DIRECT DRILLING INTO GREEN COVERS

ASSESSING the factors of success

A new form of collaboration drawing on farmers' expertise provided a vital innovation for the study, in situ, of direct drilling (DD) into green covers as a whole system.

A new experiment method, involving farmers as co-researchers, led to the discovery of the key factors of success of direct drilling into a green cover. The technical, economic and environmental performance of such a system was also analysed.

The use of innovative methodologies deployed at various working levels and relying heavily on farmers'[1] involvement, has helped to really develop our understanding of direct drilling into green covers over the last few years.

The multiple benefits of direct drilling into green covers (organic matter, diesel consumption, etc.) only become a reality when the system is properly controlled, i.e. when it produces as much as or more than a conventional system, while generating the same or a higher revenue for the farmer. In addition, even if the amount of plant protection products (PPPs) used is not necessarily higher than with a conventional system, it still relies at the moment on the use of glyphosate. So, to help farmers tackle those technical challenges, we must assess the performance of those systems from various points of view, and define more clearly which agronomic action levers have a beneficial impact, in order to make them more readily accessible to a greater number of producers. To that end, Arvalis and expert farmers in DD into green cover have been working together for four years.

« Crops don't grow differently with DD into green covers, it is the environment in which they grow that is different. »

The crop-cover balance

The introduction of the "Diagchamp" protocol (see insert) produced a useful framework to explain the success or failure of the crops being diagnosed (cereals and maize) in a DD into green cover system. This study helped to clarify an ambiguity that was a source of misunderstanding between farmers and advisors: crops don't "grow" differently with DD into green covers, it is the environment in which they grow that is different. Whatever the conditions, the yield of a cereal crop remains linked to the number of grains/m², which in itself is linked to the nitrogen status of the plants at flowering time, which is measured using the nitrogen nutrition index or NNI (figure 1). However, the Diagchamp analysis revealed other limiting factors present in the fields. If the value is firmly under the purple line (figure 1), it means that one or more limiting factors, other than nitrogen nutrition, eroded the yield. The three values situated above the purple line (only one of which is convincingly so) show better results than expected from the nitrogen nutrition diagnosis established at flowering time. Either the yield potential was underestimated (it was confirmed that this was not the case), or favourable factors and/or conditions removed previous yield limitations. The hypothesis that needs to be confirmed is that a beneficial agronomic lever was activated in the field, while other limiting factors (such as pests) were properly under control.

This diagnostic "envelope curve", as it were, based on a group of parcels with the same soil conditions, therefore becomes a tool that will help to identify which practices have a beneficial impact in such a cropping system.

Factor hierarchy

The Diagchamp method helped to "rank" limiting factors on the basis of their significance (yield loss compared with expected potential) and their extent in the plots under study (figure 2). For example, Fusarium at the base of the stem is quite often a limiting factor, but it is not particularly specific to DD into green covers. Conversely, damage caused by voles or competition from living covers are very much inherent to that practice.

One of the outcomes of this project is that covers are only of benefit to a wheat crop if they are well developed by the time the crop is being sown. They must therefore be sown long before the wheat (as soon as the previous crop has been harvested in the case of perennial species that take longer to establish). From the stem elongation stage, it is imperative to control the cover in order to limit competition with the wheat. When plants are greening up again at the end of winter, the crop must take over and the cover must not reach above 1t of DM/ha by the time the cereal crop is flowering. Although difficult to achieve successfully, the system involving a (semi) permanent living legume cover seems to be potentially the one with the greatest agronomic and economic benefits for winter crops. The success of this technique, however, is still much more risky with spring crops.

Thanks to farmer collaboration, over thirty DD into green cover cases (different plots and farm characteristics: machinery, economic items, etc.) have been assessed since 2012 using the Systerre® software. Compared with those farmers' past practices, some indicators are clearly impacted by the new "system". They are mainly, of course, mechanisation indicators: lower diesel consumption (-50% to -70%), lower pulling power required, and less time spent on a tractor. Otherwise, results vary greatly from one case to another. The uncertainties of the production process being often more difficult to control with DD into green covers (white clover competed with a maize crop for instance), the net margin can easily slip back to below that of a conventional system if there are some cropping failures.

The environmental indicators that were calculated show little difference compared to a conventional system. Within the network of farms being monitored, input efficiency rose with regard to diesel, but not with regard to any other parameters (nitrogen, PPPs), with, in some cases, a greater use of PPPs even (herbicide TFI). However, performance is largely improved if it is expressed in terms of tonnes of biomass produced per year (and not in terms of tonnes of harvested product) when covers are incorporated. In addition, there may be a methodological bias error when assessing a system that is not yet fully established when the control system (with cultivation) has had time to "bed in".

Better control of semi-permanent covers

The undestroyed, living cover option seems promising from an agronomic point of view, including to find action levers that reduce reliance on glyphosate. Reference data must be produced, including concerning the choice of cover (species and varieties) as well as its control in the crop (herbicides combined with alternative means such as frost or rolling). Before it can be utilised, such reference data must be validated at regional level (soil conditions, cash crops and markets, farm structure, etc.). Real advances will most probably result from regional projects involving regional economic and development partners, research organisations as well as farmer groups.

Understanding the mechanisms involved through the use of diagnostic tools, and assessing performance based on multiple criteria will help to improve DD into green cover systems, and to make them more readily accessible to most farmers, with design methods, suggested practices, and development of special management tools that take into account specific conditions during the season.

(1) In collaboration with the farmers of the Arvalis SCV network (with the support of the PACA Region and Conseil Départemental 04), the PERMAC project (with the support of the Pays de la Loire Region) led by Arvalis in conjunction with the Terrena cooperative, the CASDAR Agroécologie SCV 04, the Chambre d'Agriculture 04 and Agribio 04: Messrs. Abadie, Appert, Benoît, Beranger, Boissinot, Bouvier, Bouvin, Brémond, Chambe, Charpentier, Charpin, Déon, Destouches, Epoudry, Gaborieau, Giraud, Guillot, Jacob, Joly, Joubert, Lemey, Leroux, Lhermey, Masucco, Paul, Pellestor, Quillet, Richaud, Roy, Rudelle, Sauvat, Thieblemont Vernet and Vincent.

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Innovative methodology

Carried out on farms and with farmers[(1)] that implement direct drilling into cover crops, this study relied on modelling as well as on measurements taken in the fields.
The Diagchamp reference data acquisition method for large plots quantifies cropping results (gap between potential and actual) in order to explain them by identifying limiting factors, while providing the keys necessary for extrapolation (environment, weather conditions that year, etc.). Analysis was combined with an assessment using the Systerre® software, based on several criteria at farm level, as well as with more traditional factorial trials as part of experiments. The reliability of the diagnosis is further enhanced by a joint validation by the experimenter, Arvalis contact(s) and the farmer.

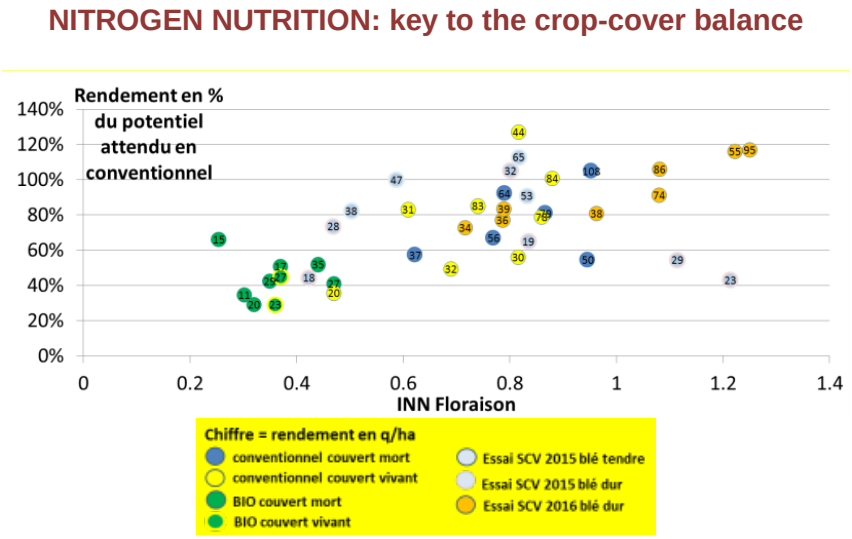

Figure 1: ***Expected soil potential over the season based on the nitrogen nutrition index (NNI at flowering time) for a durum wheat crop. SCV South-East network 2015 and 2016 (Arvalis, D Bremond, CA04, Agribio04), 40 plots.***

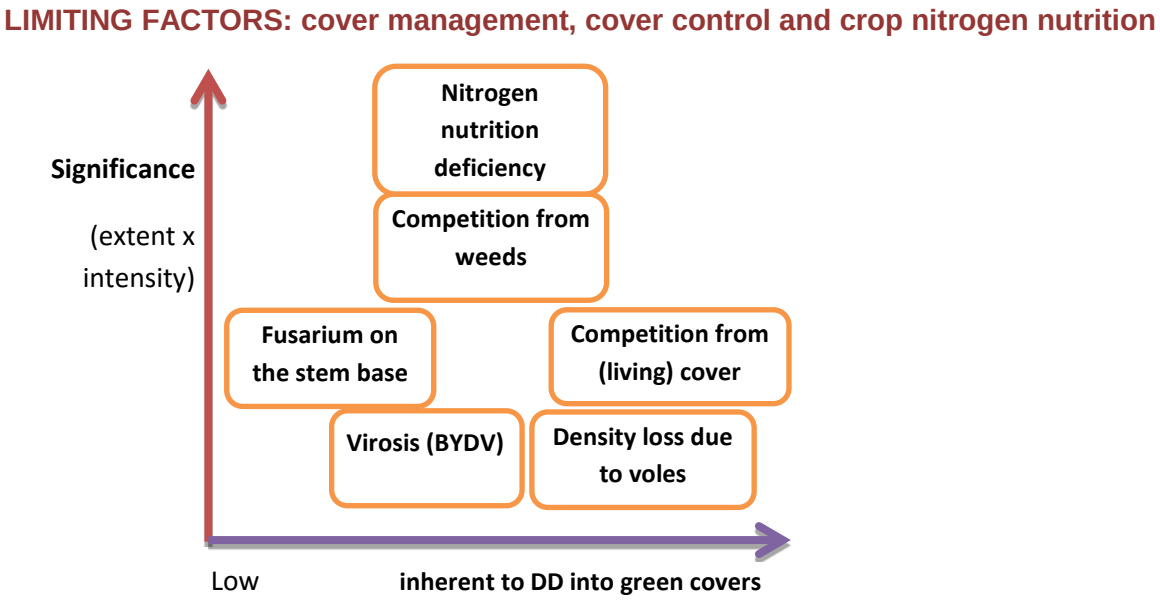

Figure 2: ***Ranking of limiting factors that have an impact on the success of direct drilling into green covers (yield compared with a conventional system with the same soil conditions). Diagchamp method - Arvalis.***