



Science for Environment Policy

High-yield crops have curbed agricultural land expansion, but care needed to avoid negative biodiversity effects

The widespread use of higher-yielding improved varieties of crops as part of the 'Green Revolution' has averted the conversion of between 18 to 27 million hectares of forests, woodlands and pastures in the period 1965 to 2004, according to a recent study. However, its authors caution that the relationship between these crops and land use change is complex, and good governance is needed to protect biodiversity from future expansion of agricultural land.

The development of crop varieties that respond well to increased fertilisers and irrigation, dramatically increasing the yields of crops such as wheat, rice and maize in developing countries, was known as the 'Green Revolution'.

By increasing crop productivity and intensifying [agriculture](#), it is argued that the Green Revolution has prevented [natural ecosystems](#) from being converted to agricultural land that would otherwise have been needed to feed the growing global population.

To assess the impact of the Green Revolution on land use and land-cover change, this study used a global economic model for the period 1965 to 2004. The model covers a range of crops and agroecological zones and incorporates market effects of technological change, including prices for food and land use decisions (affected by labour, capital and natural resources).

The results suggest that if there had been no advances in grain yields, the production of wheat would have been 43-60% lower than that achieved in developing countries in 2004. The production of other crops, including rice and coarse grains (e.g. sorghum), would also have been lower, resulting in higher regional and global prices. For example, it is estimated that wheat prices in developing countries would have been 121-272% higher than actual prices in 2004.

Furthermore, production shortfalls would have meant developing countries having to double imports of wheat, which would have increased overall demand and also pushed up wheat prices in developed countries, increasing to 29-59% more than the actual 2004 price. Global prices of rice, which is mainly grown in developing countries, would have been 68-134% higher than they were in 2004. Similarly, the global price of coarse grains would have been 20-41% higher than 2004 prices.

These higher prices, the authors suggest, would have resulted in an increase in the area under cultivation. The study estimated that the expansion of cropland would have covered between 17.9 and 26.8 million hectares in developing and developed countries had there been no introduction of high-yielding crops. Of this, 12 to 17.7 million hectares would have occurred in developing countries resulting in 2 million hectares of deforestation. Although these estimates are lower compared with those produced by other similar studies, they still represent a substantial environmental impact.

The conversion of natural habitats for agriculture is the major driver of global biodiversity loss and a significant source of global greenhouse gas emissions. However, the researchers point out that the links between growing high-yield crops and land use changes are complex. For example, although improved yields reduce the land area needed to grow the same amount of food in aggregate, under some conditions (e.g. weak governance of forests; production of export crops that are produced on the forest margins), this can have the effect of making agriculture even more profitable relative to leaving the land as forests, which can lead to agricultural expansion into forest areas and hence deforestation. Stronger forest governance is needed to ensure agricultural expansion takes place in such a way as to minimise the negative impacts on the environment and on society.

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Contact:
james.stevenson@fao.org

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