SYPPRE NETWORKS

INTRODUCING A CEREAL into a maize monoculture system

For the past three years, Arvalis has been assessing two innovative systems in the Béarn region: a maize monoculture with oats grown as an energy crop during the intercropping season, and a double barley-maize crop being compared to a ploughed and mulched maize monoculture.

Arvalis has been assessing the socio-economic and environmental performance of a maize monoculture in the Béarn region of south-western France, with barley or black oat intermediate crops.

Arvalis has been conducting experiments as part of the SYPPRE-Béarn platform[1], in Sendets, south-western France, since 2015, to study the sustainability and profitability of a double crop of winter barley followed by non-irrigated grain maize. Over three years, winter barley grown on the typical black soils of that region yielded on average 5.5 t/ha. The best result was obtained in 2017 (7.1 t/ha) and the worst (4.1 t/ha) in 2018, a year characterised by a very wet winter. Winter barley is usually harvested during the second half of June. The earlier it is harvested, the earlier the maize can be established, which reduces the risk of having to harvest it really too late in the year. It is therefore advisable to choose early barley varieties.

In order to reduce costs, maize is sown using the simplest techniques possible. However, if barley straw is not exported, it usually has to be chopped and incorporated. The maize variety should be as early as possible (G0 group) to minimise drying costs.

Late sowing sees very fast initial growth, allowing cropping techniques to be minimised compared with early sowing. However, late sowing means that the maize is more exposed to borer damage and maize leaf blight outbreaks. If it is sown without ploughing first, large numbers of barley volunteer plants are very likely to emerge. In that case, post-emergence weed control is the best option. If the field has been ploughed, pre-emergence treatment is possible if conditions allow it.
Nitrogen can be applied to maize in a single dose, at the 3-4 leaf stage.

The poor performance of a double barley-maize crop is due to low yields from both crops, as well as higher costs.

What performance can be expected from a double barley-maize crop?

Over three years, non-irrigated maize catch crops yielded on average 6.7 t/ha. However, this varied greatly depending on the weather conditions each year and actually ranged between 8.1 t/ha in 2017 (rainy summer) and only 5.6 t/ha in 2018 (dry summer). On average, the maize was harvested at the end of October at 36% moisture, which is still acceptable. However, this relatively low figure is due to the particularly warm autumns of the last three years, enhancing the natural desiccation process.
Despite the double harvest, the farm's simulated gross output using the SYSTERRE tool is 153 euros/ha lower (on average over three years) than that of a mulched and ploughed maize monoculture. Barley and maize yields are too heavily penalised some years to consistently achieve a higher gross output.
Logically, the cost of producing a double crop was higher than for a single one (+159 euros/ha average over three years). This is because all operational costs were higher, except for drying costs (since the volume to be dried is much lower). Machinery costs were 129 euros/ha higher. The net margin (inclusive of subsidies) derived from the double barley-maize crop was reduced to 3 euros/ha, compared to 362 euros/ha with the single maize crop.
The findings are not any more gratifying from an environmental point of view. With a double crop, nitrogen and fuel consumption per hectare increased by almost 50% and the treatment frequency index (TFI) by 2.8 points (i.e. more than 50%). Primary energy consumption and greenhouse gas emissions were also higher.

Introducing oats during the intercropping season between maize crops

With maize monoculture, the intercropping season can be used to produce an energy crop without it competing with food production. The introduction of black oats as an energy crop between two maize crops is being tested and assessed as part of the same SYPPRE-Béarn platform, using the same method.
To maximise biomass production from intermediate crops for energy supply, they must be sown as early as possible (between 20th September and 10th October in south-western France). For that, maize must be harvested at a reasonable moisture during the second half of September. This means choosing semi-late maize varieties, and DKC4814 was therefore sown in the innovative system, instead of the P0725 chosen for the control single crop.
Most of the winter intercrop yield is built during the second half of April, when mild temperatures ensure good plant growth. As a result, the maize is generally sown later than normal. Experience in Béarn has shown that waiting for the right stage to harvest the energy crop results in a 15-day lag on average compared to usual sowing dates.
In order to reach their full yield potential, oats need to be fertilised; around 70 units of nitrogen is sufficient. The nitrogen will be better utilised if it is applied at the very end of winter, when plants start growing again. Ideally, organic products should be used to put organic matter back into the soil. However, winters tend to be wet in Béarn, making it difficult to bring slurry tankers into fields, and mineral fertiliser (ammonium nitrate) often had to be applied instead.

Higher costs… but higher margins too!

On average over three years, oats sown as an intermediate crop for energy supply produced 6.1 t DM/ha. The best results were achieved in 2017 (8.4 t DM/ha) when the cumulative temperature for April was high, which encourages biomass production. Conversely, the cold and wet spring in 2018 had a very negative impact on the oats: some master-strands froze, which hindered plant growth, and yields were lower than expected (3.8 t DM/ha).

After the intermediate oats has been harvested at the end of April, tillage is advisable before sowing maize, to stop volunteer plants emerging if weather conditions are favourable.

Later sowing penalises maize yields slightly. On average over three years, maize grown after an oat as an intercrop produced 11.9 t/ha compared to 12.8 t/ha from the control crop), i.e. a loss of 0.9 t/ha.

However, maize was harvested slightly drier as a result of the change in earliness.

Assuming that there is a market for the intermediate crops for energy supply, its sale makes up for the lower yield in the following maize crop. On average over the three years, it generated a gross output surplus of 540 euros/ha.

However, production costs were higher, especially in relation to machinery (+260 euros/ha), essentially due to the cost of the energy crop harvest with a conventional forage harvester, and to operating expenses (+145 euros/ha), including the purchase of certified diploid black oat seed and of fertiliser to fertilise it. In the end in this case, the introduction and sale of the intermediate crop for energy supply increased the farmer's net margin by an average of 93 euros/ha over the three years, which is 26% higher than with the control single crop inclusive of CAP subsidies.

Better environmental indicators

The introduction of an intermediate crop for energy supply intensified the production system while delivering environmental services. Surface area-based indicators showed an improvement (+44% of energy produced per ha), while almost all production-based indicators showed a drop. Energy consumption was down by 15%, as were greenhouse gas emissions per dried tonne. With the intercrop, the ex-field gross energy balance, i.e. the energy produced over the energy consumed, rose by 14%.

Farmers considering the introduction of an intermediate crop for energy supply often fear a drop in organic matter levels. However, up to now, simulations have shown that the "single maize crop with an energy crop" system puts as much organic matter back into the soil as a conventional single crop system.

Research work is currently trying to make this innovative system more reliable, including through the choice of appropriate species and varieties for the energy catch crop. To avoid using deep tillage as a means of controlling volunteer plants, the choice of intermediate crops for energy supply should be based on an early ear emergence.

(1) Arvalis-ITB-Terres Inovia Inter-Institute Project: "Building tomorrow's cropping systems together".

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