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Harvesting and separating crop mixtures: YES WE CAN!

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The goal of the ReMIX project, funded by the EU's Horizon 2020 Programme, is to exploit the benefits of intercropping to design more diverse and resilient arable cropping systems. Together with farmers, ReMIX has designed productive, diversified, resilient and environmentally friendly cropping systems that are less dependent on external inputs. Intercropping delivers high quality food and sustainable returns to the farmer.

Conventional agriculture must engage in a transition towards more agro-ecological farming systems in order to solve environmental pollution and provide sufficient quantity and quality of sustainable food and feed. Diversification of cropping systems, especially in the same space through the use of species mixtures – the simultaneous cultivation of at least two species in the same field – can contribute to achieve these ambitious objectives of the Farm to Fork Strategy for a growing world population.

Despite the demonstrated interest of species mixtures, especially in low input systems (Bedoussac et al. 2015), uptake by farmers is limited. One of the main obstacles to their development is the difficulty in harvesting and subsequently separating the products. It is not usually possible to sell the harvest as a grain mixture for human consumption. The grains need to be separated and the end-product needs to meet high quality standards in terms of level of broken grains or impurities. The feasibility of separation depends mostly on the species in the mixture but also on the settings of the combine harvester during harvest. However, the greater the degree of separation, the higher the associated cost.

The challenge is therefore, to maximise economic performance by optimising both harvesting and sorting for each species mixture to

limit losses, broken grains and impurities to finally propose solutions to farmers allowing increasing the economic value of their harvest. This requires compromises in the field, by adjusting the settings of the harvester and later needs to separate grains very precisely to achieve the highest market value of the intercrop.

This is what was targeted by experiments carried out as part of the European H2020 ReMIX project on two-species mixtures with various grain sizes (wheat–lentil, rapeseed–pea, barley–pea, wheat–lupin) aiming at:

- Assessing, as a proof of concept, the very feasibility of harvesting and separating these two types of grains;
- Determining for each species mixture the harvest-sorting couple maximizing the economic performance for the farmer;
- Making this knowledge accessible to the actors of the agrifood chain.

Harvest was performed with a Laverda M410 from AGCO Group (Figure 1) and sorting with a vibrating cleaner SVD 100 from Etablissements Denis (Figure 2).

Solutions for separating mixed crops

Stop broken grains

Separating grains after harvesting remains a major obstacle to the development of associated crops. Opinions differ on the feasibility of sorting because the constraints are different between the farmer sorting on the farm, the manufacturer of sorting equipment and the collection managers of a cooperative. The expected results also



Figure 1 Harvest of a wheat–lupin mixture in Denmark with a Laverda M410 combine harvester from AGCO Group (14/08/2020, Picture from Hans Henrik Pedersen).



Figure 2 SVD100 vibrating cleaner from Etablissements Denis used to demonstrate the feasibility of the separation of species mixture and the resulting economic benefit (Picture from Patrick Bourrachot)

depend on the outlet. In any case, the feasibility of sorting depends on the species mixed but also on the quality of the crop, the presence of broken grains being the main problem.

Grain separation after harvest is the key to provide added value

Our work demonstrates that a single sorting with classical sorting equipment seems sufficient for mixtures of barley-pea and wheat-lupin. For rapeseed-pea, a second separation step is needed to clean the rapeseed while lentil-wheat mixtures require at least a second separation step and the use of an optical separator to meet food quality standards.

Sorting and cleaning grain mixtures after harvest is key for increasing the marketable value of harvested grains as illustrated by Figure 3 for four types of species mixtures. Indeed, this allows the grains to be sold for human food with higher economic returns compared to selling as a grain mixture for animal feed.

Separation improves the gross product

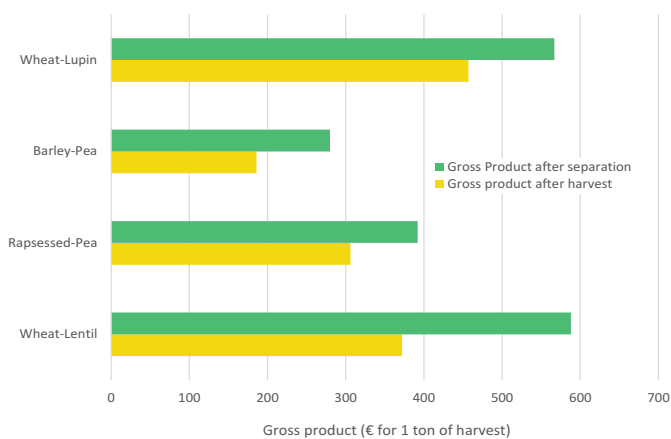


Figure 3: Separation removes most of the impurities improving the gross economic product of all mixtures compared to that directly after harvest.

Harvest should not be a lock-in

Mixed species can be economically valorized by optimizing the harvest in order to make sorting possible at lower cost. Indeed, we demonstrated that after optimizing the settings of the combine harvester, even with a delay of a few days in the grain maturity of the species mixture, the losses as well as amounts of impurities and broken grains can be limited and the gross product improved as illustrated by Figure 4.

Adjusting a combine to harvest a mixture of species is not easy and requires a thorough knowledge of the equipment used. Above all, it implies making compromises between losses in the field, unthreshed ears/pods, broken grains and various impurities. To do this, it is necessary to take the time to test different settings and, for those who use contract work, to prioritize quality over speed. Investing in on-farm sorting is one more step, knowing that it is a job in its own right requiring time and technical expertise.

The twofold challenge of harvesting and separating grains

ReMIX has shown that species mixtures can be economically profitable when optimising the harvest-sorting jointed management. The feasibility of sorting without the need for expensive sorters such as densimetric tables or optical sorters depends on the species mixed.

For a given pair, it is the quality of the crop after harvest that determines the ability to sort and therefore the economic

Harvest settings impact the gross product

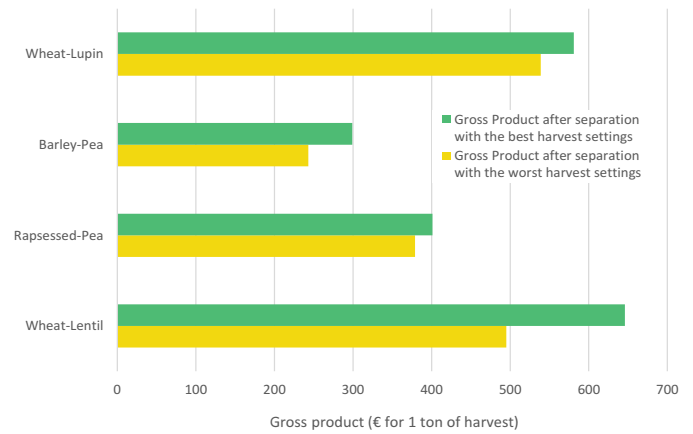


Figure 4: Gross product after grain separation depends on the settings of the harvester as illustrated here between the worst and the best settings.

performance of the mixtures even if the final benefit depends on the cost of grain separation. This confirms that species mixtures are a promising solution for farmers willing to move towards a more agroecological agriculture. However, the cost of grain separation remains a very important factor to consider, which is a key challenge to address in the future.

POLICY RECOMMENDATIONS

The difficulty of harvesting and separating crop mixtures grown for grain production is an obstacle preventing the widespread adoption of intercropping but much can already be achieved with existing equipment.

Public authorities should support:

- Technical research aimed at identifying the best combinations of equipment and settings for harvesting and sorting; »»» Innovation development for designing combine-harvesters more suited for species mixtures;
- Training of advisors and farmers to improve their practical knowledge of using these complex machines in order to optimize their settings;
- Investment in combine harvesters domain in a context where more and more farmers use subcontractors for harvesting their intercrops.

Public support is needed to:

- Promote the development of low-cost grain separators of different sizes allowing rapid and efficient sorting of small and large grain volumes, either for use on farm or by large-scale grain collectors and buyers.
- Encourage their purchase by farmers, farmer's collective and grain buyers.

Four priorities to support

Finally, knowledge and solutions for better harvesting and grain sorting of intercrops needs to be made available to all actors in the agri-food chain. We suggest the following four priorities that public authorities should support:

- Development of farmer's collectives for the use of agricultural equipment;
- Big cooperatives to reorganise their infrastructure to encourage the use of intercrops;
- Redesign of agri-food chains to adapt their requirements regarding the "purity" of products from species mixtures and to develop new products that don't need total grain separation;
- Adapt norms of impurities, as much as reasonable for food security, to allow products from intercropping to enter the value chain in a significant way.