

A Forest in Peril, A Science in Practice: The Proven Success of Silviculture in Spain.

An exploration of the origin, evolution, and evidence-based results of scientific forest management.
Based on the monograph by Gregorio Montero González for the Royal Academy of Sciences of Zaragoza.

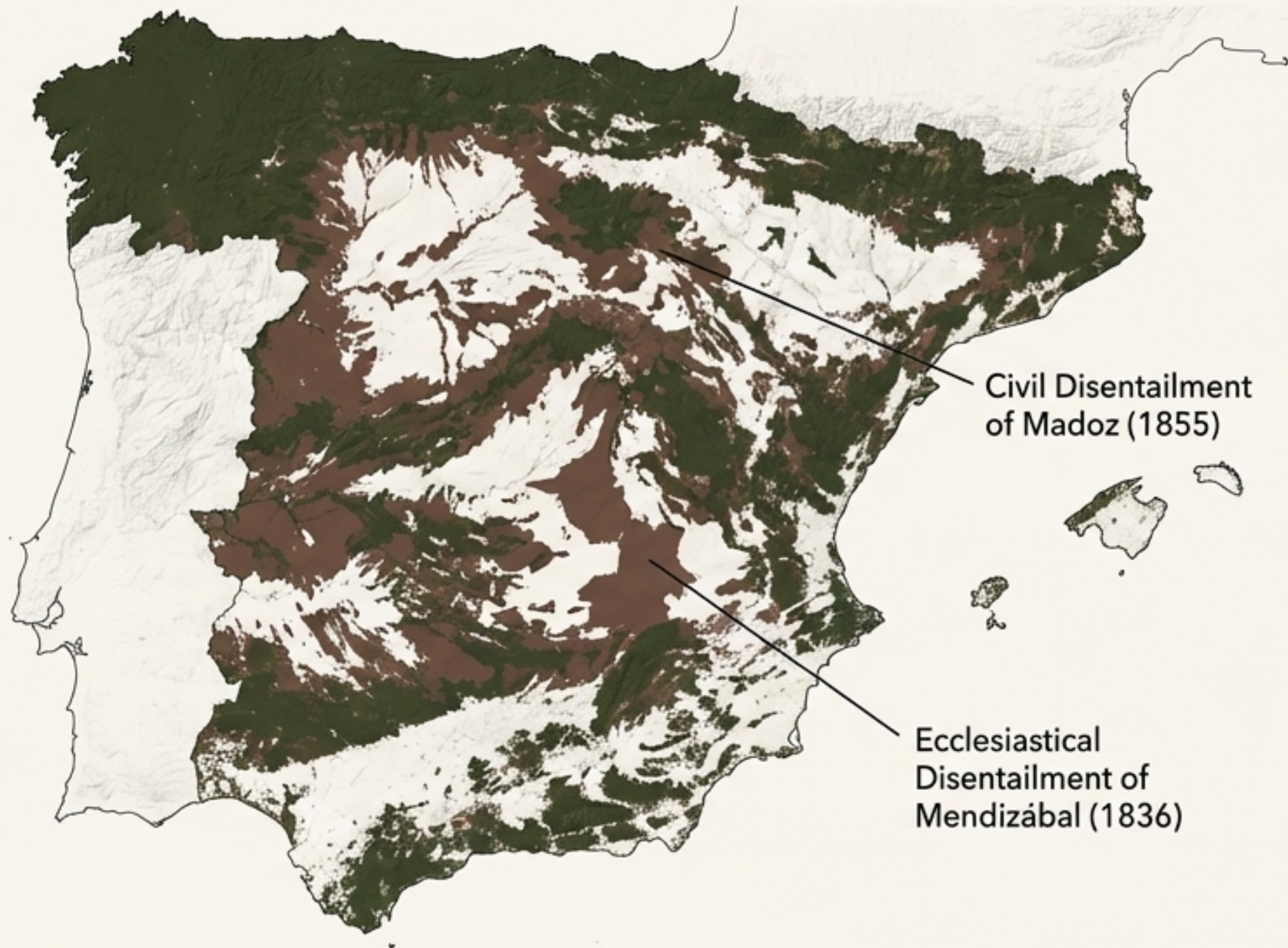


Europe's Forests Faced a Crisis of Over-Exploitation.

By the 17th century, European forests were being systematically degraded. The primary drivers were the need for agricultural land, mining, salt production, and timber for shipbuilding and early industry. Common practices like clear-cutting ("cortas a hecho") and high-grading ("entresacas por huroneo intenso") removed the best trees and extracted far more timber than the forests could naturally replenish, leading to widespread deforestation and resource scarcity.



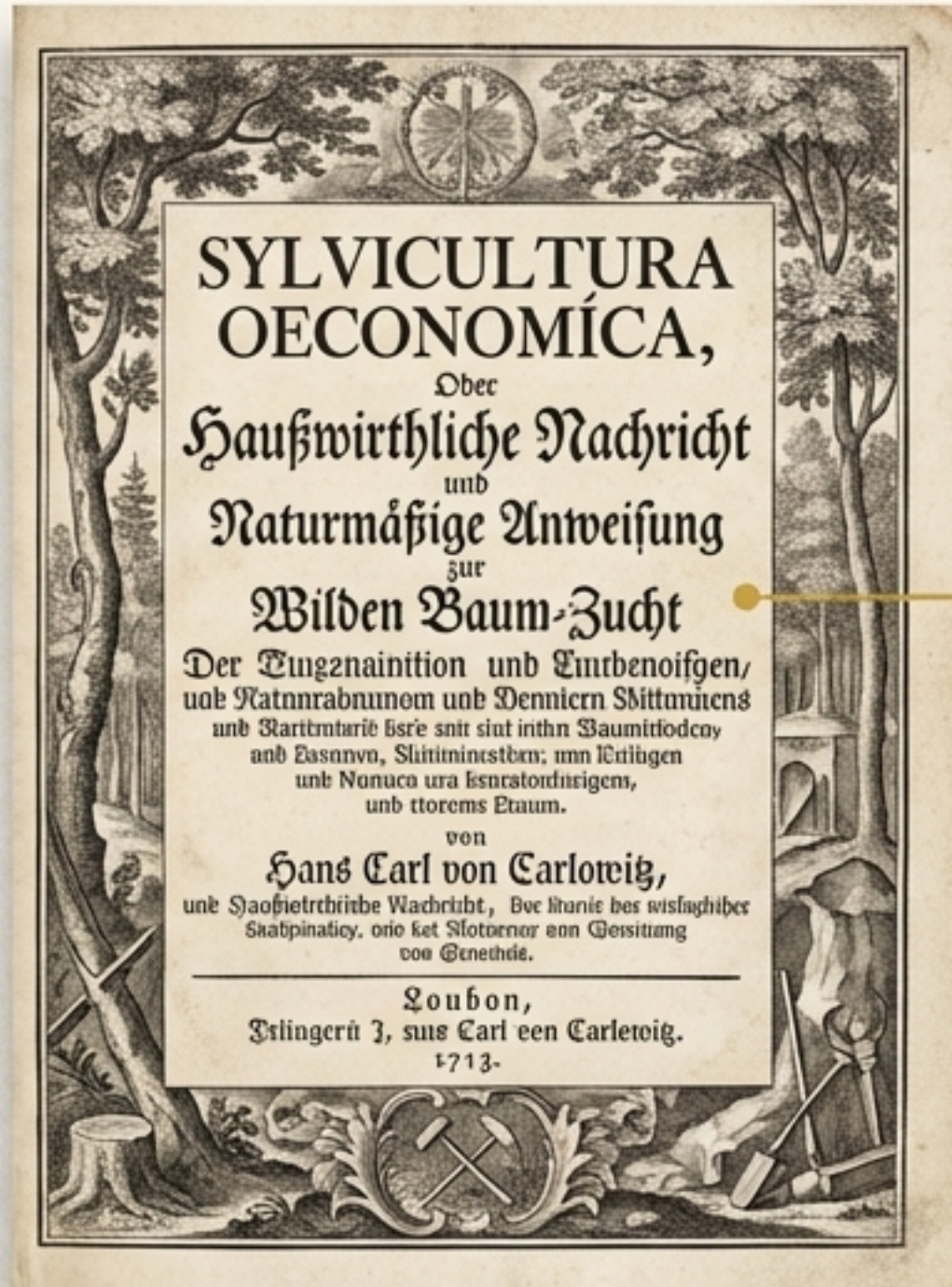
In Spain, 19th-Century Policies Massively Accelerated Deforestation.



The situation in Spain was exacerbated by major policy decisions. The ecclesiastical disentailment of Mendizábal (1836) and the civil disentailment of Madoz (1855) led to the privatization and subsequent clearing of vast areas of public forest land.

This period of intense deforestation highlighted a critical conflict: the pursuit of short-term profit versus the long-term health of the nation's natural resources. It was in this context that the need for a scientific, sustainable approach to forestry became undeniable.

The Solution Began with a Single Word: “Nachhaltigkeit.”



“Instructions
for the wild
cultivation of
trees.”

In 1713, Hans Carl von Carlowitz, an administrator of Saxon mines facing a timber shortage, published *Sylvicultura Oeconomica*. In it, he documented for the first time the concept of “Nachhaltigkeit”—sustainability or persistence. He proposed a simple yet radical idea: never harvest more than the forest can regenerate. This principle, born from necessity, became the cornerstone of modern forestry and has guided sustainable management for over 300 years.

The New Science Was Built on a Principle of Intergenerational Duty

The concept of sustainability was soon refined into an ethical imperative. German forester Ludwig Hartig articulated it with a clarity that resonates today: a wise forest management must utilize the forest in such a way “that future generations can draw from it at least the same advantages as the present ones.”

This philosophy—balancing present needs with future rights—drove the establishment of the first specialized forestry schools across Europe, institutionalizing the new science.



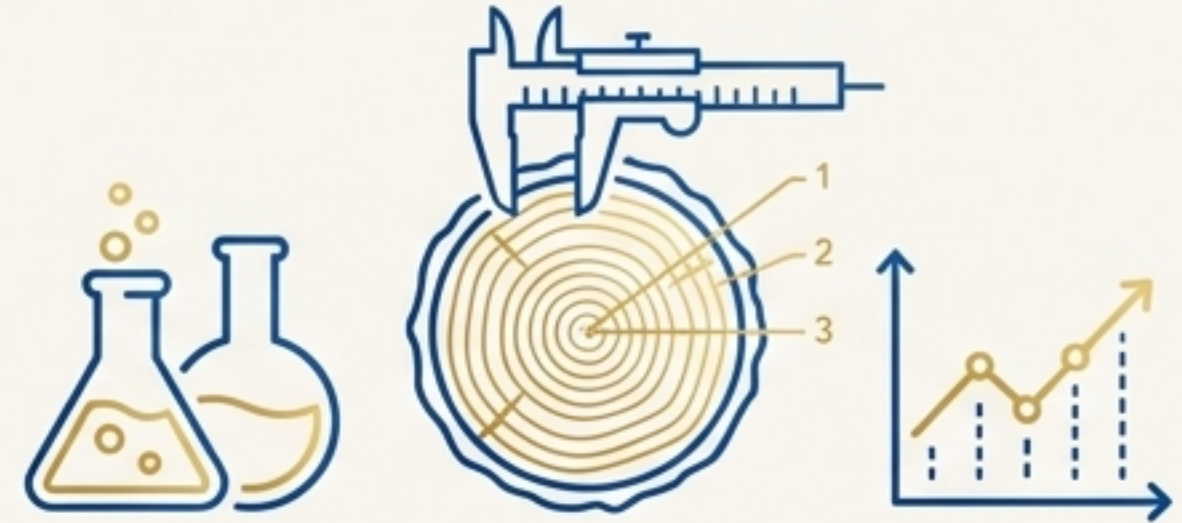
Forestry Matured from Empirical Rules to Rigorous Scientific Experimentation

By the 19th century, forestry science evolved beyond “pure observation.” As Karl Gayer argued, it was necessary to move to “provoked observation”—that is, controlled experimentation. This shift demanded a scientific method to test hypotheses about tree growth, density, and regeneration.



Pure Observation

Empirical rules based on watching natural processes.



Provoked Observation (Experimentation)

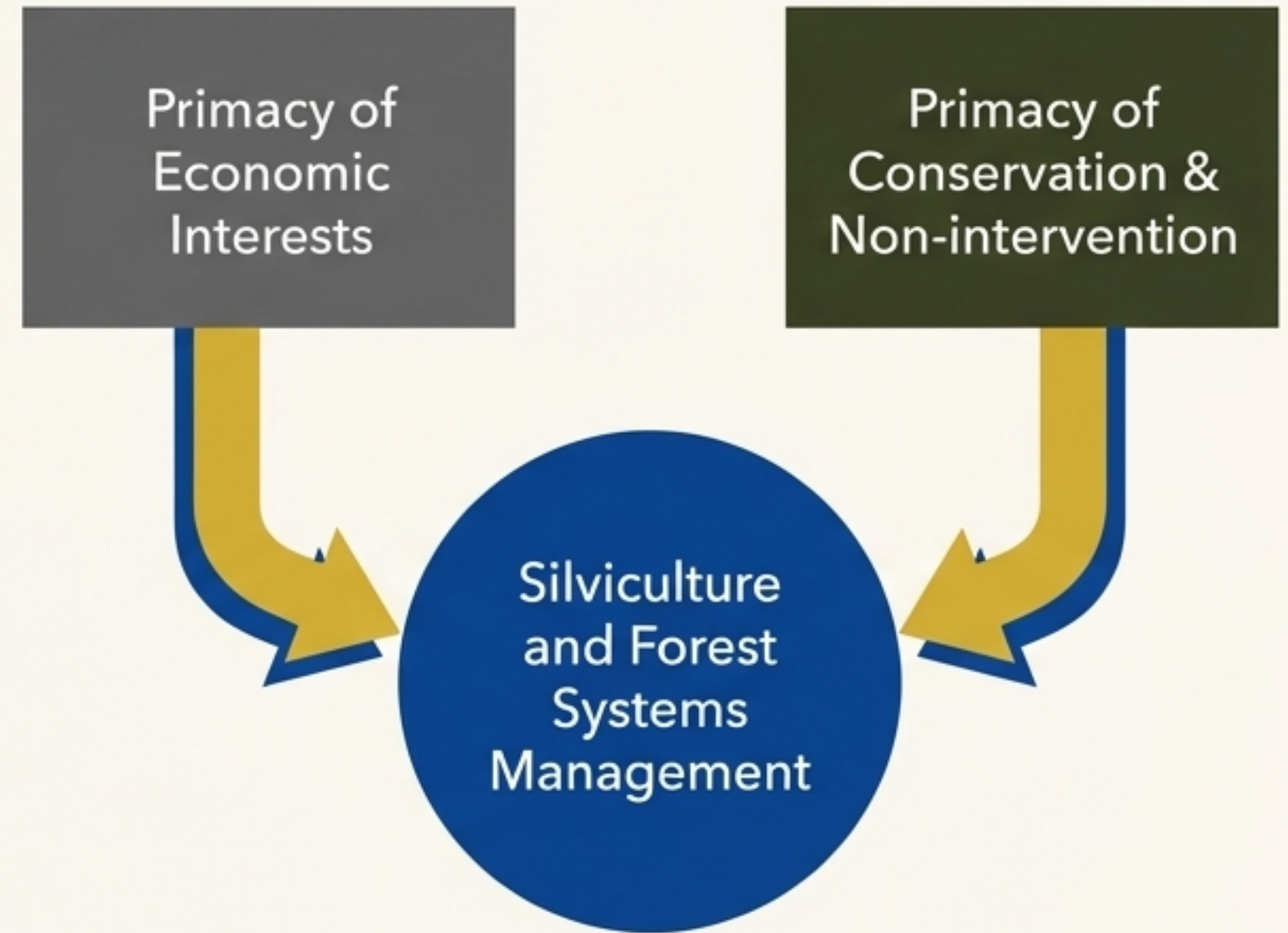
The scientific method: testing hypotheses with controlled experiments and permanent plots.

The result was the creation of the first international forestry research organizations (IUFRO, 1891) and national institutes like Spain's ICETF (1907), dedicated to establishing permanent experimental plots to build a true, evidence-based science. As José Echegaray stated, “To know Nature it is necessary to go to it... make it work before our eyes and in our hands.”

Silviculture Navigates the Divide Between Absolute Conservation and Pure Economics

The rise of scientific forestry occurred alongside a philosophical debate that continues today. On one side was a focus on the primacy of economic interests. On the other, an ecocentric view, championed by figures like John Muir, advocated for non-intervention.

Silviculture and scientific forest management emerged as the bridge between these two poles. It is a discipline that recognizes both the economic needs of society and the ecological integrity of the forest, seeking a sustainable balance where we can “utilize while conserving” (*aprovechar conservando*).



The Proof: Over 130 Years of Meticulous Data from Spain's Managed Forests

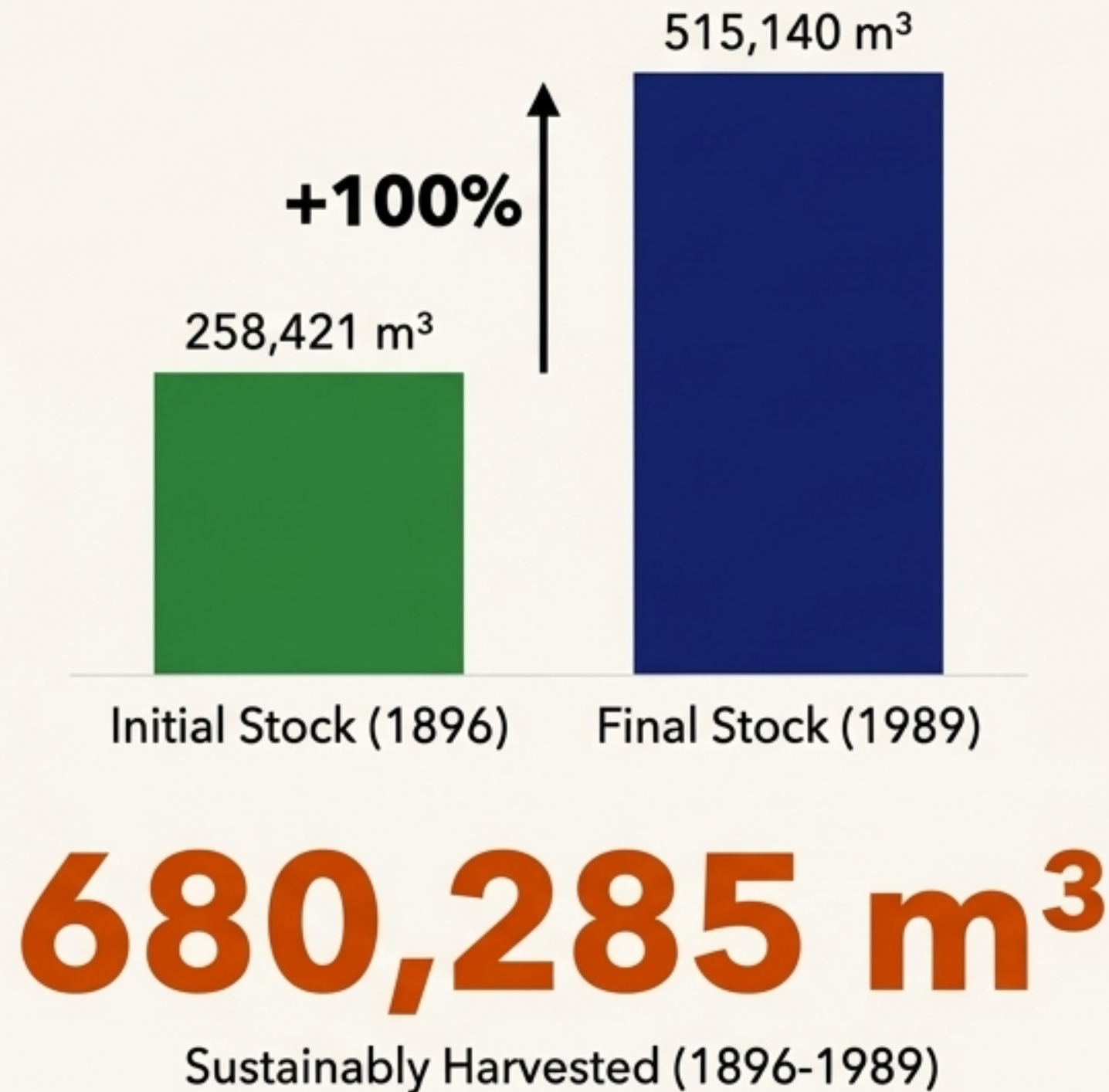
Since the late 19th century, Spain has applied scientific management principles to its public forests. These management plans are not static; they are periodically revised (typically every 10 years) based on detailed inventories. This continuous process has created an invaluable, century-long **dataset** tracking the evolution of these forests under active management.

This data provides a unique, real-world experiment to answer the critical question: Does silviculture work in the long run?

The following examples present the unambiguous results.



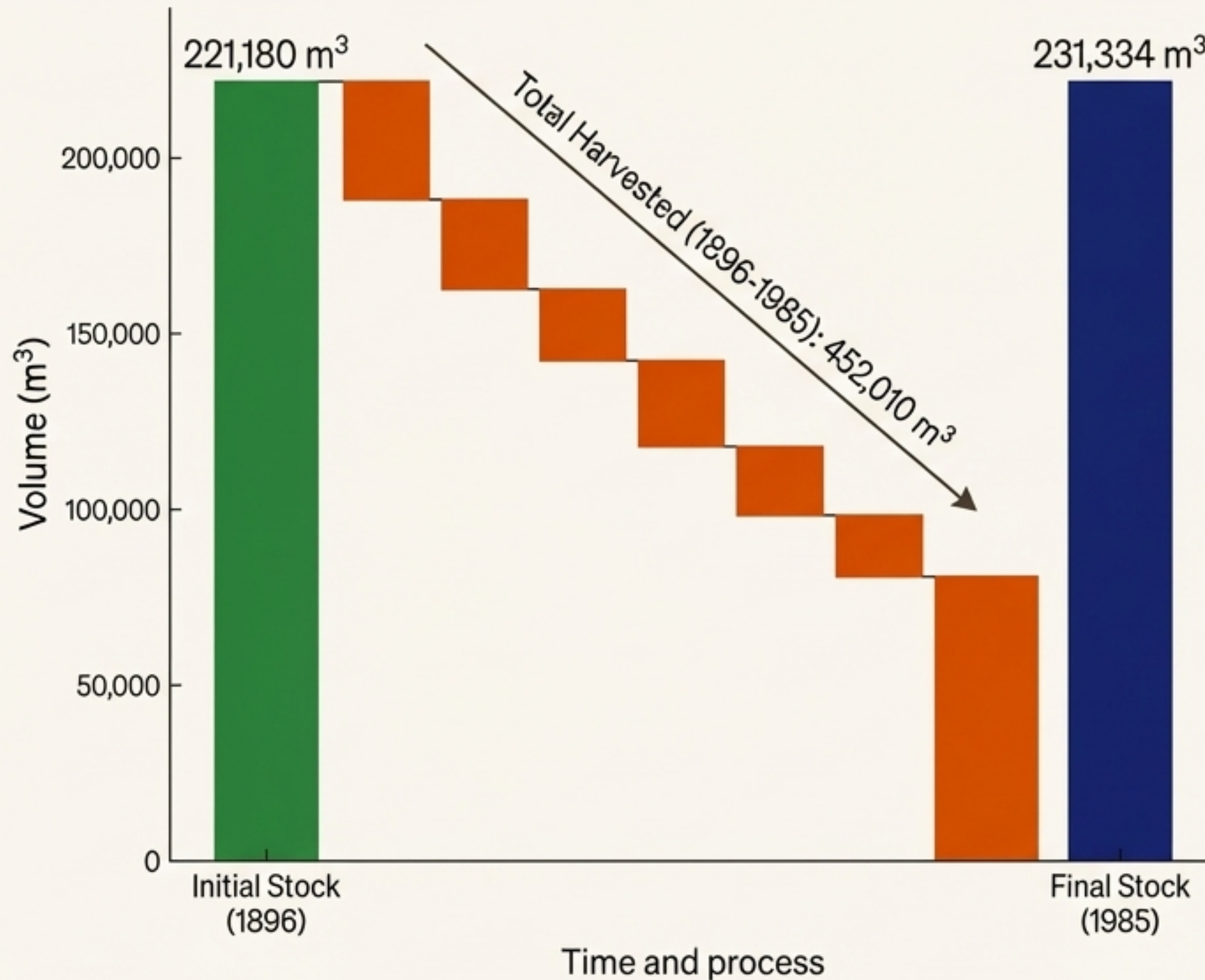
Case Study: A Century in Pinar de Navafría (*Pinus sylvestris*)



The data from Navafría forest in Segovia provides a stunning confirmation of silviculture's success. Between 1896 and 1989, under a consistent management plan:

- The standing timber volume **DOUBLED**, from 258,421 m³ to 515,140 m³.
- The forest sustainably yielded **680,285 m³** of timber—an amount equal to **2.6 times** the entire forest's original stock.
- The number of large trees (>20 cm diameter) **increased by 55%**, demonstrating a healthier, more mature forest structure.

Case Study: Sustained Yield in Los Palancares (*Pinus nigra*)



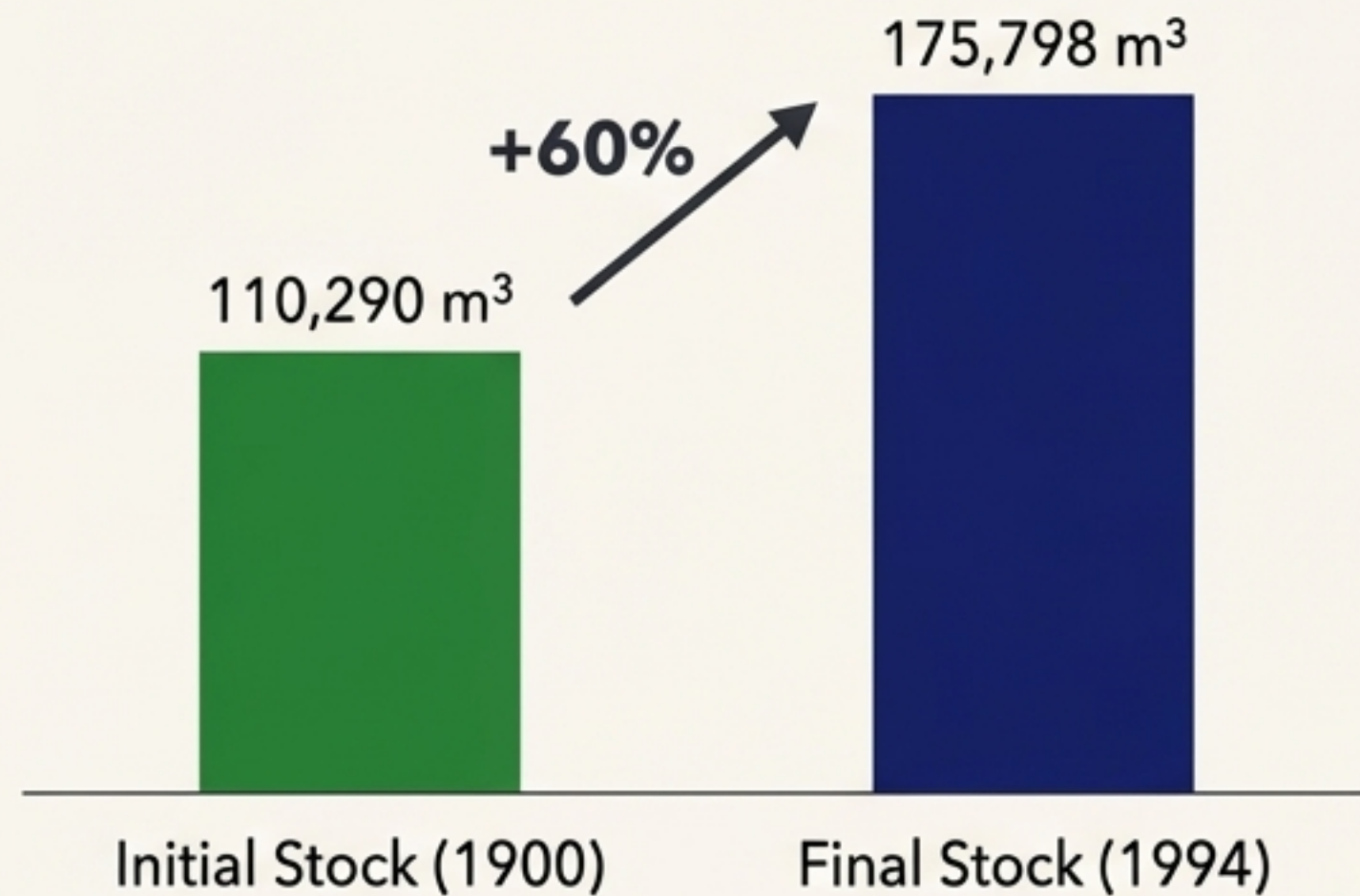
The 'Los Palancares y Agregados' forest in Cuenca provides another century of data.

From 1896 to 1985, the forest was managed with a focus on consistent, sustainable yield.

- Standing timber volume and the number of large trees were **maintained or slightly increased** compared to initial levels.
- During this period, the forest produced **452,010 m³** of harvested timber, an amount equal to **2 times** its entire original stock.

This demonstrates a perfect example of a system in equilibrium, providing a continuous flow of renewable resources while conserving the capital of the forest itself.

Case Study: Enhancing a Beech Forest in Aralar (*Fagus sylvatica*)



257,745 m³

Sustainably Harvested (1900-1994)

The principles of silviculture are not limited to pines. In the Aralar beech forest in Navarra, management between 1900 and 1994 resulted in clear improvements:

- The standing timber volume **INCREASED BY 60%**, from 110,290 m³ to 175,798 m³.
- The number of large trees grew by 11%, indicating a more robust forest structure.
- Simultaneously, the forest provided a sustainable harvest of 257,745 m³ of timber—more than 2.3 times its starting volume.

This case proves that scientific management enhances both the ecological and economic value of diverse forest types.

The Verdict Is Clear: Scientific Management Achieves Both Conservation and Use

The results from Navafría, Los Palancares, Aralar, and numerous other managed forests across Spain tell a consistent story. Over more than a century, the application of silviculture has not depleted our forests. Instead, it has:

- Increased the total volume of timber stock.
- Improved the structural health and maturity of the forests.
- Provided vast quantities of renewable raw materials for society.

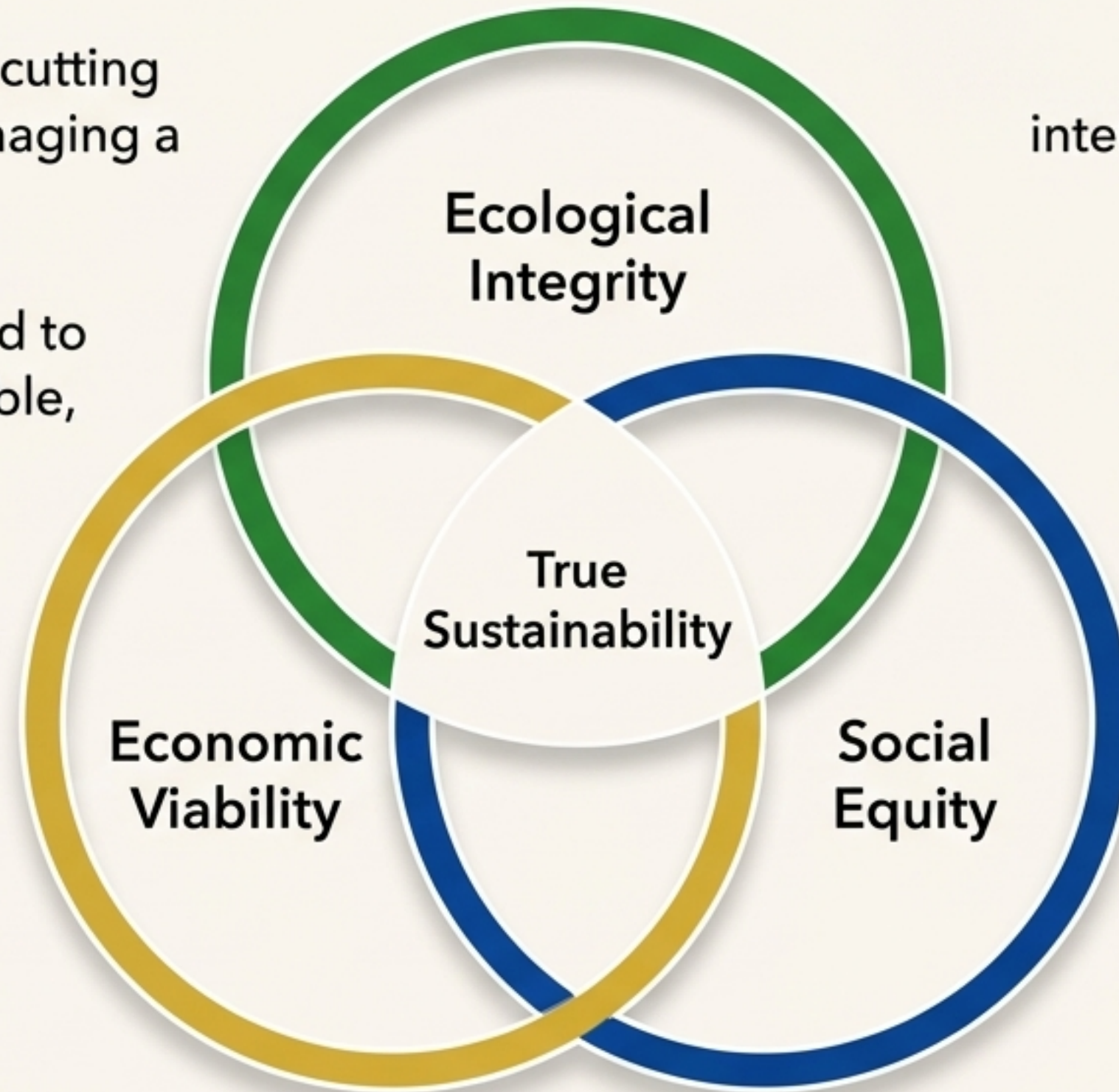
This is the empirical proof of the guiding principle of Spanish forestry: it is possible to *aprovechar conservando*—to utilize our forests while conserving them for all future generations.

Modern Silviculture Is a Form of Applied Ecological Engineering.

Silviculture is more than just cutting trees; it is the science of managing a complex adaptive system.

For any management method to be considered truly sustainable, it must satisfy three interconnected functions: ecological integrity, economic viability, and social equity.

Through carefully planned interventions,



Through carefully planned interventions, silviculture guides a forest from a purely "natural equilibrium" to a "cultural equilibrium"—a stable, healthy, and productive state that provides goods and services to society without losing its core ecological functions.

It is, as some have termed it, "ecoculture" in practice.

A Centuries-Old Science for 21st-Century Challenges.

The principles proven over the last 130 years are more relevant than ever. In an era of climate change and a search for sustainable economies, scientific silviculture is a critical tool. It allows us to:



Contribute to the **green economy** with renewable, reusable raw materials.



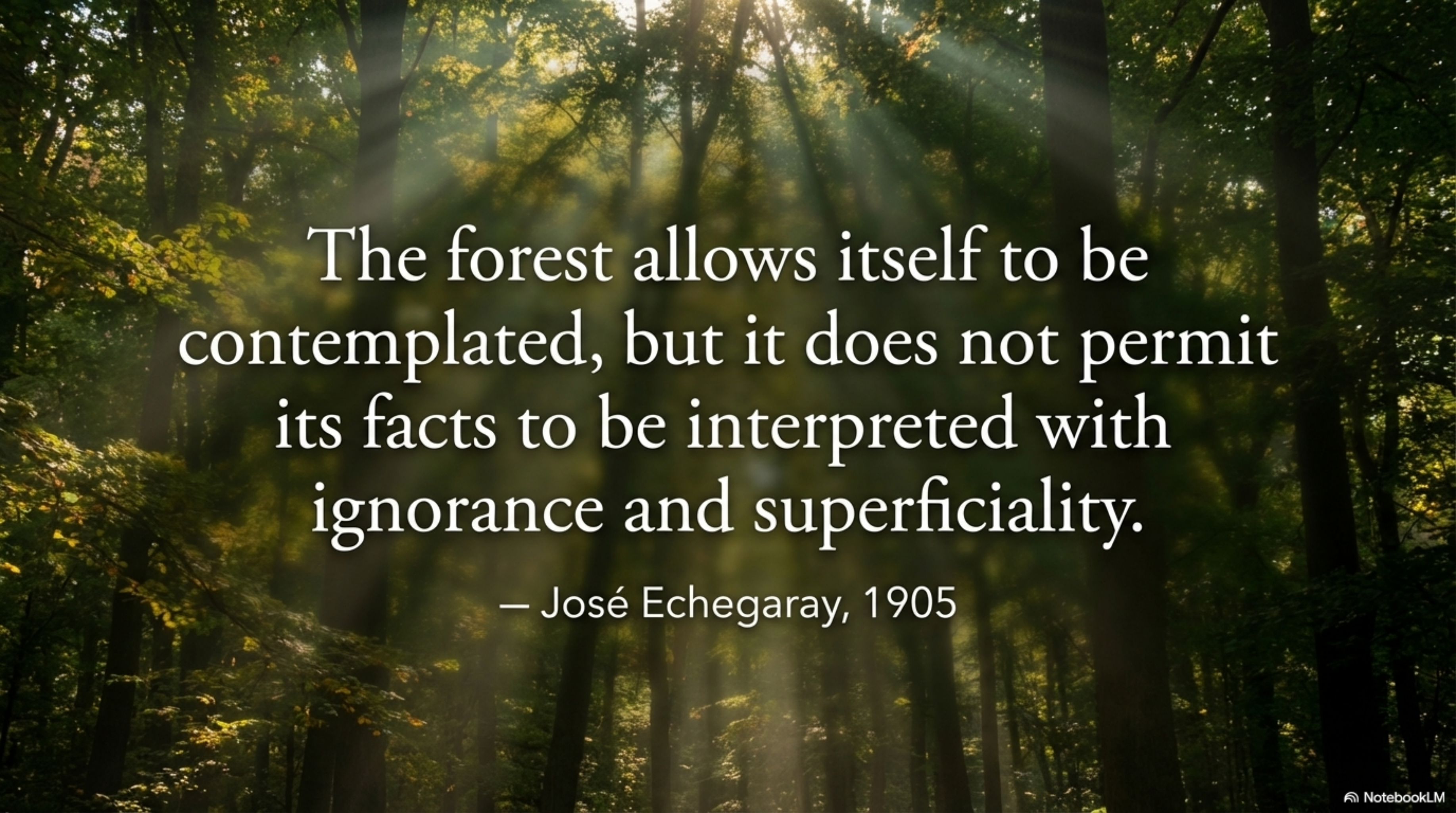
Create and sustain vital **rural employment**.



Actively **adapt our forests** to be more resilient to climate change, fires, and other threats.



Manage forests for a **multifunctional landscape** that includes biodiversity, recreation, and water protection.

A photograph of a dense forest with tall, slender trees. Sunlight filters through the canopy, creating a dappled light effect on the forest floor. The leaves are green, with some showing hints of yellow, suggesting an autumn setting. The overall atmosphere is serene and natural.

The forest allows itself to be
contemplated, but it does not permit
its facts to be interpreted with
ignorance and superficiality.

— José Echegaray, 1905