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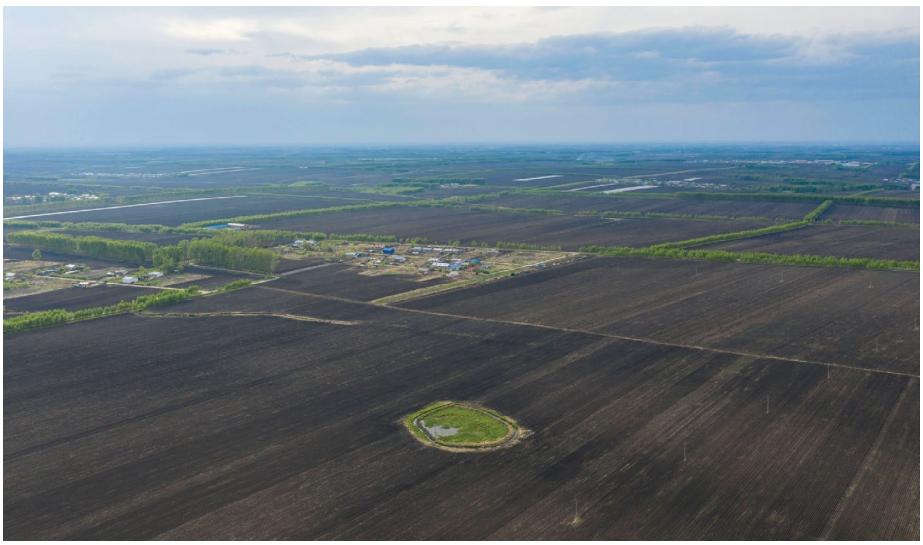
For the protection of black soils

Black soils are highly fertile, characterized by thick, dark-coloured horizons rich in organic carbon. In the northern hemisphere, three major black soil zones located along the mid-latitudes across north-east China, North America and southern Russia–Ukraine contribute greatly to world agriculture[1], often being considered the food baskets of the world[2]. In 2022, 42% of maize, 19% of rice and 63% of soybeans harvested in China were from black soil regions[3].

During the past 100 years, intensive farming practices on black soils have led to extensive erosion[4]. Notable examples include the Dust Bowl in Ukraine in 1928 and in the United States in the 1930s. In China, the degradation of black soil under climate change includes thinning, nutrient depletion, compaction and acidification. Recent estimates indicate that the organic matter content of the black soil cultivation layer in China has decreased by one-third over the past 60 years (with some areas experiencing a 50% decline), while the layer thickness has decreased by more than 20 cm (ref. 5).

Some countries, including the United States and Ukraine, have adopted measures to protect black soils since the 1930s, including the enactment of laws and regulations as well as research and extension of new technologies for sustainable soil use. These measures have helped control soil erosion, leading to an improvement in soil fertility and crop production levels. In the United States specifically, conservation tillage has been used on two-thirds of the cropland since the 1960s (ref. 6) with considerable benefits for the soil (for example, erosion reduction by up to 90%, improved soil structure and 30% more soil organic matter) and yields, particularly in rain-fed fields[7].

In August 2022, the Chinese government implemented the Black Soil Protection Law, the world's only national-level legislation specifically dedicated to the protection of black soils. This law emphasizes the critical role of science and technology innovation for soil preservation under climate change, including the design and implementation of new agricultural production systems that encompass crop production and soil conservation – notably through soil-enriching systems[8,9].



An intercropping system of maize with peanuts (or soybeans) established by Liaoning Academy of Agricultural Sciences and China Agricultural University provides an interesting example; this system makes better use of local radiation and heat resources, leverages the nitrogen-fixing ability of leguminous crops, reduces nitrogen fertilizer input and effectively increases per-unit area productivity. Another example is the 'Lishu-Mode', which centres around conservation tillage, combining a cropping system of maize rotation and fallow planting with straw mulching and reduced tillage. Over 10 years, the Lishu-Mode has increased the soil organic matter content by 11–17%, improved nutrient supply capacity by 9–25%, increased soil water storage by 40–50 mm and increased annual average maize yield by 3–5% along with improved yield stabilities[10].

Continuously enhancing soil productivity and ensuring the production of sufficient food through innovative farming systems is crucial to achieving Sustainable Development Goal 2, 'Zero Hunger', under climate change. To achieve that, more research on black soil areas is necessary, particularly to adapt to local environmental conditions and agricultural practices. For instance, in the central regions of north-east China, characterized by medium-thick black soil, efforts should focus primarily on conservation and fertility improvement; By contrast, in the south-eastern areas experiencing severe soil erosion, soil stabilization and fertility conservation should be prioritized. At the same time, deepening international cooperation among the world's leading research institutions in black soil areas can help advance scientific and technological innovation. Finally, conducting technical training for agricultural personnel and producers is key to support these efforts.

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Competing interests
The authors declare no competing interests.