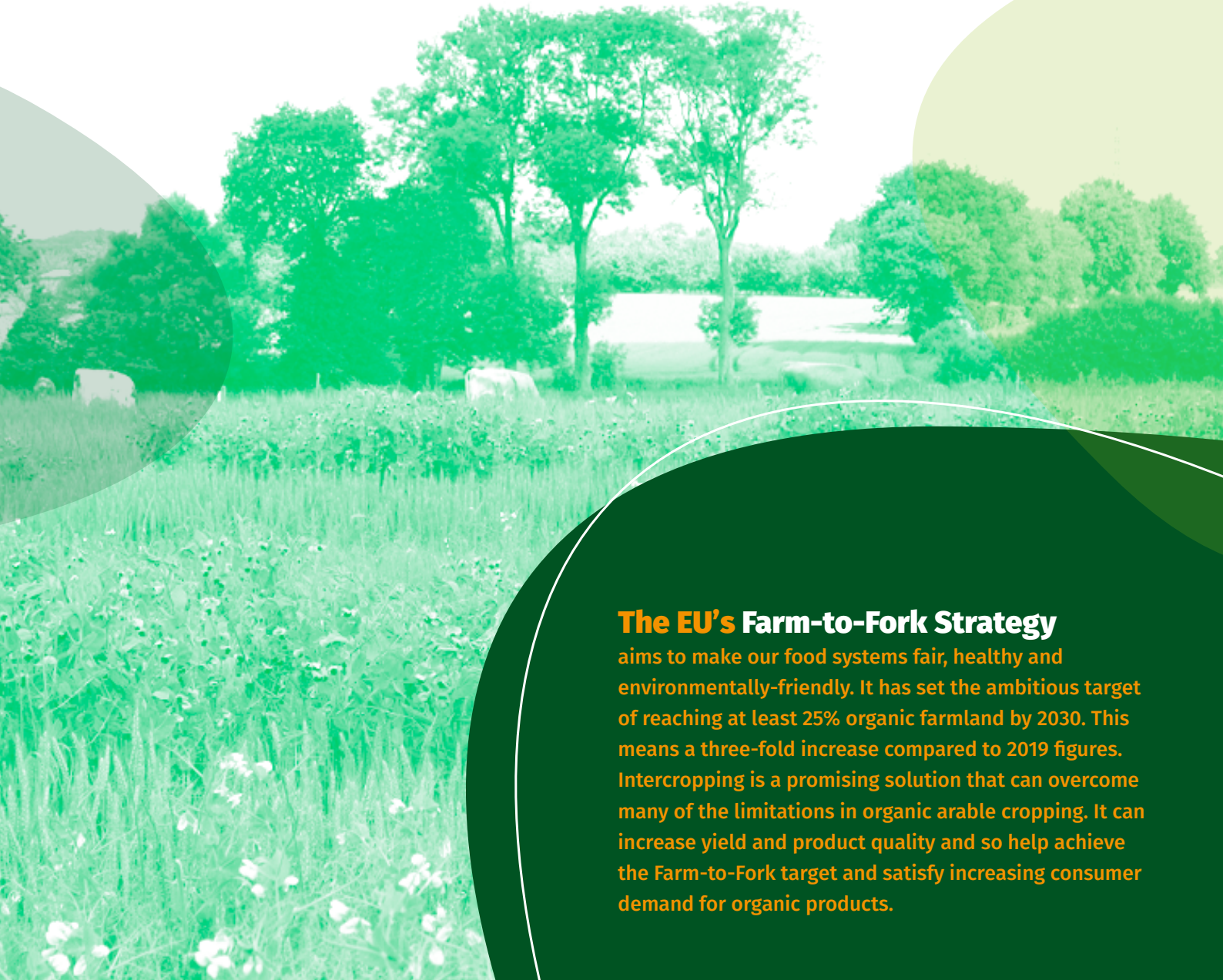
ReMIX
Species mixtures for redesigning European cropping systems

POLICY BRIEF / APRIL 2021

Intercropping for boosting organic farming in Europe

About ReMIX

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.



The EU's Farm-to-Fork Strategy

aims to make our food systems fair, healthy and environmentally-friendly. It has set the ambitious target of reaching at least 25% organic farmland by 2030. This means a three-fold increase compared to 2019 figures. Intercropping is a promising solution that can overcome many of the limitations in organic arable cropping. It can increase yield and product quality and so help achieve the Farm-to-Fork target and satisfy increasing consumer demand for organic products.

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The challenges of organic farming

Organic arable cropping in the EU is faced **with five main challenges**. Mixing cereals and legumes can be a solution for all of them.

1

Improving, securing and stabilising yields of organic arable crops

While organic farming protects the environment and biodiversity, yields are on average 20% lower than in conventional farming. However, there are huge differences between regions and crops. Furthermore, yields can vary a lot between years depending on weather conditions and pest pressure. That is why the first challenge is to increase yield and yield stability in organic farming.

Intercropping can increase yields and their stability in organic farming. The cumulative yield of crops in a species mixture is higher than the average yield of the two sole crops (**Fig. 1**).

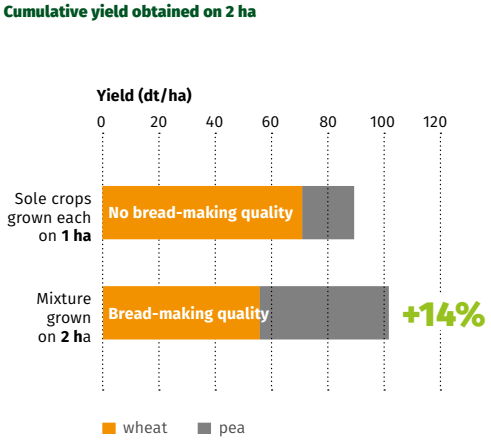

Fig. 1: Average yields obtained over 10 bread wheat varieties and 9 field pea varieties grown in sole crop and on the 90 corresponding mixtures (INRAE Rennes 2019 – organic farming – ReMIX Project)

This is mainly due to the complementary use of natural resources (light, CO_2, water, nitrogen and other nutrients in the soil) between species. The most obvious example is the use of soil mineral nitrogen by non-leguminous crops (e.g. cereals) complemented by atmospheric nitrogen fixation by leguminous crops (e.g. lentils). Complementarity in nutrient use can also be achieved by crops exploring different soil horizons with their roots. Better and more stable yields mean higher and more stable income for the farmer. Moreover, should one crop fail, the other crop can compensate the loss. Intercropping thus limits the risk of no harvest.

2

Easily controlling weeds, diseases and pests by optimising biological regulations

In all agricultural systems, the management of plant health is a major concern. In organic farming, this is more difficult than in conventional farming because weed, pest and disease control cannot be based on synthetic molecules. Therefore, organic farmers need to make the best use of biological regulations that are naturally available to them.

Intercropping makes better use of natural resources and covers the soil better. As a result, very few water, nutrients and light are available for weeds (**Fig.2**). Increasing the cultivated biodiversity at landscape, farm and field levels supports biological control of pests and diseases. For example, one crop can prevent the pest to reach the sensitive crop via a “barrier effect” or “dilution effect”. While in other cases, a partner crop may have attractant or repealing properties that keep a certain pest away from the sensitive crop. Finally, intercropping of cereals and legumes allows to grow legumes that are very sensitive to pests and diseases and that usually produce low and unstable yields in organic farming.

Fig. 2:
Weed control by pea and wheat grown as sole crops and in mixture (N. Moutier, INRAE France)

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3

Improving the protein autonomy of organic farms

Nitrogen is one of the main limiting factors in organic farming, in particular in systems without livestock. Stockless organic farmers are faced with the challenge to maintain soil fertility while keeping inputs of external nutrients to the minimum. Livestock farmers, especially in pigs and poultry, rely on imports of protein-rich feeds.

All organic farmers can benefit of introducing legume-based mixtures into the cropping system. Intercropping of cereals and legumes enhances the productivity of the farm and improves nitrogen autonomy.

4

Improving the protein content of cereals

Organic farmers do not apply synthetic nitrogen to the soil. Therefore, the amount of nitrogen available to the non-leguminous plants is limited. Modern cereal breeds are not adapted to this and as a result the grains have lower protein content. This affects the baking quality. Organic farmers face the challenge to obtain good protein contents despite limited levels of nitrogen in the soil.

Mixing wheat with a leguminous crop improves protein content. Because leguminous crops can fix atmospheric nitrogen, they do not compete with wheat for mineral nitrogen. Furthermore, seeding densities per crop are generally halved and so each wheat plant has a greater quantity of nitrogen available. This additional nitrogen allows, on the one hand to slightly increase the yield compared to the sole crop but above all, to increase the protein content of the wheat grains, making them suitable for transformation into bakery products (**Fig. 3**).

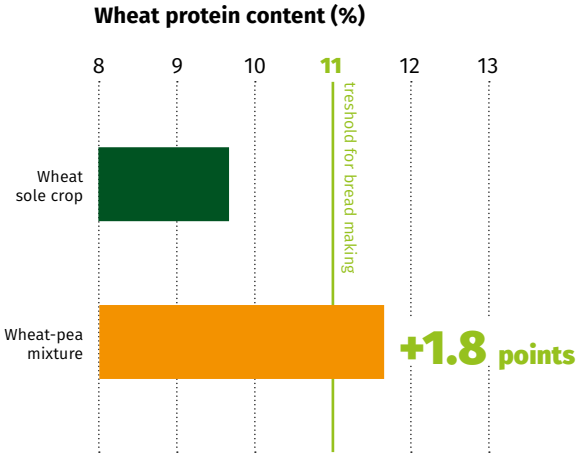

Fig. 3: Wheat protein content obtained over 10 bread wheat varieties in sole crop or mixed with James field pea variety (INRAE-IGEPP France 2019 – organic farming – ReMIX Project). The 11% threshold is commonly used in the calculation of the market access indicator for common wheat varieties for use in human food (breadmaking)

5

Saving worktime and inputs

Organic farmers spend more time on monitoring weeds, diseases and pests than their colleagues in conventional farming. Weeding must be done mechanically and several times during the growing season. As a result, working time and fuel consumption are often higher than in conventional agriculture.

With intercropping, no (or very limited amounts) of external nitrogen or plant protection products are needed. Mechanical weeding is not necessary anymore, except sometimes very early in the growing season. Besides sowing and harvesting, no cultivation operations are needed. Hence, less fuel is used.

All in all, intercropping allows organic farmers to save inputs (fertilisers, pesticides and fuel) and time. However, there are some additional costs linked to intercropping, in particular the costs of additional seeds and sorting of the harvest.

Policy Recommendations

Intercropping is still a minor practice, but areas cultivated with cereal-legumes mixtures have steadily **increased for 10 years**, mainly in organic farming. The cultivation of species mixtures must be strongly encouraged because of the many ecosystem services it provides. Intercropping must be a pillar of the Farm-to-Fork Strategy. It is particularly relevant in organic farming where few inputs are used. For the adoption by a larger number of farmers, policy and financial support is needed. **ReMIX makes the following recommendations:**

1

Use farm subsidies to boost intercropping

European farm subsidies of the Common Agriculture Policy (CAP) should favour intercropping. In addition, other CAP rules preventing intercropping should be terminated (e.g. rules for species proportions that are not agronomically relevant). Contradictions in the rules and administrative barriers should be resolved. The EU should set up a promotion programme to disseminate technical information for agricultural advisors and (organic) farmers.

2

Develop sorting techniques, outlets and markets

After the harvest, farmers often have difficulties in finding a trader that accepts their mixture of legumes and cereals. In the case of minor or new crops, there may simply not be a supply chain in the region. If the crop cannot be valorised directly on the farm or in short circuits, it is often difficult to find a buyer who will want to bother with small quantities. Grain traders need to adapt their logistics and invest in sorting equipment. Public authorities need to support the investment in new logistics and stimulate the development of new markets.

3

Support breeding programmes for intercropping and provide advice on suitable varieties

For intercropping, farmers get little advice on what variety suits best their conditions and there is almost no specific varietal selection. Farmers base their varietal choice on the traits of cultivars grown in sole crop. However, the performance of varieties in sole crop does not necessarily predict their performance in mixtures. Public authorities should continue to encourage breeding programmes for intercropping. Registration criteria for new cultivars should consider traits that are relevant for intercropping. Agricultural advisory services should support farmers in selecting the right cultivar and designing their intercropping system.

4

Stimulate co-learning and on-farm experiments

There is no standard recipe for intercropping. The performance of species mixtures depends a lot on the growing conditions, especially in organic farming where these conditions can be very different from region to region. Therefore, farmers need to be actively involved in research. Co-learning between farmers, researchers and farm advisers results in better knowledge. Public authorities should support participatory research capitalising on the know-how of farmers and allowing them to take ownership of new practices.

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