# A NECESSARY MIX of solutions

*Emphasis will have to be placed on prevention, especially for weeds, including through soil cultivation.*

**Plant protection will face many challenges over the next few years, including resistance control, regulations that are more restrictive and changes in bio-aggressor presence. Here is a review of the array of solutions available at present as well as for the future.**

The growing shortage of chemical solutions to protect plants is likely to intensify, and to be compounded by new restrictions on the use of such products (protection of residents as well as of biodiversity, presence in the air, etc.). This is connected to a new crop protection model that includes the advent of integrated and agro ecological protection.

## Getting equally good or even better results, with fewer products

As far as disease control is concerned, prophylactic measures will take back centre stage. They will include rotation diversification, companion plants during the intercropping season (biofumigation…), and optimisation of local conditions to boost prophylactic measures. The number of "biocontrol" solutions capable of complementing reduced agrichemical rates, or even of replacing them altogether, is consequently on the increase (stimulation of plants' natural defences or direct disease control). The use of microorganisms or of their metabolites could also come into play.

The importance of diagnosis and epidemiovigilance will be reinforced. Real time monitoring of resistance to fungicides and varietal resistance-breaking will require field tools (spore traps and/or PCR analysis in the field).

In that context, it will be crucial to optimise varietal resistance to diseases, and in particular its geographical distribution (gene "mosaic" over a production area to reduce the ability of pathogens to resistance-breaking.

The increased use of decision support tools made possible by technological advances, will complete this array of measures with spatial meteorological data (more easily accessed than networks of expensive and difficult to maintain weather stations), simpler and connected weather stations, real time epidemiological monitoring data and even linkage to field sensors.

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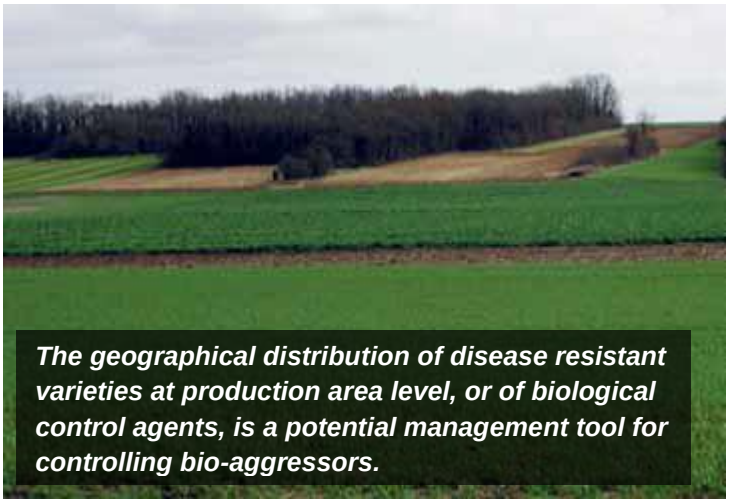
## Prevention and precision farming

The situation is the same for weed control: fewer products available and problems related to developing resistant populations.

Alternative solutions must therefore be found, and used in combination. For an innovation to be adopted, it must satisfy certain criteria: it must be easy to use, have an advantage over current practices (cost, etc.), and be visibly effective rapidly. That is why time-consuming solutions are rarely compatible with work systems.
In any case, prevention will have to take centre stage, for example with soil cultivation measures, where possible (or necessary), and false seed-bed (which must be implemented as soon as there is any sign of resistance, as it takes two or three seasons to show any result). The "change in rotation" action lever can be effective but involves modifying the way the production is utilised or marketed, as some options may no longer be available (niche markets, etc.). Other preventative levers that do not necessarily involve reviewing the production system can be activated, such as using varieties with high ground cover power and changing sowing dates (plant-weed competition). The reducing cost of using precision farming tools will also help their development (precision spraying, etc.).
In addition, there will be significant innovations born of research programmes in the medium to long term, including the use of RNA interference (RNAi), which would improve herbicide function by activating or repressing certain metabolic pathways, of natural bio-control substances, or of microorganisms situated close to the roots.

**Ecosystem-based services**

Thanks to current research work, natural regulation of bio-aggressors by biological control agents may be used a lot more by 2020-2025. In addition, biological control through conservation (preservation and creation of habitats, cropping practices that encourage the presence of biological control agents) should be considered at production area level. It will then be possible to define which crop rotation optimises the presence of a habitat mosaic that encourages the natural enemies of pests. Studies are currently aiming to determine which impact field margin management has on the presence of biological control agents and pests. Once again, connected tools (e.g. smartphones) will have a role to play and help to recognise biological control agents, input field data and assess the state of various populations.



***The geographical distribution of disease resistant varieties at production area level, or of biological control agents, is a potential management tool for controlling bio-aggressors.***

## Reducing population levels

For pest control, most of the solutions that are still available are likely to become less effective as well as see their spectrum of action get more limited. It will therefore be even more crucial to combine various techniques in order to keep pest population levels low and reduce the need for direct control measures. To achieve this, crop management operations will not be limited to the cropping season and will have to span the whole system and involve companion plants, soil cultivation, natural regulation by biological control means such as conservation *(insert)* or the introduction of other organisms (micro-organisms…). As a result, facing less dense populations, the technical value of those products that are still available should be preserved. One thing is certain however: the situation will vary depending on which pest is present and on conditions each year.

Denis Gaucher (diseases) - d.gaucher@arvalisinstitutduvegetal.fr
Ludovic Bonin (weeds) - l.bonin@arvalisinstitutduvegetal.fr
Jean-Baptiste Thibord (pests) - jb.thibord@arvalisinstitutduvegetal.fr
Véronique Tosser (biodiversity) - v.tosser@arvalisinstitutduvegetal.fr
**ARVALIS - Institut du végétal**

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