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NEWS

INTERCROPPING SUSTAINABLY INCREASES YIELDS AND SOIL FERTILITY

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Intercropping involves growing two, or more, annual crop species at the same time in the same field, aiming at better resource use efficiency and greater productivity[1,2]. For instance, intercropping of maize with wheat, faba bean, soybean, chickpea or oilseed rape, and wheat with faba bean are the predominant systems for multiple benefits practiced widely by farmers, especially in north-west China (Fig. 1). The performance of intercropping systems has been well studied, focusing mainly on yields and resources utilization[3–5]. Recent work has suggested that countries with higher number of effective crop groups and crop diversity tend to have greater inter-annual stability of national total agricultural yields[6]. However, beyond in-season benefits, long-term yield advantages, stability and soil fertility have received little attention in intercropping research.

In a new paper published in *Nature Sustainability* entitled "Long-term increased grain yield and soil fertility from intercropping"[7], using four long-term (10–16 years) experiments on soils of differing fertility in Gansu and Ningxia in China, Li et al. reported that grain yields in intercropped systems were on average 22% greater than those in matched monocultures and exhibited greater inter-annual stability. This field-level result is consistent with the effects of plant diversity on temporal stability observed in grasslands[8–10] and forests[11], and in line with the results at the national scale[6]. In addition, yields of both intercropping and monoculture were increased over time in a decade scale, with intercropped yields increasing by an average of 2.5% per year, but monoculture yields of these same crops increased by only 1.7% per year. These results reveal that intercropping could increase yield benefits compared with monoculture over a longer time scale.

Maintaining and enhancing soil fertility are key goals for agricultural productivity and sustainability. Li et al. reported that in addition to N fertilization effects, long-term field intercropping increased large soil macroaggregates (> 2 mm) compared with monocultures, while simultaneously declining the abundance of the smaller classes of soil aggregates, indicating that intercropping may accelerate the transformation of small soil aggregates into larger ones[7]. Large soil aggregates produced by intercropping might be a possible mechanism driving the long-term increase in the yields[12]. Additionally, intercropping enhances soil C and N, especially on infertile soils, such as Hongsibu and Jingtan sites[7], which is consistent with the effects of higher plant diversity in perennial grasslands[13–15].

For farmers, economic benefits likely dominate the choice of crop and cropping system, rather than higher yields, greater stability or environmental benefits. Across the study period and the experimental sites, the majority of maize-based intercropping (except for soybean and maize intercropping) increased estimated net farmer profits by 24%–75% with a mean of 47%, equivalent to about 645 USD·ha^{-1} across four intercropping systems, when compared with the two corresponding monocultures[7].

Fig. 1 Intercropping of faba bean and maize (a), wheat and maize (b), wheat and faba bean (c), oilseed rape and maize (d), soybean and maize (e), chickpea and maize (f) practiced by farmers widely in north-west China (Photos credit: Long Li).

Intercropping promotes multiple benefits by retaining yields while reducing chemical fertilizer application by 19%–36%[5], decreasing pesticide use on crop pests, parasitoids[16] and diseases[17], and improving pollination[18]. Overall, the new study highlights that widespread adoption of intercropping might increase crop yields, long-term soil fertility and stability, increasing crop production and its long-term sustainability. However, intercropping may be challenging to implement in machine-intensive, large-scale modern agriculture because appropriate large equipment is not commercially available for planting and harvesting various crop mixtures grown with strip intercropping. Thus, for those combinations of in-demand crops for which intercropping offers yield, environmental or economic benefits, the rapid development of appropriate machinery and adoption of intercropping could offer multiple societal benefits.

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