



# SCIENCE FOR ENVIRONMENT POLICY

## Intercropping technique may improve agricultural sustainability and productivity



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**Producing sufficient food supplies for our growing population is a major global challenge.** Intercropping, an agricultural technique whereby multiple crop species are cultivated in the same field, may be more sustainable than mono-crop practices, resulting in a greater yield per unit of land and fertiliser than sole crops. This study analyses the effect of intercropping on yield gain, exploring the effects of different crop species combinations, temporal and spatial arrangements and fertiliser input.

Improving crop productivity is a global priority. While intensive agriculture provides high yields, it also causes negative environmental impacts on air, water, and soil quality — such as soil acidification, habitat loss or pollution, fertiliser run-off and surface-water eutrophication — and resulting declines in biodiversity. Due to its essential role in supporting growing communities but also its negative impact on biodiversity, the European agricultural sector is seeking innovative ways to improve yields while supporting [the EU Biodiversity Strategy for 2030](#)<sup>1</sup>, which aims to protect European land and sea and to restore nature.

Intercropping has emerged as a potentially sustainable way forward, offering ecological mechanisms for suppressing weeds, controlling pests and diseases, conserving soil resources, increasing yields, and using light, space and water more efficiently than pure stands of crop species that are nowadays the norm in agriculture. However, the absolute yield gain that intercropping can bring on a global scale, compared to sole crops, has not been quantified. This study therefore performed a statistical analysis of a global dataset<sup>2</sup> on yields in intercropping. The records on intercropping were retrieved from a total of 132 research papers which reported results of 226 field experiments, constituting the largest statistical analysis on intercropping to date.

The researchers identified two different intercropping strategies: one type of intercropping system including maize (*Zea mays*), with high inputs, and a staggered relay sequence for sowing and harvesting multiple species of crop (a configuration commonly practiced in China and known as relay-strip intercropping); and another type of system without maize, with low inputs and



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## Intercropping technique may improve agricultural sustainability and productivity (continued)

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with simultaneous sowing and harvesting of multiple crop species (commonly practiced in Europe, Asia and Africa). The researchers surmise that these systems evolved in different parts of the world to meet different demands and constraints — food security in China, reduced environmental impact in Europe and shortage of resources in parts of Africa.

Compared with monocultures, absolute yield gains were greatest when maize was mixed with short-grain cereals or legumes with a substantially different temporal niche (growing period) to maize and grown with high nutrient inputs in multi-row species strips. Mixing temporal niches in this way may enable greater agricultural adaptivity to the extended growing seasons and higher average temperatures that accompany ongoing global warming and could allow agricultural producers to more precisely time their application of fertiliser to reduce the total amount needed.

Such an approach provided absolute yield gains of about four times as large as those in the other intercropping strategy analysed by the researchers. This alternative strategy comprised growing mixtures of short-stature crop species with the same growing period and low-to-moderate nutrient inputs. The overall yield gain (compared to monocrops) was 1.5 tonnes per hectare (Mg/ha)<sup>3</sup> across both intercrop strategies; 2.1 Mg/ha in intercrops with maize; and 0.5 Mg/ha in intercrops without.

Both strategies required less land (16 to 29% less) and fertiliser (19 to 36% less) than monocultures grown under the same management; and each is beneficial depending on desired outcome. Relay-strip intercropping exploits species' differences to enable high yields and land-use efficiency (e.g. by choosing differing temporal niches to reduce periods of co-growth, where species compete for resources); while the alternative approach exploits species' complementary features to enable drastically reduced inputs (and, as a result, lower nutrient losses and emissions), and is easier to implement and maintain (due to simultaneous sowing and harvesting).

Overall, the researchers state that their statistical analysis indicates the potential of intercropping in the sustainable intensification of both high- and low-input agriculture. These benefits could bring greater profits for farmers, lower environmental impacts and a more stable, secure food supply. However, they note that their analysis did not consider water use, and that intercrops — due to their extended growing season — need greater irrigation than sole crops. While previous studies suggest that this increased water consumption would be offset by gains in productivity, the researchers highlight a need for further analysis to quantify the worldwide water footprint of intercropping<sup>4</sup>.

1. EU Biodiversity Strategy for 2030 Bringing nature back into our lives

2. The global dataset comprised 568 records on intercropping with maize and 366 on intercropping without maize. Maize intercropping included companion species belonging to the bean family (legumes) such as pea, faba bean, soybean and peanut; or small grains such as wheat or barley. Intercrops without maize were dominated by legume-based intercrops mixed with small grains such as wheat, barley, oats or rice, another legume, or other species such as oilseed rape or sesame.

3. 1 Megagram (Mg) = 1 000 000 grams = 1 tonne

4. The researchers add that the high-input strategy with maize, which provides the largest yield gains and is predominantly used by smallholder farmers, would need innovation of mechanisation to enable its use on modern farms.