Feedback

Agro-ecological transition of innovative irrigated farming systems in the Coteaux de Gascogne area

In the Coteaux de Gascogne area, farmers, researchers and water service managers are committed to an agro-ecological transition of irrigated farming systems. It is against this background that, in 2019, a pilot project carried out an initial assessment of the agro-economic performance of irrigated cropping systems based on soil conservation farming practices and water-saving irrigation techniques and/or strategies.

Since 2012, experiments on plot-based water savings have been jointly carried out on the experimental farm of La Mirandette, located at Masseube in the Gers department, by the Coteaux de Gascogne Development Company (CACG) and the Joint Research Unit G-EAU (INRAE-CIRAD) with support from the Adour Garonne Water Agency and the Occitanie Region.

There is naturally a structural water deficit in the Coteaux de Gascogne area. Irrigation is essential to meet the needs of the crops during the summer. However, this practice is subject to societal pressure, which is pushing for a reduction in the amount of water withdrawn for irrigation. This area is also considered to be one of the most sensitive to soil hydroerosion in France (Gis Sol-INRAE, 2011). The phenomena of runoff and soil erosion are amplified by the conventional methods currently used: ploughing and soil left bare during a period of the year exposed to the harsh rains and wind. Moreover, many of the plots are located on hillsides and therefore on slopes likely to amplify the processes of runoff and erosion. At the plot level, the negative impacts of erosion are not only reflected in a decrease in the fertility, and therefore in the productivity, of the soil, but also in a lower degree of efficiency in the application and distribution of irrigation. At the level of the hydro-agricultural basin, the harmful effects of the erosion of cultivated soils result in pollution of the watercourses of both a physical (sediment) and chemical (herbicides, pesticides, synthetic nitrogen, etc.) kind.

There is an alternative to the usual agricultural practices in arable farming that can reduce the pressure of water withdrawal on the environment, to control soil erosion and restore/maintain soil fertility. Concerning cropping practices, it is based on conservation agriculture practices (CA), the principles of which are based on a significant reduction (or even elimination) of tillage, an (almost) permanent plant cover of the soil and diversified crop rotation systems. With regard more particularly to irrigated cropping systems, SCF-type cropping practices associated with more water-efficient irrigation techniques are worthy of testing and even demonstrating, especially their agro-environmental benefits during the agro-ecological transition phase.

❶ Glossary

AEAG – Adour Garonne Water Agency.
CA – Conservation agriculture.
CACG – Coteaux de Gascogne Development Company.
CIRAD – Centre for International Cooperation in Agronomic Research for Development, France.
DS – Direct seeding.
ETM – Maximum evapotranspiration.
INRAE – National Research Institute for Agriculture, Food and the Environment, France.
IRR – Irrigated.
NOT-IRR – Not irrigated
OIRR – Overhead irrigation.
SMT – Minimum Tillage.
SSD – Subsurface drip.
TASCII – Agro-ecological transition to innovative irrigated cropping systems.
UMR G-EAU – Joint Research Unit "Water Management, Actors, Territories".

This pilot project will enable an analysis of the contributions of CA to the improvement of environmental conditions related to erosion, fertility, soil water retention (and to consequent savings in irrigation water and reduction of the pressure of water withdrawal from the environment), and also to a reduction in the use of pesticides, while nevertheless guaranteeing a good level of economic profitability.

The project's approach combines co-building, experimentation, pre-diffusion and participatory monitoring and evaluation of the short- and long-term effects of AC and the reduction of water input. Significant in-house scientific monitoring is carried out at the experimental farm of La Mirandette (component No. 1, Figure ❶) and limited off-site monitoring is carried out at certain farmers' premises. Initiated in 2020, this second component is organised around a partnership with six pilot farmers whose plots of land are located within a radius of twenty-five kilometres around La Mirandette (component No. 2, Figure ❷). This component also enables us to carry out experiments in different contexts: organic farming, livestock farming, monocropping; clay soil, clay-loam (known as boulbène), etc. It is thus a useful teaching tool for extension and demonstration purposes among farmers.

The methodology is based on the field testing of different irrigated cropping systems through the combination of :

- Soil tillage practices: minimum tillage (MT) vs. direct seeding (DS) and Conventional Tillage; and
- irrigation: Overhead irrigation (OIRR) vs. subsurface drip (SSD), at 100% or 80% of the plant's needs (ETM).

In 2019, experiments were conducted on maize cultivation, in a rotation (maize, straw cereals and soya). This project will continue over several years (at least four years).

Results of the 2019 season

An initial assessment of the agro-economic performance of irrigated cropping systems based on conservation agriculture (AC)practices and water-saving irrigation techniques and/or strategies was made after the experimental season conducted in 2019 within the framework of the TASCII pilot project.

Irrigation equipment method

The work carried out on the comparison of irrigation equipment since 2012 has shown a better water efficiency of the SSD compared to sprinkling, at 15% more average grain yield per m3, except in 2014 when the weather conditions were particularly wet.

Indicator of plant development

Under comparable sowing conditions, the result is an emergence of -3 to -12% on DS compared to MT. After emergence (45 days after maize sowing), and at the 6/7 leaves stage, plots under DS show slower plant development compared to MT. Then, DS starts to catch up and achieve plant development equivalent to MT at the kernel growth stage.

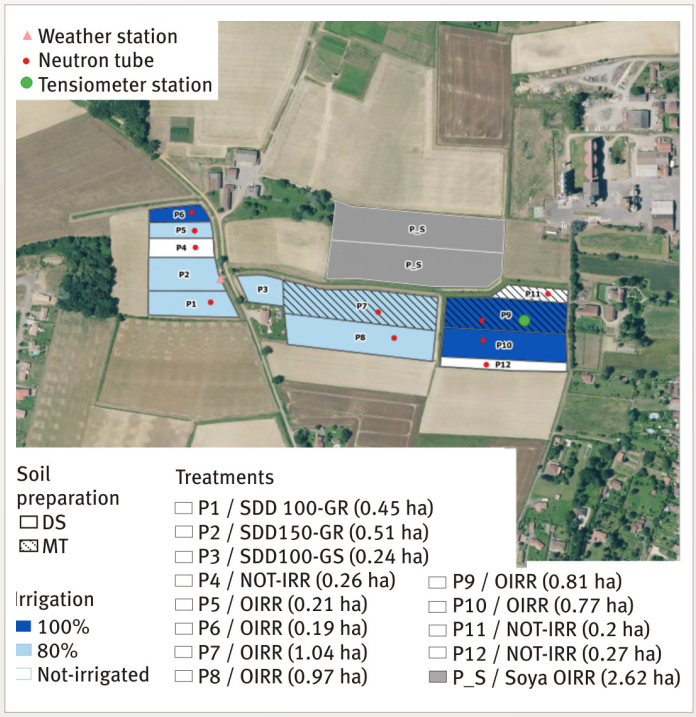
The hypothesis that can be put forward is the combined effect of no-tillage and mulch on the surface soil warming process which, compared to that on MT tilled soil, would penalise seedling development due to cooler soil temperatures.

❷ A farmer's view

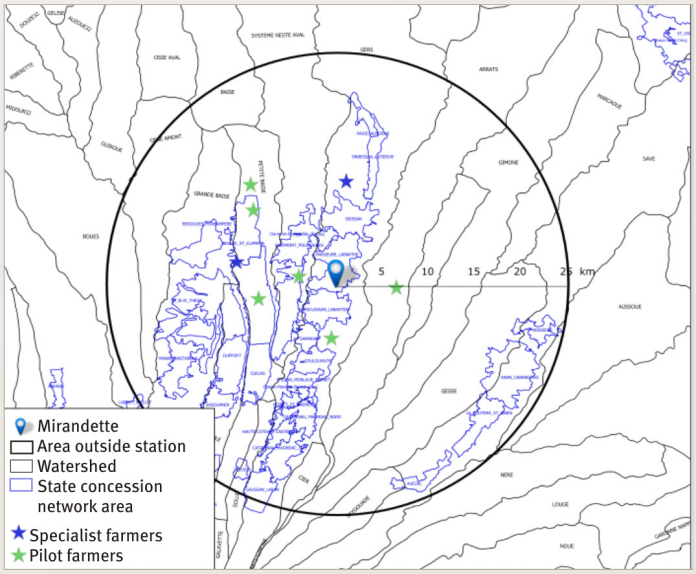
Florent ESTEBENET, pilot farmer

"We need to be able to test, without taking risks, new techniques and tools that limit costs and inputs to maintain economic profitability on farms and restore the soils of our lands. The Mirandette [platform] offers a fine example with very good results. The TASCII project offers us this opportunity."

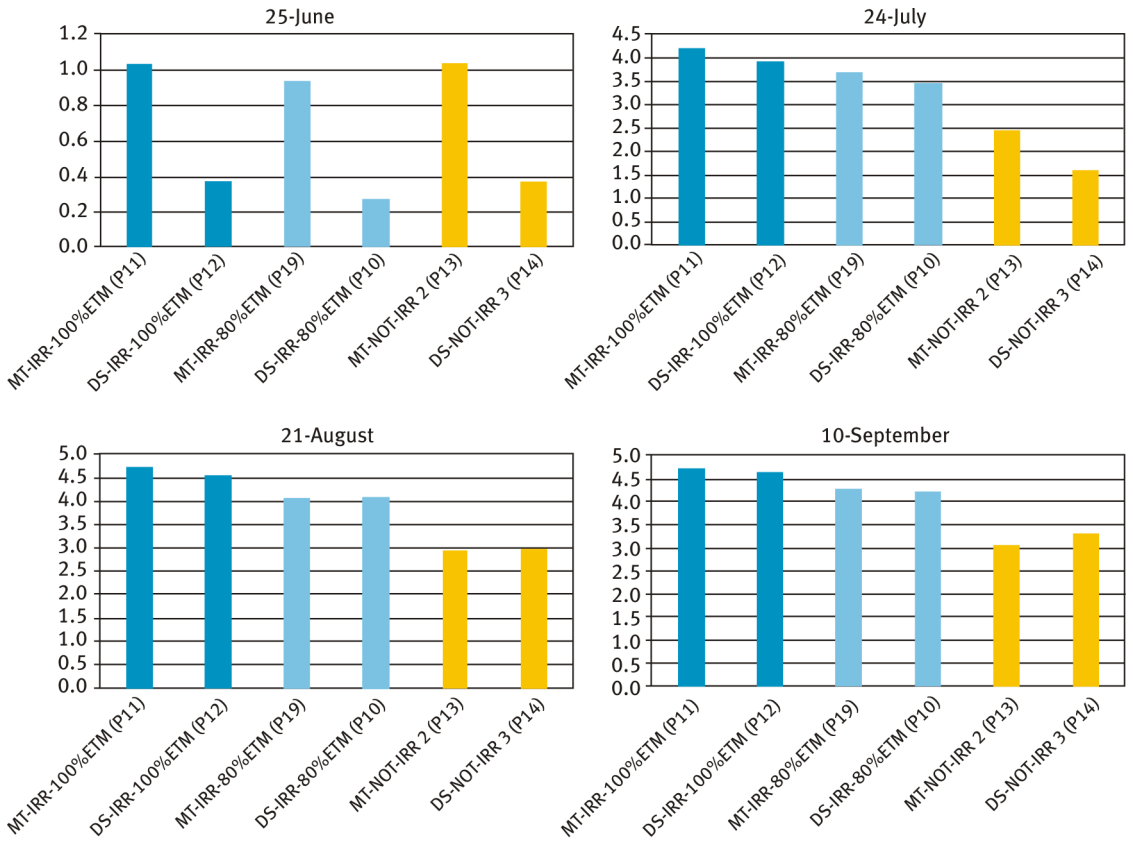
❶ **Testing at La Mirandette in 2019 (component 1 of the project).**



❷ **Testing among pilot farmers in 2020 (component 2 of the project).**



❸ Foliar index LAI [Leaf area index] (MT: Minimum Tillage, DS: directing seeding).

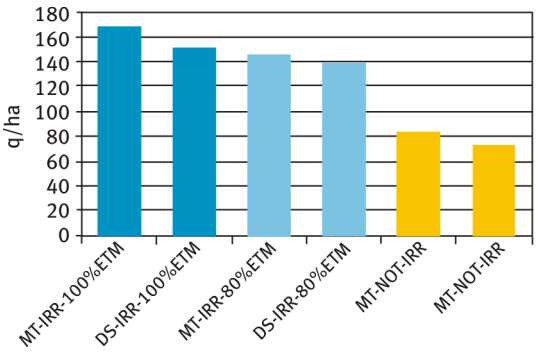


For all vegetative stages, plant development is directly impacted by irrigation conditions, reduced or no irrigation reduce consequently vegetation (Figure ❸).

Yield indicator

In line with the Leaf Area Index recorded during the different growing periods, the maize (corn) yields (hu.15%) obtained in 2019 on the experimental plots of La Mirandette ranges from 72 qx/ha for the plot sown in seeding direct non-irrigated, to 168 qx/ha for the plot tilled in MT and irrigated at 100% of the plants' water requirements (Figure ❹). These results are therefore proportional to the water satisfaction scale. In addition, very high production levels (142 qx/ha on average) are measured on irrigated plots at 80% of the plants' water needs. For all

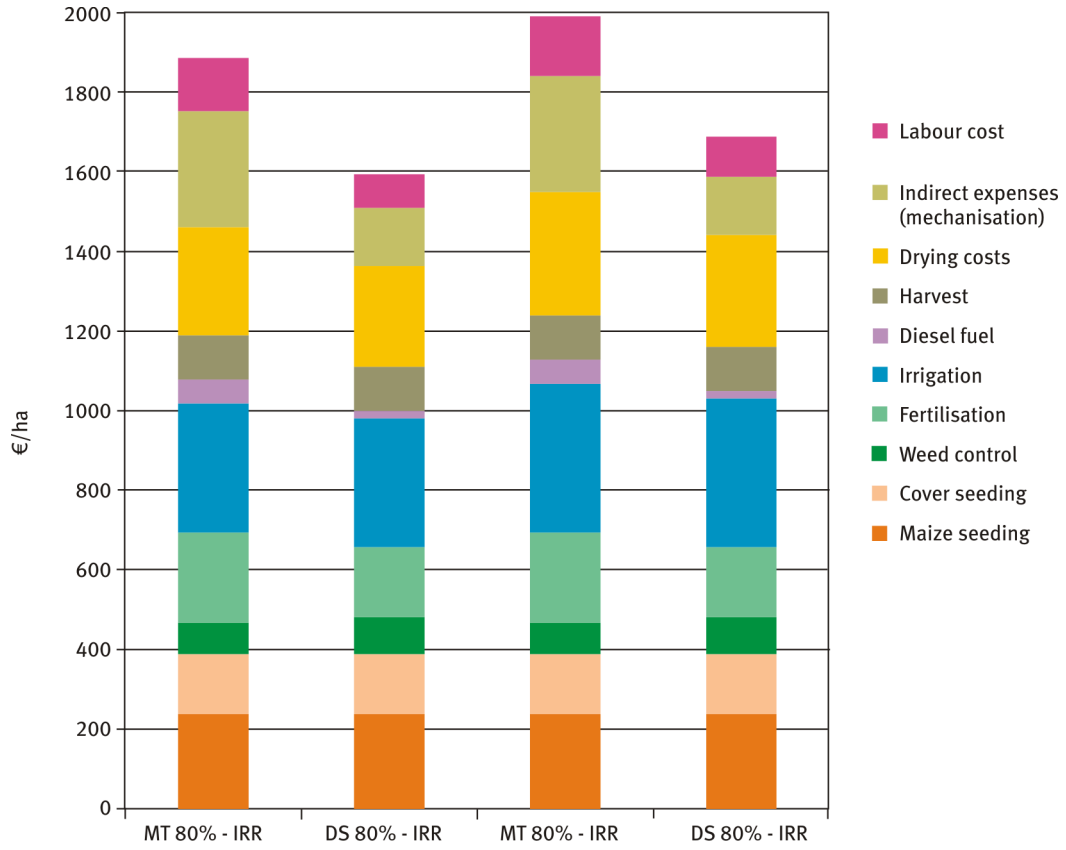
❹ Yield in quintals per hectare.



❶ Margin in euros per hectare per technical methodoute.

Technical	MT - 80% ETM	DS - 80% ETM	MTS - 100% ETM	DS - 100% ETM
Turnover (gross revenue)	1 899	1 771	2 169	1 969
Total variable costs	1 460	1 363	1 549	1 441
Gross margin	**439**	**408**	**621**	**528**
Structural costs (mechanisation)	291	146	291	146
Labour cost	133	84	150	101
Net margin	**15**	**178**	**180**	**281**

❺ Cost in euros per hectare per technical method.



treatments, there is a difference of about 7% between DS and MT, which can be explained by the differences in emergence between the two systems.

Economic indicators

MT generates higher costs than DS due to the additional mechanisation costs for MT tillage. In addition, DS saves on fertiliser costs (€51 per hectare on average) due to the higher plant cover inputs (Figure ❺). Irrigation at 80% ETM also offers cost savings of €50/ha in costs compared to irrigation at 100% ETM.

Despite its additional costs, MT provides higher yields than DS and therefore higher turnover. Calculation of the turnover per hectare was based on yields based on the cooperative's norms (i.e. 7-9% less than the yields measured at the experimental plot) and a maize price of €140 per tonne.

If we restrict ourselves to gross margin alone, we find that MT generates more gross margin than DS (Table ❶), but if we go further in the analysis by including mechanisation and labour costs, then DS generates more net margin.

Irrigation has a considerable effect on the margin, with inputs of 80% ETM only saving €50/ha (3% of costs) but causing a loss of more than €200/ha of turnover on average. Irrigation that fulfils the plants' water requirements (100% ETM) results in a gross margin of more than 36% and more than double the net margin (140%) compared to irrigation at 80% ETM. ■

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