Service-Smart Shade Trees: Choosing Species & Spacing for Tea Producers in Northern Laos

ABOUT THIS BRIEF

This research brief reveals how smart shade design can make Lao tea farms more productive and resilient. Across nine plots in Xieng Khouang, results show that trees shape everything: yield dips close to trunks, but tea quality and soil protection soar under moderate shade. Not all trees are equal, Mak-Kho (*Livistonia speciosa*) stands out as a top performer.

The takeaway: space trees 3-6 m apart and choose service-rich species for better cups and safer soils.

Why this matters? Better cups, safer soils, less forest pressure

Tea cultivation stands as a strategic perennial crop for certain upland communities in Lao PDR, offering both economic and ecological potential. While ancient tea forests, limited in extent, remain culturally and environmentally significant, the pressing policy challenge lies in guiding the expansion of tea production onto non-forest lands. This expansion must prioritize sustainable, quality-focused agroforestry systems as a viable alternative to slash-and-burn agriculture.

For new tea plantations to be truly sustainable, they must mitigate soil erosion, preserve biodiversity, and ensure high cup quality. Agroforestry, where tea is cultivated alongside shade trees, emerges as a practical solution, balancing productivity, quality, and soil conservation while avoiding encroachment into high-conservation forests. Global and regional evidence demonstrates that integrating trees can stabilize yields and enhance ecosystem services, such as soil health and biodiversity conservation.

However, agroforestry systems are highly diverse, varying in shade tree species and spatial arrangements. In Laos, there remains a critical knowledge gap: **How do different shade tree species influence the provision of ecosystem services in tea agroforestry?**

Addressing this gap is essential to provide farmers with science-based recommendations for optimizing shade tree selection and system design

What we did? Quantify services on 400 tea trees according to distance to shade tree

To evaluate how shade trees influence tea productivity and ecosystem services, we conducted field measurements in Pek District, Xieng Khouang Province.

The study included **9 agroforestry plots**, encompassing **400 tea trees** and **100 shade trees** across six locally relevant species: Plum (*Prunus salicina*), Peach (*Prunus persica*), Mak-Kor (*Castanopsis hystrix*), Mak-Ken (*Zanthoxylum rhetsa*), Mak-Xang (*Litsea cubeba*), and Mak-Kho (*Livistonia speciosa*). These species were selected for their prevalence in farmer-managed systems and their additional economic or ecological value.

For each tea tree, we recorded:

- **Tea tree productivity**: A tea production index (buds per canopy area)
- **Tea quality**: Leaf biochemical traits (polyphenols, amino acids) analyzed via Near-Infrared Spectroscopy (NIRS)
- **Tea tree nutrition**: Foliar chlorophyll content (SPAD readings)
- **Soil Protection**: A soil-cover score (0-4 scale)

The key independent variable was the distance from each tea plant to its nearest shade tree, allowing us to assess spatial relationships between shade proximity and tea performance.

Why distance matters?
Better tea, steadier yields, safer soils around shade trees

1. The Power of Proximity: Distance-Dependent Effects

Shade trees create distinct micro-environments that influence tea productivity, quality, and soil protection, with distance from the trunk of shade trees as a critical factor:

- **Yield Trade-offs:** Tea production drops by ~30% within 3 meters of shade trees, regardless of species, but recovers beyond this threshold. This suggests that strategic spacing and canopy management can mitigate losses while preserving benefits

- **Soil Protection:** Soil-cover scores peak near trees and decline with distance, confirming that shade trees act as a protective "halo" against erosion, especially on slopes.

- **Quality Sweet Spot:** Polyphenol levels, a key quality indicator, are optimized at ~3 meters from the trunk, aligning with moderate-shade conditions.

- **Tea Tree Nutrition Neutrality:** No significant distance effects were observed for SPAD (leaf nitrogen proxy) or amino acids, indicating that quality responses are driven more by light/microclimate than nitrogen availability alone.
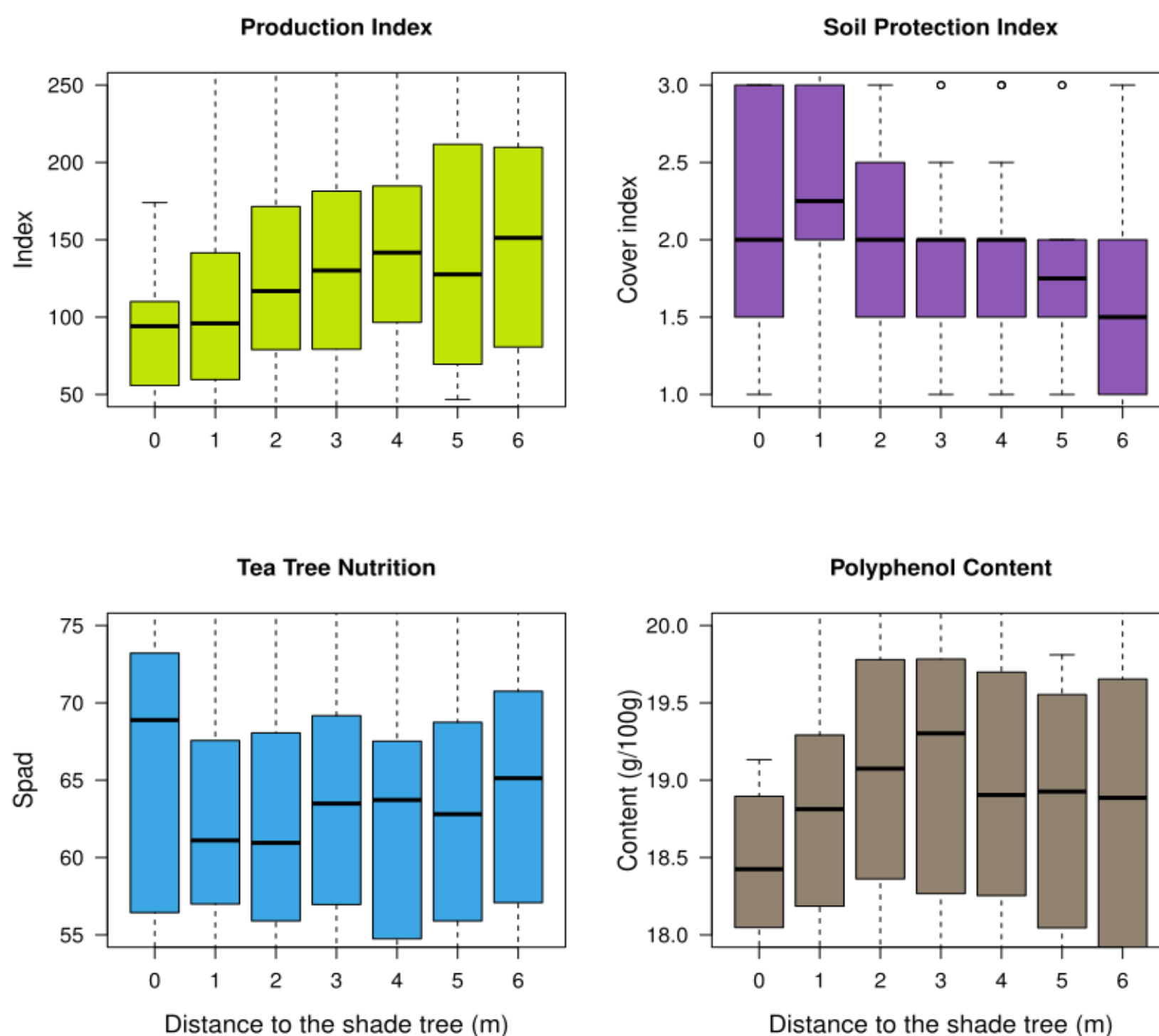

Figure 1: Services provided to tea trees as a function of to their distance to shade trees

2. Species-Specific Nuances

Not all shade trees are equal. Their effects vary significantly, offering opportunities for tailored agroforestry design:

- **Leaf Health (SPAD):** Some species boost chlorophyll levels, others have neutral or even detrimental effects, underscoring the importance of species selection.

- **Yield Sensitivity:** The magnitude of near-tree yield penalties differs by species, influencing optimal planting patterns.

- **Polyphenol Patterns:** Responses range from distance-dependent declines to bell-shaped optima, reinforcing that species choice directly shapes quality outcomes.
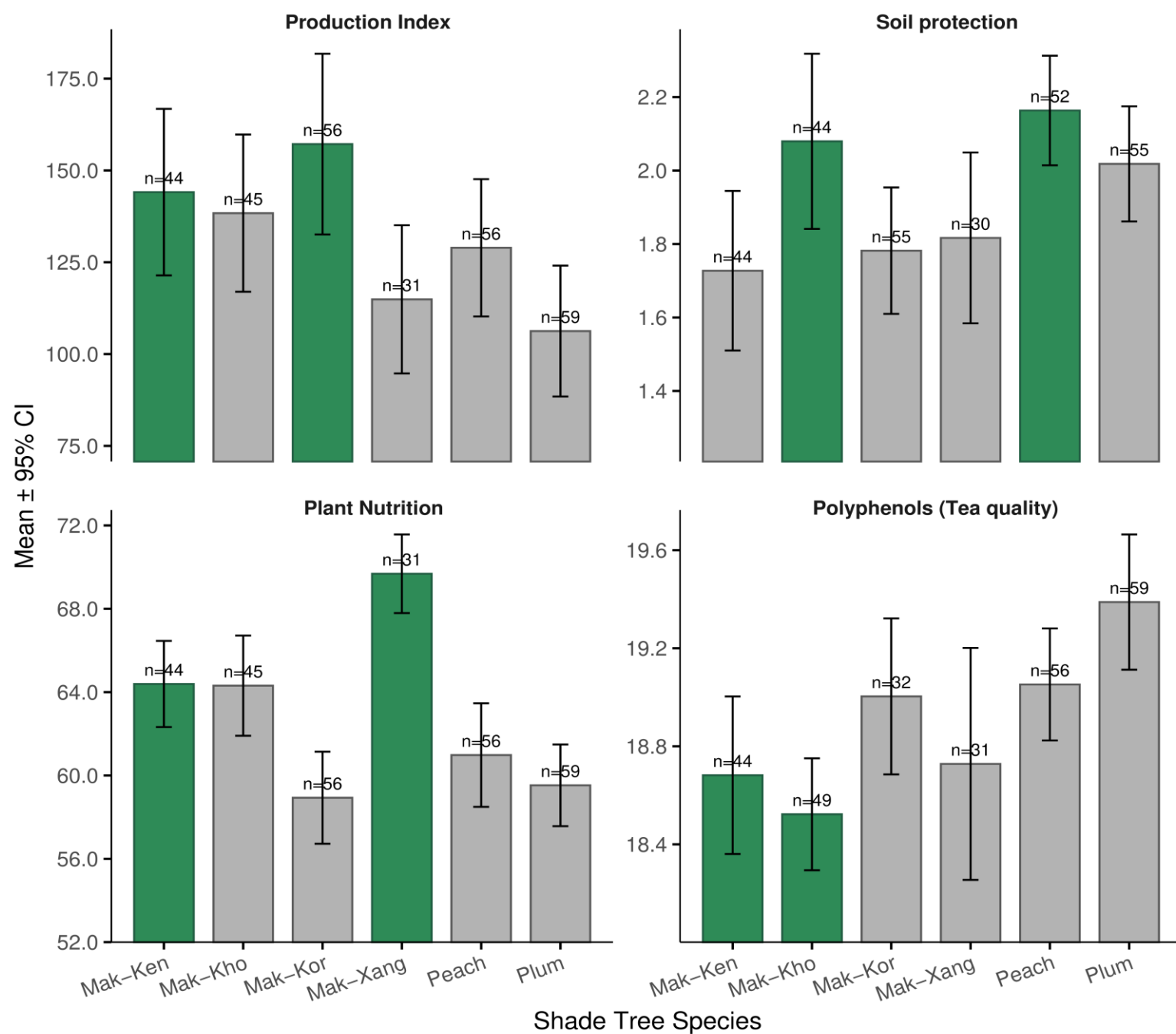
Figure 2: Variation of overall services provided according to the species of shade trees

3. Service Bundles: Maximizing Multi-functionality

When evaluating how many ecosystem services each species supports (e.g., yield, quality, soil protection), clear winners emerge:

▪ **Top Performer:** *Mak-Kho* delivers significantly more services of *Mak-Kor*, making it a standout for multifunctional systems.

▪ **Distance Dynamics:** Some species show declining service provision with distance to the shade tree, while others remain consistently supportive, valuable insight for designing resilient, high-performing tea agroforestry portfolios.

Figure 3: Cumulated services provided by shade tree species
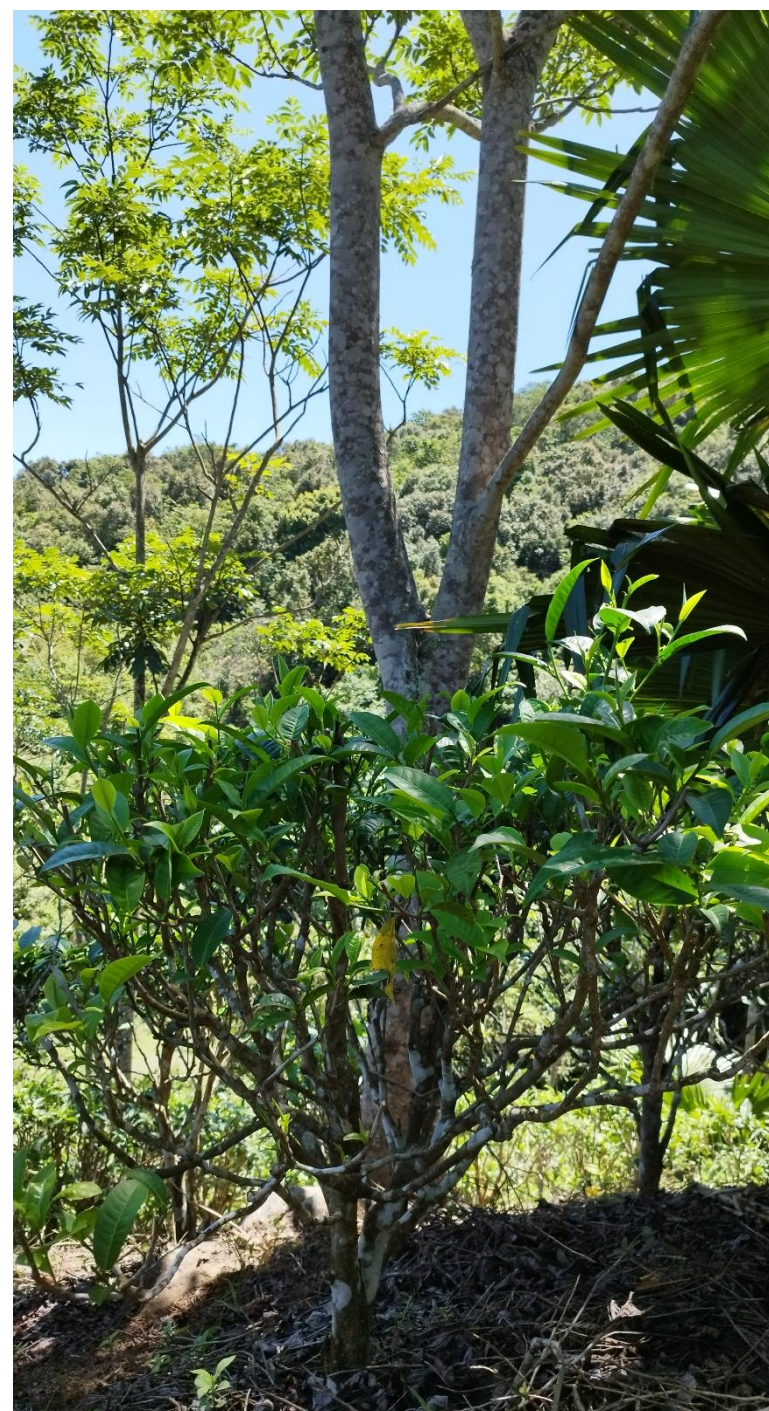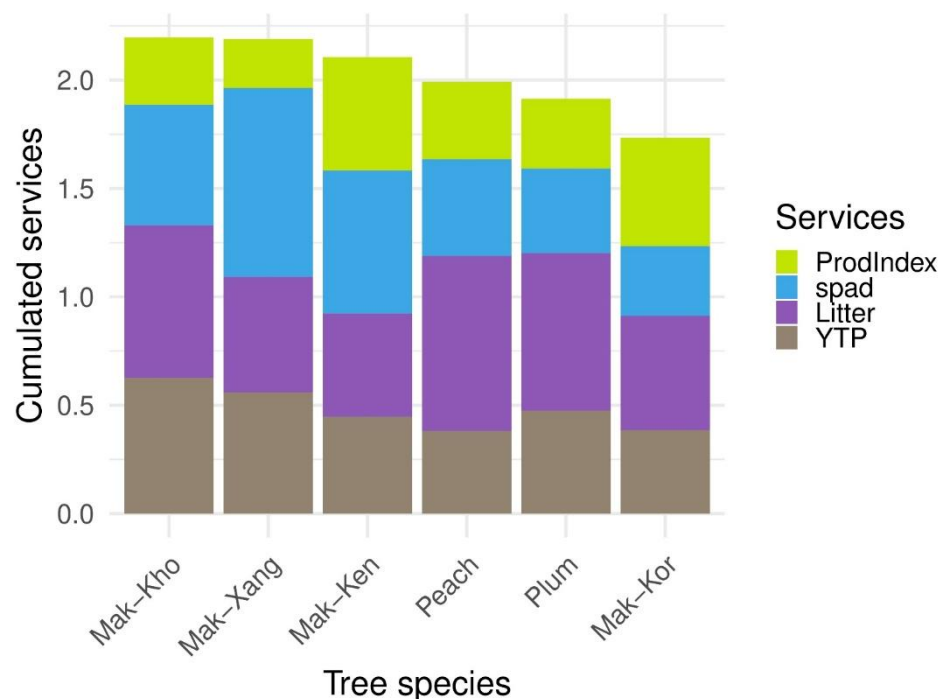
What does it mean for design and policy? Space plants well, choose service-rich species, keep slopes covered

The distance-based responses translate into simple, field-ready rules. Plot layouts should prioritize a 3–6 m band between tea plants and shade stems to capture soil and quality benefits while limiting near-tree yield penalties. Crown-lifting and pruning can shrink the ≤3 m penalty zone without losing shade benefits. Because species matter, seed and seedling systems should favor high-performing species such as Mak-Kho, while maintaining diversity to hedge climate and pest risks. Finally, quality-linked incentives (e.g., GI add-ons, buyer premiums) should reward layouts that place a substantial share of tea around the ~3 m quality sweet spot, aligning farm-gate value with sustainable design.

WHY THIS MATTERS?

These findings highlight that shade tree identity and spatial arrangement are levers for optimizing tea agroforestry. By selecting the right species and managing distance, farmers can balance trade-offs, enhance quality, and protect soils, all while avoiding encroachment into high-conservation forests. The next step: translating these insights into practical recommendations for Lao tea growers.

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