ReMIX
Species mixtures for redesigning European cropping systems

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Intercropping
Redesigned cropping strategies for food production and environmental services

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.

Future agricultural systems need to embrace biodiversity to deliver sustainability and profitability for people and the planet.

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Intercropping

Intercropping, also known as **species mixtures**, is where 2 or more species are grown together and it is based on four principles – we call this the 4C approach – the pictures below show examples of how the different principles contribute to providing positive outcomes from intercropping.

C1

Competition

Is an important determinant of the structure and the dynamics of the total crop stand. The intercropped species can outcompete weeds by using up available light, water and nutrients forcing patterns of species distributions along gradients of soil fertility. **This example of barley and peas show the dense canopy of an intercrop.**

C3

Cooperation

Where one species provides a direct service to another crop: In an intercrop, one species can provide physical support for another as shown **in this example where wheat act as posts for lentils** – this keeps the lentils off the ground for possible harvesting, whereas harvest is compromised in sole crop lentils due to severe lodging.

C2

Complementarity

Allows resource use to be optimised: Species mixtures can use above and belowground resources more efficiently than sole crops – **for example, chickpeas and barley share vertical and horizontal space.** The most well-known example of complementarity is the fixation of nitrogen by the legume allowing the intercropped cereal to use the available soil nitrogen.

C4

Compensation

Extreme weather conditions and unexpected biotic factors can cause important yield losses and negative economic impacts. If one species fails completely due to poor germination or difficult growing conditions, the other species can thrive and produce a profitable yield.

Left: Chickpea with low emergence percentage and poor vigour for growth during Autumn resulting in a significantly reduced yield potential.
Right: Chickpea intercropped with Durum wheat, which germinated well and compensated for the low rate of chickpea emergence, resulting in a much better yield of the intercrop, compared to the sole crop of chickpea.

How does the 4C approach of intercropping link to EU policy ambitions?

The EU is undergoing a fundamental change in the aims for its agriculture and food systems, with a significant emphasis on meeting sustainable goals and reducing reliance on imports from outside Europe. The ReMIX project collaborates with farmers and additional key partners such as agricultural advisors to achieve these ambitious goals within the context of application, arising from problem solving and not necessarily governed by the paradigms of traditional scientific disciplines. It is useful to consider how intercropping can contribute to the desired outcomes of different EU policies. The **4C approach** of intercropping contribute to crop yield as described above but in policy terms they also mean that intercrops deliver many public goods.

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C1 Competition

Intercropping in a broad sense addresses the challenges of sustainable food systems and the links between healthy people, healthy societies and a healthy planet. The outputs delivered by ReMIX support this ambition for a sustainable food system by increasing intercropping in EU agriculture. Through "positive" Competition intercrops can compete strongly with weeds, reducing the need for herbicides. Delivering species mixtures supports a more nature-based solution to manage soil within temporal and spatial biotic and abiotic growth factors moving agricultural production away from a reliance on agro-chemicals through self-regulation.

Example of contribution to policy target: e.g. Halving pesticide application by 2030.

C2 Complementarity

Through Complementarity, for example, intercrops which include nitrogen fixing grain legumes require less synthetic nitrogen fertilisers than other crops. This reduces the agricultural land area that receives artificial nitrogen fertiliser which in turn could reduce nitrogen fertiliser manufacture and nitrous oxide losses associated with it. This type of intercrop contributes to home grown protein feed and thus the EU Protein Strategy but also to the EU Action Climate Targets and the Farm to Fork Strategy at the heart of the European Green Deal.

Example of contribution to policy target: e.g. Reduce the use of fertilisers by at least 20% by 2030.

C3 Cooperation

Cooperation is also important here where one crop can support another, as in the case of cereals and lentils, allowing both crops to be harvested where lentils grown alone can lie on the ground surface and could not be harvested mechanically or only in small quantities, leading to high grain losses.

Example of contribution to policy target: e.g. to limit waste will help contribute to reducing greenhouse gases to at least 55% below 1990 levels by 2030.

C4 Compensation

Through Compensation intercrops can reduce the risk of crop failure. The use of species mixtures allow the selection of species which are sensitive to different kinds of stress such as diseases or drought susceptibility. For example, If one crop fails to germinate or is affected by disease, then the companion crop can still ensure crop production and harvestable yield from the field.

Example of contribution to policy: e.g. improving resilience in farming income proposed within the EU Farm to Fork Strategy.

Policy Recommendations

To help support the development of intercropping in Europe for food and the delivery of public goods **we see the need for**:

1

Going beyond agronomy and working across the entire agri-food system all the way to consumers. All parts of the supply chain need to adapt. Suitable crop varieties are needed alongside modified machinery, processing plants willing and able to deal with mixtures, food processors with exciting ideas about how to use the products and expand their markets and consumers who want to purchase and consume the products.

2

Intercropping specific research, advice and tools to support decision making, since local adaptation of techniques are needed for growing optimised intercrops.

3

Improved understanding and modelling of intercrops to improve adaptation to local conditions.

4

Building on trust, acknowledgement and efficient peer learning between researchers and practitioners.

5

Courses and training for practical intercropping in the field and for processing at both practical and academic levels.

Finally, these recommendations apply across all intercropping systems in arable, horticultural and mixed farming as well as in agroforestry.

Participation by farmers and other actors in the supply chain was a very important part of the ReMIX project **and this is what some of them said:**

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Crop mixtures can provide high quality feed early in spring when all the animal feeds have finished.

Mixtures with a legume component are an ideal greening element: it increases biodiversity, is beneficial in crop rotation and additionally increases the production of native protein. They should be permanently entered in the CAP.

Being organic intercropping is a no brainer – higher yields, more protein, good livestock feed and noticeable soil improvements all with less inputs and disease pressure.

If species mixtures are adjusted to local conditions, we might be able to reduce pesticide use, working hours and possible also artificial fertilizers giving lower investment costs and thereby higher net profit.

The early soil coverage (from the intercrop) was remarkable and the weed pressure was low.

I am happy to see progress in agro-ecological solutions that allow me to reduce the use of fertilizers and pesticides.

The mixed culture helps to keep diseases and pest infestations much smaller, so to speak, that it cannot spread over the whole stand. That is to be seen quite positive.

I am happy with the mixtures, if one crop fails due to a severe pest or disease attack, I have the other crop to compensate.

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