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Article in *Biological Diversity* · July 2024

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Converting farmlands to forests or forests to farmlands?

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1 | CHANGES IN CHINA'S AGRICULTURAL LAND USE SINCE 1998

China's land use policies have undergone significant changes, driven by the dual objectives of meeting the food demands of its growing population and safeguarding its fragile ecological balance. In 1998, following catastrophic floods along the Yangtze River and Songhua River, the Chinese government considered the consequences of long-term pressures stemming from rapid population growth and extensive production practices. The conversion of substantial forests, grasslands, and wetlands into farmlands resulted in intensified water and soil losses. Persistent droughts and floods exacerbated the ecological deterioration, particularly in the upper and middle reaches of the Yangtze and Yellow Rivers, which are now among the areas most severely affected by soil erosion globally.¹

In response to the rapidly deteriorating ecological environment, China initiated the "Grain for Green" Program in 1999. This ecological engineering endeavor aimed to restore the ecological conditions by strategically ceasing cultivation on severely eroded farmlands, farmlands affected by serious desertification, salinization, and rocky desertification, and farmlands characterized by low and unstable grain yields. Widely regarded as the world's largest ecological initiative, the program has contributed over 4% to the global increase in green cover. By the end of 2020, the central government had invested 76.7 billion US dollars (in 2015 US dollars), facilitating the conversion of 34.8 million hectares of farmlands to forests and grasslands. This accounted for 40% of the total afforestation area of 16 national key projects during the same period (Figure 1). The program's implementation has effectively curbed desertification in

northern and southwestern regions, restored wildlife habitats, bolstered biodiversity conservation efforts, and directly benefited 158 million farmers.² Over the past two decades, the program has been pivotal in propelling China's progress towards the "Zero Net Land Degradation by 2030" goal, as set forth in the United Nations' 2030 Agenda for Sustainable Development ahead of schedule.

However, since 2000, there has been a noticeable trend of farmland abandonment, primarily driven by the escalating costs of agricultural labor and the limited economic benefits associated with traditional agricultural practices.³ As of 2022, China's arable land stood at approximately 128 million hectares, a decrease from the 135 million hectares recorded a decade ago. It is estimated that in 2017, China's main grain production areas suffered a loss of 22.66 million tons (4.69%) of grain production due to abandoned farmlands. In addition, the adjustment of agricultural planting structures, such as the conversion of fields to ponds or orchards, has led to a 3.7% reduction in total farmland.⁴

China has managed to ensure food security and continuously improve people's living standards by safeguarding 120 million hectares of arable land while moderately importing food. In recent years, the Chinese government has given greater focus to food security due to the impact of global geopolitical events, such as the Russia-Ukraine war, the COVID-19 pandemic, climate change, and the fluctuation of international food prices. Since 2021, major grain and livestock-producing provinces such as Henan and Inner Mongolia have initiated measures to adjust the situation, involving converting some of the already afforestation lands into cultivated lands and implementing the "Converting Forests to Farmlands" policy.¹ The policy shift has garnered considerable attention and sparked

Hai Ren, Lei Gao, Dafeng Hui, and Qinfeng Guo contributed equally to this work.

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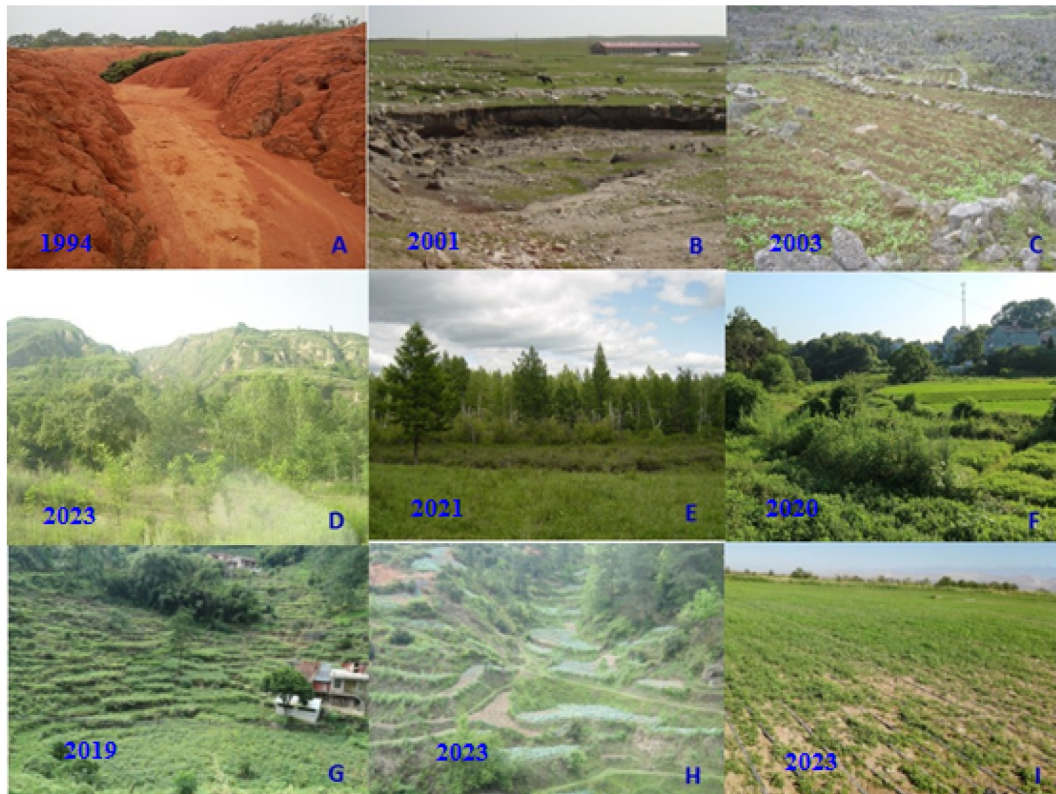


FIGURE 1 Examples of agricultural land use and consequences in China. (A) Soil erosion resulting from agricultural activities in Dianbai County, Guangdong Province, 1994. (B) Grassland degradation caused by excessive grazing in Hulunbuir League, Inner Mongolia, 2001. (C) Farmland in a karst rocky desertification area of Puding County, Guizhou Province, 2003. (D) Transformed landscape after returning farmlands to forests in Yan'an Loess Plateau, Shaanxi Province, 2023. (E) Conversion of farmlands back into forests in Jixi City, Heilongjiang Province, 2021. (F) Abandoned arable land in Wuhan, Hubei Province, 2020. (G) Abandoned arable land in Changde, Hunan Province, 2019. (H) Conversion forests back into farmlands in Ganzhou, Jiangxi Province, 2023. (I) Reversal of grasslands to farmlands in Baoding, Hebei Province, 2023. Photographs courtesy of Hai Ren.

scholarly debates,⁵ as it could significantly impact China's environment and ecological issues.

2 | ECOLOGICAL, ECONOMIC, AND SOCIAL ISSUES BEHIND CHANGES IN AGRICULTURAL LAND USE

To balance the contradiction between production, living, and ecological land use, China has implemented the “Three Zones and Three Lines” system. The “Three Zones” refer to three types of national space: urban, agricultural, and ecological. The “Three Lines” correspond to three control lines delineated in urban, agricultural, and ecological spaces, including urban development boundaries, permanent basic farmland, and ecological protection redlines. Among them, the ecological protection redline designates areas within ecological spaces with significant and crucial ecological functions. These spaces and lines designate areas for agricultural production and the provision of ecosystem services. Approximately 30% of China's land area currently falls within the ecological redline, with protected nature reserves accounting for 14.9%. The land allocated for implementing the Grain for Green Program predominantly resides within the ecological redline boundaries and often exhibits limited economic benefits. Most abandoned land is concentrated within the boundaries of the permanent basic farmland redline.

Approximately 5% of threatened plants and some threatened animals, as identified within China's Red List, exist outside the ecological redline but within the permanent basic farmland redline range.⁴

To enact the “three zones and three lines” system, China is in the process of implementing the “National Land Space Planning Outline (2021–2035),” a framework designed to harmonize the protection and management of both arable and forest lands. This outline highlights the critical role of converting farmland to forests and grasslands in rural land management policies. These initiatives aim not only to protect the ecological environment but also to promote sustainable agricultural development. However, challenges have emerged during the early stages of these conversion projects, largely due to regional disparities (such as differences between mountainous and plain areas), concerns regarding the long-term viability of policies, inadequate government subsidies, and the economic considerations of farmers. This is evident in the increased conversion of less ideal farmland (including sloping or low-grade arable land) and the transformation of high-quality basic farmland into fruit orchards. Economic disincentives have prompted farmers to abandon their farmland. Additionally, the “one-size-fits-all” approach adopted by local governments in policy implementation, coupled with the adjustment of agricultural structure, such as the transformation of farmland into orchards and fishponds, has resulted in the establishment of extensive green belts following rural urbanization. These factors have collectively affected the outcomes of forest and

farmland conversion projects in some provinces, attracting public concern over issues such as low agricultural yields, reduced economic benefits, and severe soil erosion.

The large-scale implementation of “Converting Forests to Farmlands” projects may raise significant ecological concerns. Although the conversion is occurring in a gradual and targeted manner, with major ecological problems not yet evident, traditional agricultural practices in China have profoundly impacted biodiversity, ecosystem functioning, and the provision of ecosystem services at both regional and national scales, consequently affecting the diversity, stability, and sustainability of ecosystems.

China has long overlooked vegetation restoration in agricultural areas. The typical agricultural production mode in China is large-scale contiguous farmlands, lacking natural vegetation patches that are crucial for pest and pollinator control, hydrological improvement, and wind and sand prevention. Consequently, agricultural zones have become a significant obstacle to effective biodiversity conservation. Restoring the abandoned farmland into near-natural vegetation and establishing ecological transition zones between forests, wetlands, grasslands, and farmlands can promote ecological connectivity. Furthermore, such ecosystem restoration efforts could protect and revitalize rural ecological functions, preserve biodiversity, enhance natural disaster resilience, and maintain the natural landscape of rural areas.

The implementation of the Kunming-Montreal Global Biodiversity Framework (GBF) adopted in 2022 should go beyond mere protection actions and encompass restoration efforts, sustainable production practices, and enhanced integration with climate change mitigation. We can steer towards a nature-positive trajectory through comprehensive actions across all relevant fields. The GBF emphasizes the need to safeguard 30% of Earth's land by 2030 through nature reserves or protected areas and other effective area-based conservation measures (OECM). Abandoned land can be a pilot area for farmers' nature conservation movements. In this way, in rural China, core protected areas can be established as the center of nature conservation, while abandoned land can be designated as OECMs, serving as buffer zones and biological corridors between nature reserves and farmlands, maximizing the protection and restoration of biodiversity in agricultural regions and sequestering more carbon.

3 | CONVERTING FARMLANDS TO FORESTS OR FORESTS TO FARMLANDS?

China aspires to advance its development in an ecologically sustainable manner. The Grain for Green Program represents a proactive ecological construction initiative by the government, while the abandonment of rural farmlands signifies passive ecological protection within the market economy. The decision to convert farmlands to forests, or vice versa, necessitates striking a balance between conserving biodiversity and carbon sequestration on abandoned lands and addressing the imperative of food production. This dilemma reflects the trade-offs between economic, social, and ecological development. Undeniably, abandoned farmland, characterized by its high spatiotemporal heterogeneity, can serve three functions: protection, restoration, and utilization.

There is a growing recognition that relying solely on nature reserves may be inadequate in effectively safeguarding biodiversity, given the challenges of allocating sufficient land and water for conservation purposes. The complex issue of converting farmlands to forests and vice versa calls for an integrated and coordinated approach. This involves focusing on converting marginal farmlands to forests and grasslands and restoring abandoned farmlands. A critical aspect of this approach is enhancing ecosystem services provided by forests, farmlands, and grasslands. From a systemic perspective, exploring the most effective strategies for combining ecosystem restoration with sustainable development is imperative. China can gain valuable insights from the United Kingdom's Local Nature Recovery.⁴ Emphasizing the construction of ecological conservation and restoration is essential to achieve a harmonious coexistence between humans and nature under the backdrop of global change. Naturally, deciding whether to convert farmlands to forests or grasslands or to convert forests or grasslands back to farmlands requires open debates and effective communication with all stakeholders to mitigate potential social conflicts throughout the implementation process. In line with the implementation of the GBF and the UN Framework Convention on Climate Change, China should persist with its policy of converting farmlands into forests. Policies that involve the conversion of farmland to forests and vice versa must carefully consider the carrying capacity of land and forests, as well as the ecosystems' restoration potential. An excessively large-scale conversion of farmland to forests could jeopardize farmers' livelihoods and incomes and adversely affect local ecosystems. Therefore, it is imperative to thoroughly assess land attributes, the feasibility of policy implementation, and the economic interests of farmers. For example, remote and small pieces of farmland in hillyland and mountainous areas can be converted into forest land, while large-scale abandoned farmland in plain areas and farmland converted into orchards can be transformed into standard farmland. The coexistence of the two policies—converting farmland to forest and vice versa—requires the formulation of flexible and sustainable measures to achieve both sustainable development and the protection of the ecological environment.

AUTHOR CONTRIBUTIONS

Hai Ren: Conceptualization; methodology; data curation; investigation; writing – original draft; writing - review & editing; visualization; formal analysis. **Lei Gao:** Writing – review & editing; conceptualization. **Dafeng Hui:** Conceptualization; writing – review & editing. **Qinfeng Guo:** Conceptualization; writing – review & editing.

ACKNOWLEDGMENTS

We thank the anonymous reviewers for constructive comments. The opinions expressed here are not official positions of authors' institutions.

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How to cite this article: Ren, Hai, Lei Gao, Dafeng Hui, and Qinfeng Guo. 2024. "Converting Farmlands to Forests or Forests to Farmlands?." *Biological Diversity*: 1–4. <https://doi.org/10.1002/bod2.12015>.