Organic" systems: they use no chemical or synthetic products at all (Dir. UE 834/2007). They therefore involve a global approach encompassing the whole farming system, in order to limit the risk of a negative impact on safety quality, as well as of serious nutrient deficiencies.
Agricultural environmental management/sustainable intensive farming*: It is an unreferenced approach, with a very similar definition to that of agro-ecology. It involves harnessing ecological processes and, to a lesser extent, synthetic inputs, to improve five balances on a farm: carbon, energy, resources (water, soil, matter), biodiversity and safety/toxicity.
Conservation agriculture*: a type of agriculture focusing on maintaining soil quality. Introduced in the USA and Brazil to address wind erosion and organic matter depletion, this approach is based on three main principles: reduction or withdrawal of soil cultivation, continuous soil cover, lengthier and diversified rotations.
Agroforestry*: technique based on associating crops or pastures with productive or amenity trees.
**according to INRA*

Stimulating plants' natural defences

At plant level, agro-ecology should promote new varietal profiles for cereals in the next few years: resistance to bioagressors; efficient use of water, nitrogen, etc.; as well as development of stimulators of the plant's natural resistance with a view to reducing the use of plant protection products. To control weeds, agro-ecology invites us to gain a better understanding of allelopathic and biofumigation phenomena, as well as of the power of smother crops.

From agronomy to agro-ecology

Agro-ecology is therefore a continuum of agronomy and promises new levers to improve the performance of agricultural businesses in an uncertain climatic and economic context. Biological mechanisms and their interaction with cropping systems are given priority, to improve productivity and reduce dependency on fossil resources and technical means.

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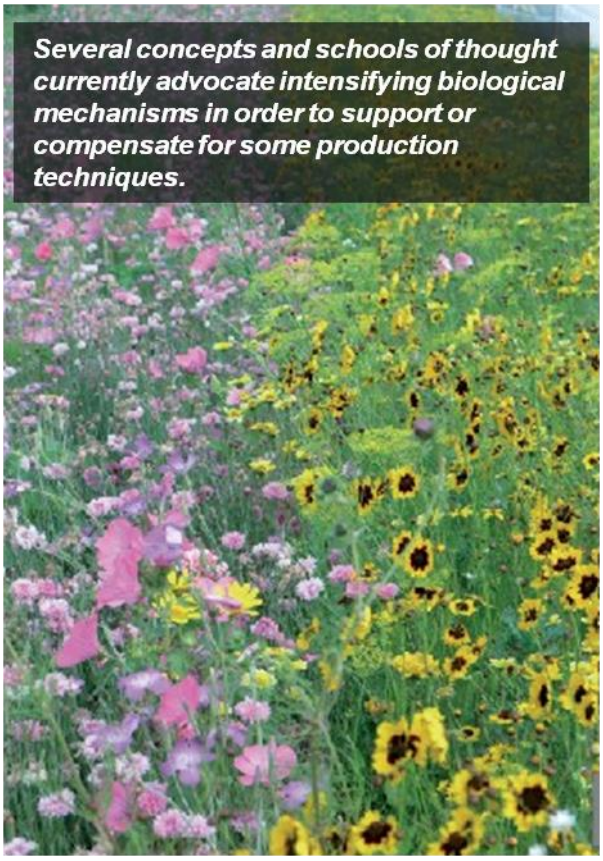
Some mechanisms are already well known and must be brought back to light. Many others remain to be discovered and assessed. But we must bear in mind that the use of biological control in the various agrosystems does not necessarily guarantee sustainability: harmful or uncontrolled developments are possible.



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MULTI-CRITERIA ANALYSIS : the challenge of ensuring biodiversity and farm income

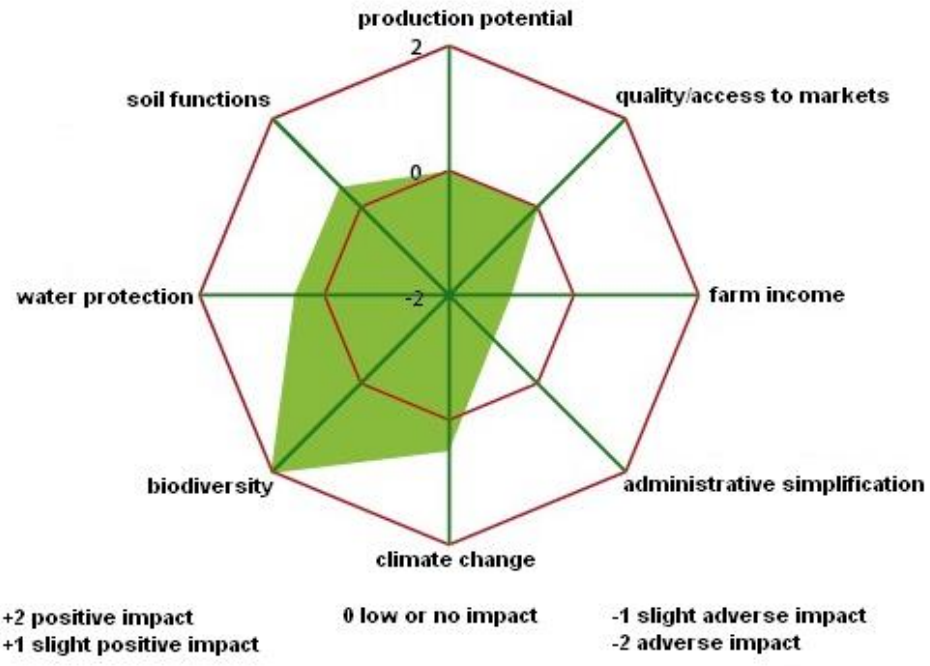

Figure 1 : Impact of preservation and upkeep of topographical specificities off-cultivated areas (field borders, ditches, hedges, copses, ...) on general indicators at the farm scale

Source : expertise ARVALIS-Institut du végétal for Cereactif