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SUSTAINABILITY

Agroforestry in the Sahel

West African farmers adjust tree cover to realize the co-benefits of agroforestry, according to analyses of remote sensing data.

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In agriculturally intensive regions devoted to large-scale production of field crops, woody plants are a nuisance: trees and shrubs are cleared to make way for highly mechanized and highly productive fields of wheat, maize, rice, soy, sugarcane, potatoes and other row crops. The socio-economic context is such that the loss of trees, and the potential services they provide, is an acceptable trade-off, given the higher yields and economic benefits that come with intensified farming practices. For subsistence farmers in Africa and elsewhere, however, where the ability to invest in mechanization and intensification may be lacking, the potential benefits from woody plants can shift the trade-off balance to favour woody plants in agricultural landscapes. Writing in *Nature Geoscience*, Brandt et al.[1] report that farmers in the semi-arid Sahel and seasonal woodlands of West Africa have contrasting effects on tree canopy cover. In particular, they find that farmlands in the drier Sahelian region have enhanced tree cover, relative to adjacent non-agricultural savannahs, while in the more humid regions, tree cover is reduced in agricultural areas.

Trees in West African farmland provide a range of benefits, including fruit and leaves for human consumption, fuel for cooking, fodder for animals, yield increases for crops grown under trees in soils with improved nutrient and water conditions, shade for people and animals, and traditional medicines. Since the early twentieth century, however, concerns have been raised about declining woody cover in West Africa, as human populations grow in tandem with agricultural expansion and demand for fuel-wood and charcoal. Indeed, it has commonly been assumed that agriculture and wood harvest in West Africa contribute only to loss of vegetation cover and land degradation[2].

Brandt and colleagues[1] counter this popular misconception. They use satellite data to quantify woody cover in West African farmlands and show that when considered alongside the African agroforestry literature[3,4], a more positive picture emerges of farmers protecting seedlings, and sometimes planting them, in their agricultural fields. The researchers also demonstrate an interesting characteristic of the trade-offs made by West African agro-foresters. In the drier Sahel, where mean average rainfall is about 300 to 600 mm per year, tree cover is naturally low, primarily because of long dry seasons and herbivory (particularly by goats and other livestock) that act as bottlenecks to seedling establishment[5]. Trees in the Sahel are also short in stature and have open canopies, so they do not compete strongly with crops for light and can enhance crop growth through improved water and nutrient availability[6,7]. In these regions, farmers often increase tree density by selectively protecting seedlings from livestock, and sometimes by watering or building small water impoundments around seedlings. By contrast, in the wetter savannahs, where mean average rainfall reaches 600 to 1,000 mm per year, tree cover can be much higher[5], and larger trees compete more strongly with crops (and other herbaceous plants) growing underneath them[7]. In these regions, farmers must reduce tree cover if they want to cultivate cereals and other field crops, and they do so by clearing most trees, but selectively sparing native species that provide useful services and planting a variety of non-native trees.

While satellite data of the kind used by Brandt and colleagues can enable quantification of woody cover, these data do not allow the identification of tree species. Relative to adjacent non-agricultural areas, however, the diversity of tree species in farmlands is almost certainly considerably reduced in favour of those species that provide valuable services (Fig. 1). Thus, overall diversity of tree species in agroforestry systems is reduced, but far less than is typically the case in intensive agricultural systems.

The presence of trees in West African agricultural landscapes increases rural food security and livelihood options[3,4], creating multifunctional landscapes that contribute to multiple United Nations Sustainable Development Goals that relate to climate, sustainability, equity and resilience[8]. For example, tree-based products are traditionally harvested by women in West Africa, contributing to household equity while also sequestering carbon that mitigates, to some degree, global climate

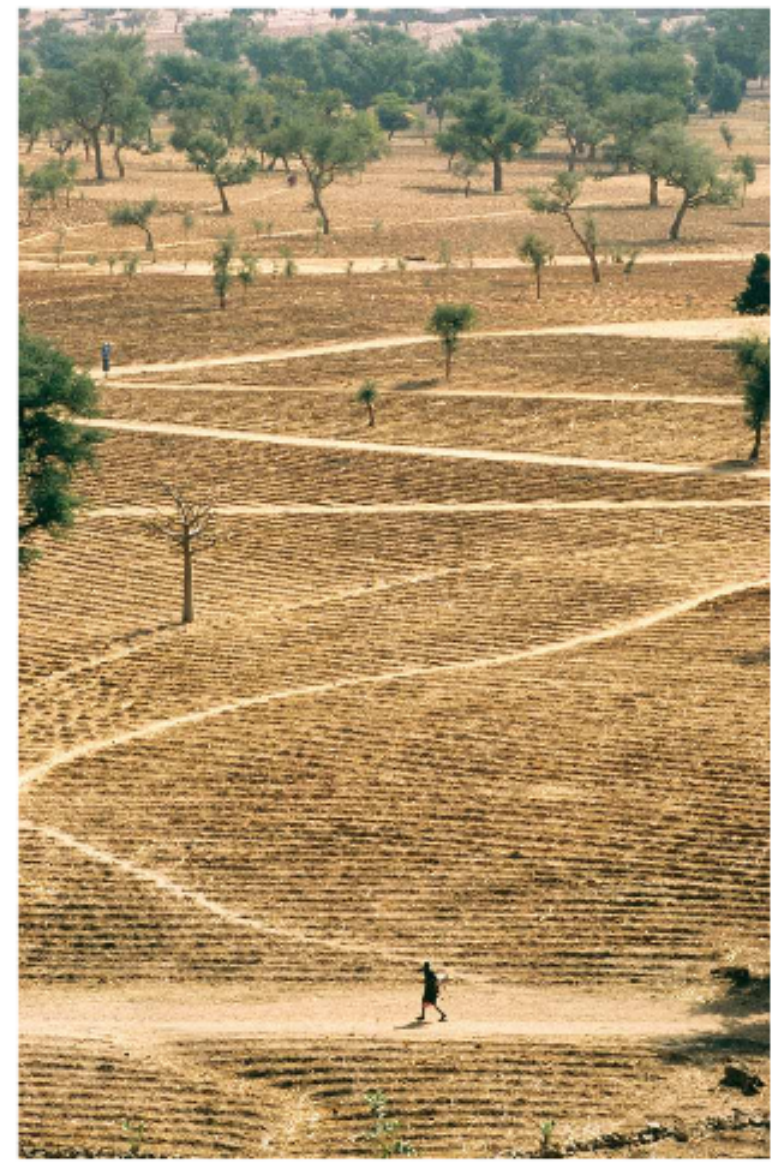

Fig. 1 | Sahelian agroforestry. A single *Adansonia digitata* or baobab tree (foreground), with smaller, green *Balanites aegyptiaca* or desert date trees (mid-ground), and *Faidherbia albida* and other larger trees (background) growing in fields in central Mali, West Africa. Trees of these types are useful for fruit, fodder, wood and soil nutrients. Brandt and colleagues[1] use analyses of satellite data covering West Africa to show that farming practices in the semi-arid Sahel lead to an increase in woody cover compared to the surrounding savannahs, calling into question the simplistic idea that population growth necessitates the destruction of woody cover. Credit: Paul Kingsley / Alamy Stock Photo

change. The conventional wisdom that subsistence farming in Africa degrades the environment needs to give way to an understanding of how agricultural land uses represent trade-offs between potential services[9], and how African farmer–foresters seek to optimize long-term agricultural and forest production via rational decision-making, given their local environmental, sociological and economic constraints[10].

The satellite-based view presented by Brandt and colleagues[1] reveals the continental-scale patterns in tree cover that emerge from countless individual and very localized trade-offs made by West African farmers in search of improved and sustainable food security and resilient livelihoods. ❐

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