YALE FOREST FORUM
SPEAKER SERIES SUMMARY

SPRING 2023

YFF Review

Smallholder Planted Forests and Trees for Climate, Restored Landscapes, and Livelihoods

January 17 – April 25, 2023
New Haven, Connecticut, USA

The Forest School at the Yale School of the Environment

YALE FOREST FORUM TEAM

Mark Ashton
Senior Associate Dean, The Forest School at the Yale School of the Environment; Morris K. Jesup Professor of Silviculture and Forest Ecology; Director, Yale Forests

Gary Dunning
Executive Director, The Forest School and The Forests Dialogue

Liz Felker
Assistant Director, The Forest School; Associate Director, The Forests Dialogue

Sara Santiago
Communications Manager, The Forest School

Lisa O'Brien
Senior Administrative Assistant

Yale SCHOOL OF THE ENVIRONMENT
The Forest School

Yale Forest Forum
The Forest School at the Yale School of the Environment
Yale University
360 Prospect Street, New Haven, CT 06511
Phone (203) 432-5117 | yff.yale.edu

Front cover photo: A smallholder farmer explains his restoration plan for his plot of land in Peru. Photo: The Forests Dialogue (TFD).

Left photo: Fruit, fodder, and timber tree seedlings in a nursery in the Democratic Republic of the Congo.

YFF Review

YALE FOREST FORUM AND *YFF REVIEW*

The Yale Forest Forum (YFF) is the convening hub of The Forest School at the Yale School of the Environment. YFF offers weekly webinar Speaker Series during the academic year to provide opportunities to hear from leaders in forest management, conservation, academia, and policy. Each YFF Speaker Series is organized around a key theme or challenge facing forests, forestry, and people. Guest speakers represent a wide range of perspectives and organizations, including government, NGOs, and businesses, and across scales from local to international. The *YFF Review* is a publicly available output of the series, summarizing key learnings and examples from the YFF Speaker Series.

Agroforestry crops like coffee and papaya are important for smallholders in Peru. Photo: TFD.

SEMINAR INSTRUCTORS

Mark Ashton
Senior Associate Dean, The Forest School at the Yale School of the Environment; Morris K. Jesup Professor of Silviculture and Forest Ecology; Director, Yale Forests

Gary Dunning
Executive Director, The Forest School and The Forests Dialogue

Thaís Linhares-Juvenal
Team Leader Sustainable Forest Value Chains, Investments and Innovation and Secretary of the International Commission on Poplars and Other Fast-Growing Trees Sustaining People and the Environment (IPC), Forestry Division, Food and Agriculture Organization of the United Nations (FAO)

Faustine Zoveda
Forestry Officer (Planted forests and Restoration), Forestry Division, Food and Agriculture Organization of the United Nations (FAO)

SERIES SPEAKERS

Thaís Linhares-Juvenal

Bob Kazungu

Stefano Bisoffi

Charles Nyanjui

Mariem Dkhil

Jelmer van de Mortel

Richard Donovan

Dianne Staal Wästerlund

Stephanie Chizmar

Kobsak Wanthongchai

Meredith Martin

Carolina Toapanta

Zoraida Calle

SUMMARY AUTHORS*

Jake Barker

Raqib Valli

Ryan Smith

Thokozile Changufu

Thokozile Changufu

Katie Michels

Ryan Smith

Ryan Smith

Isaac Merson

Ryan Smith

Ryan Smith

Ryan Smith

Ryan Smith

SERIES EDITOR

Sara Santiago

ISSUE EDITORS

Wyatt Klipa

Arun Dayanandan

**Summary authors were students in a Yale seminar series.*

A small cooperative produces fruit, fodder, and timber tree seedlings to be planted in smallholder farms in the DRC. Photo: TFD.

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Introduction

By: Wyatt Klipa

In the spring of 2023, the Yale Forest Forum (YFF) brought together over 1,300 registered attendees for the webinar speaker series "Smallholder Planted Forests and Trees for Climate, Restored Landscapes, and Livelihoods." The series, which ran from January through April 2023, was hosted in collaboration between The Forest School at the Yale School of the Environment and the Food and Agriculture Organization (FAO) of the United Nations.

Planted forests comprise an increasingly large share of global forest cover, with the area of planted or deliberately seeded forestland growing larger even as global forest coverage declines overall. Many believe that planted forests have the potential to play an increasingly important role in climate mitigation, conservation of biodiversity, environmental services, wood products supply, and livelihood support.

A large portion of planted forests and individual trees are on lands owned by smallholders. Smallholder lands are typically non-industrial, individually owned parcels. The global land area under smallholder ownership has increased substantially over the last few decades. Smallholders owned over a quarter of planted forestland worldwide as of 2005, playing a substantial role in the management of global forests.

However, smallholders also experience recurring policy, commercial, ecological, and technical challenges, which can make financial success and long-term viability a tenuous prospect. These challenges run the risk of forcing

Smallholder cacao trees in an agroforestry plot in Peru. Photo: USAID.

smallholder forest owners to abandon forest management for a different more lucrative option, such as intensive agriculture or land development. If forests are to be not only conserved, but expanded globally, smallholder forest owners must be supported.

In this series, The Forest School and FAO invited experts, researchers, advocates, and landowners to share their work and knowledge and to explore the role that smallholder planted forests can have in global forest management. The series set out to ask the following questions:

1. What are the key success factors in the establishment and management of forests and trees planted by smallholders outside of forests?
2. Which management objectives do smallholders pursue and how are they implemented according to business best-practices?
3. What are the operational risks, financial risks, and vulnerabilities smallholders face related to quickly evolving markets and a changing climate?
4. Which models and practices are most promising?
5. Which opportunities and business models arise from the transition toward carbon-neutral economies and the global momentum for ecosystem restoration?
6. What can be done to support smallholders?

Over the course of the series, we invited 13 different guest speakers, each of whom highlighted a different element of the challenges associated with supporting smallholders in planting trees, drawing from their own research, practices, or forest ownership experiences. To open, **Thaís Linhares-Juvenal** (FAO) introduced the series. **Bob Kazungu** (Ministry of Water and Environment, Uganda) was asked to explore policies, investments, and capacity development for smallholders. **Stefano Bisoffi** (formerly Council for Agricultural Research and Economics, Italy)

CIPAV silvo-pastoral system in Colombia. Credit: Alliance of Biodiversity International and CIAT.

delved specifically into research and innovation in smallholder planting. We invited **Charles Nyanjui** (Farm Forestry Smallholder Producers Association of Kenya) to describe the role of producers' associations in smallholder success.

Next, **Mariem Dkhil** (Crédit Agricole du Maroc) examined smallholder access to financial services. **Jelmer van de Mortel** (Acorn, Rabobank) outlined the concept of carbon farming. **Richard Donovan** (Rainforest Alliance) introduced the seminar to the broad world of certification schemes.

Speakers also focused on the ways in which smallholders respond to risk. **Dianne Staal Wästerlund** (Swedish University of Agricultural Sciences) described the role of technology in smallholder risk management. **Stephanie Chizmar** (USDA Forest Service) highlighted the ways in which smallholders in the United States demonstrate resilience to climate change.

Kobsak Wanthongchai (Kasetsart University, Thailand) described the importance of fire management for many smallholders. **Meredith Martin** (North Carolina State University) delved into the often-messy world of tree planting organizations. **Carolina Toapanta** (BOMACO Foundation) explored the role that smallholders can play in forest restoration. Finally, **Zoraida Calle** (Environmental Training & Leadership Initiative; Center for Research on Sustainable Agriculture) examined the ways in which smallholders can implement agroforestry approaches.

This series follows YFF's fall 2022 series "(Re)Considering Planted Forests for the 21st Century," which explored industrial-scale plantations worldwide and their associated socioeconomic advantages and disadvantages. This series pivots to focus on smallholders and the significant role they play in a diverse range of land uses and values. While less focused on timber production, their use of land and products reflects local social, economic, and biophysical circumstances and can inform global forest policy, management, and research. We hope that all those who read this review find it informative and thought provoking.

WATCH SESSION VIDEO

Series Introduction and Overview

Presented: January 17, 2023

Thaís Linhares-Juvenal

LEARN MORE

THAÍS LINHARES-JUVENAL
TEAM LEADER SUSTAINABLE FORESTRY, VALUE CHAIN INNOVATION, AND INVESTMENT STREAM; SECRETARY OF THE INTERNATIONAL COMMISSION ON POPLARS AND OTHER FAST-GROWING TREES SUSTAINING PEOPLE AND THE ENVIRONMENT (IPC), FORESTRY DIVISION — FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS

Summary by: Jake Barker

Thaís Linhares-Juvenal, team leader at the Food and Agriculture Organization (FAO) of the United Nations, highlighted the importance of addressing the issue of smallholders and planted forests as a central component in the development of forestry and rural agendas of our time. In considering the importance of forests and trees for climate-restored landscapes and livelihoods, an important socioeconomic component is the cultural aspect, which is essential in smallholders' role. Linhares-Juvenal gave an overview of the series and provided some critical elements for understanding this complex subject.

PLANTED FORESTS FOR SDG GOALS

As a team leader at FAO, Linhares-Juvenal outlined the organization's UN-derived Sustainable Development Goals framework and how forests can help achieve those goals by 2030. One of the UNSDG's universal value principles is to 'leave no one behind' by eradicating poverty and promoting equality by working with small farmers and landowners worldwide. Another recent directive started by the UN is focusing on addressing land and forest degradation. Four specific goals that planted forests and smallholders contribute to are no poverty, zero hunger, climate action, and life on land. Rural poverty is responsible for 80% of extreme poverty in the world,

and the livelihoods of smallholders are often essential for the food supplies and economies of rural places. Zero hunger strives for more productive food systems with better natural environments and ecosystem services by increasing sustainability and promoting farmers' working conditions and income. Additionally, forests are vital players in climate mitigation and adaptation of the climate action goal. Planted forests help protect natural forests while providing sustainable products, wildlife habitat, and buffer zones. Lastly, planted forests' soils and ecosystem services are essential for sustainable landscapes for life on land.

DEMOGRAPHY OF RURAL LANDSCAPES

At least 95% of people live within 5 km of a forest, and 75% live within 1 ha of forest based on data from 2019, Linhares-Juvenal explained. In tropical forest areas, the density of people living near forests is greater than in temperate zones. There is a strong relationship amongst forests, the environment, and poverty. Tree-proximate are those who live within one kilometer of trees on cropland (excluding potential grazing land). These are potential forest owners, tree owners, and tree planters thus these communities are vital in the tropics.

DEFINING SMALLHOLDERS

Defining smallholders is essential for this series and has been controversial historically. Some consider property size, while others lean towards socioeconomics. Linhares-Juvenal provided the definition used by FAO:

"Smallholders are small-scale farmers, pastoralists, forest keepers, and fishers who manage areas varying from less than one hectare to 10 hectares. Smallholders are characterized by family-focused motives such as favoring the stability of the farm household system, using mainly family labor for production, and using part of the produce for family consumption." (http://www.fao.org/3/i6858e/i6858e.pdf) (Used when monitoring SDG indicator 2.3.1).

These family-oriented landowners are an essential group within global trends of farm ownership and food production. Farms under

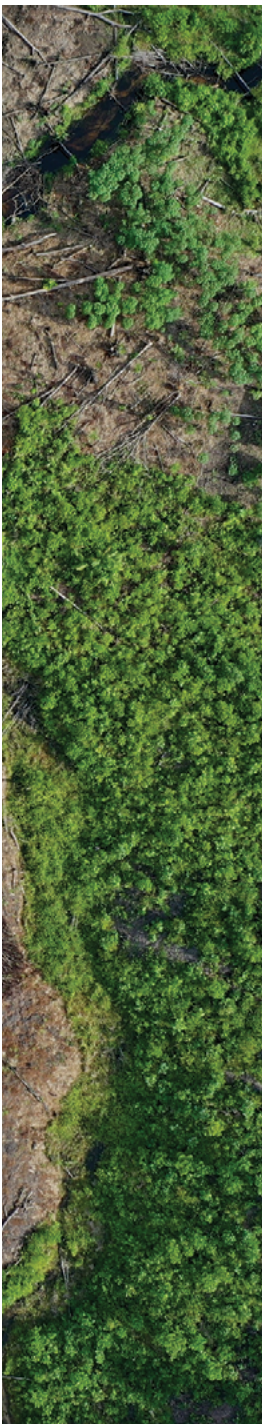


Photo: Rhett Ayers Butler.

five ha account for 94% of all farms supporting crop and livestock production. Recent estimates indicate that while smallholder farms account for a large percentage of total farms, they produce a disproportionately lower amount of food. Farms less than one ha account for 70% of all farms worldwide but only 7% of food production. Farms up to two ha account for 84% of all farms worldwide but only 35% of food production. Importantly, small farms in low- and middle-income countries control a larger share of agricultural land than in higher-income countries.

Forest ownership data is less up-to-date, partly because it is harder to identify them in global statistics. FAO's assessment in 2009 reported that smallholders held 32% of planted forest ownership (up to 100 ha), producing $2-4 billion in timber products annually. Studies in 2020 found that timber and wood-related products increased smallholder income, with a specific example in Uganda showing that owners increased their total consumption by expanding the area allocated to trees on their farms.

POTENTIAL FOREST LANDSCAPE RESTORATION

When looking at the potential for forest landscape restoration and agroforestry, of the 2.2 billion hectares of degraded land identified as potentially available for repair globally, 1.5 billion hectares may be best suited for mosaic restoration combining forests and trees with agriculture. Understanding the size and distribution of smallholder properties, these landowners play a critical role in restoring landscapes. Commercial planting of forests and trees in pure or mixed species plantation models can reduce the restoration cost per capita. There has been an increase in private sector interest in rehabilitation and tree planting. Still, not all investors will follow corporate social responsibility or consider other non-financial return investments.

Cost Data Retrieved from the Literature on Forest Restoration in Tropical and Subtropical Countries (23 Studies)

Intervention	Cost Category	Cost Range (USD/ha)
Assisted natural regeneration	Establishment	12-3,880
	Annual maintenance (years 1-5)	2-213
Agroforestry	Establishment (year 1)	125-1,240
	Annual maintenance (years 1-5)	5-720
Planted forests (for restoration)	Establishment (year 1)	105-25,830
	Annual maintenance (years 1-5)	167-2,421
Planted forests (commercial/ monoculture plantations)	Establishment (year 1)	34-6,888
	Annual maintenance (years 1-5)	43-150

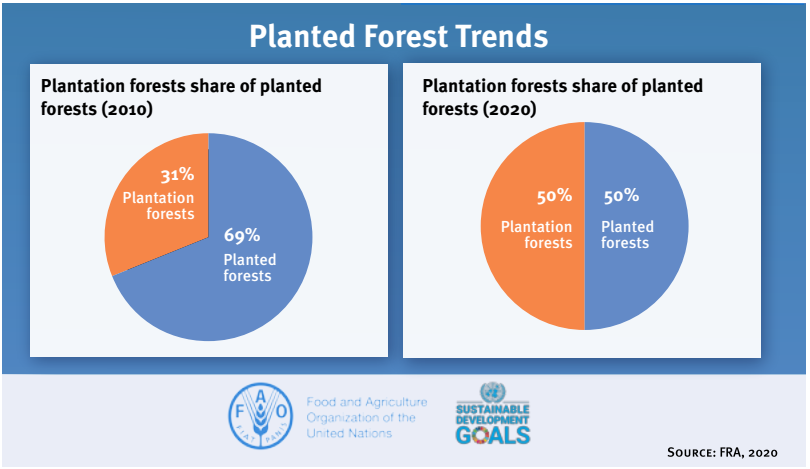
Source: FAO 2022 (based on **Bodin, B.**, **Garavaglia, V., Pingault, N., Ding, H., Wilson, S., Meybeck, A., Gitz, V. et al.** 2021. A standard framework for assessing the costs and benefits of restoration: introducing The Economics of Ecosystem Restoration. ***Restoration Ecology***).

FAO outlines the cost for planting and caring for trees through assisted natural regeneration, agroforestry, planted forests for restoration, and commercial planted forests. Figure courtesy of FAO 2022 (based on Bodin et al., 2021).

GLOBAL FOREST SECTOR OUTLOOK 2050

Another angle to consider is that wood product use and industrial roundwood demand are expected to increase. Based on FAO's Global Forest Sector Outlook 2050, the world will consume 37% more primary processed wood products in 2050 (an additional 31 billion cubic meters), and industrial roundwood demand will increase by 0.5 to 0.9 billion cubic meters. Furthermore, another 199 million cubic meters will be needed to substitute for non-renewable materials. In 2020, 54% of industrial roundwood came from naturally regenerated forests, whereas 46% came from planted forests. Projecting that to 2050, we know that the reduction of naturally regenerated forests will not increase substantially, so the additional supply will probably come from planted forests. To support growing demand, an estimated 33 million hectares of plantations will be needed, assuming a productivity of 8.3 cubic meters per hectare per year.

Between 2010 and 2020, intensively managed plantations have increased from 31% to 50% of all planted forests, while globally grown forest growth has decreased in all regions, particularly between 2015 and 2020. This is at the core of the discussion because it is essential to understand the relationship between planted forests and plantations when finding ways to increase planted forests and agroforestry practices across the landscape in the face of growing wood product demand and climate change. Smallholder forest and farm owners play an important role in implementing sustainable practices while increasing the production of diverse goods.



Between 2010 and 2020 plantations have grown to a 50% share of all planted forests globally. Figure courtesy of Thaís Linhares Juvenal / Credit: FRA 2020.

To find sources of additional supply for growing markets, FAO's Global Forest Sector Outlook 2050 found increased opportunities to produce timber and fiber from modern agroforestry systems and trees outside forests, to implement financially viable agro-forestry and silvopastoral systems with rising land prices, and to provide wood fuel through woodlots with fast-growing tree species. The latter finding is significant for Africa, where forest degradation and deforestation result from harvesting for fuelwood,

and the demand is expected to increase to 185 million cubic meters by 2050 for sub-Saharan Africa.

SERIES OBJECTIVES REVISITED

Tying it back to the main objectives of this series, our goal is to explore the meaningful role that smallholders play and will continue to play for forest landscapes worldwide. First, we must understand and build the case for including smallholders in forest-based ecological and economic interventions. We must incorporate an understanding of farmers' practices, management, and tree-planting decisions. Second, as we hear from speakers with field-based research programs, we hope to bridge science and field experience on forest and tree planting by exploring research results, policies, and constraints. Third, by demystifying the role of planted forests in sustainable landscapes, we hope to paint a more holistic picture of how planted forests can provide diverse values for communities, economies, and ecosystems in the face of increasing investment in tree-planting initiatives and the use of fast-growing species for plantations. Finally, we will address some critical factors for successfully growing smallholder forests and tree planting, including policies, markets, technologies, and silvicultural practices.

In summary, our discussions of smallholder tree and forest planting will address many diverse issues, such as increasing resilience to extreme weather events, fighting soil erosion and degradation, increasing crop productivity, increasing supply of sustainable wood products, reducing pressure on natural forests, and growing income and consumption for smallholders. These issues affect rural communities worldwide and radiate into the larger SDG goals FAO and the UN outlined. Building innovative solutions for forests and smallholders is essential to achieving the 2030 objectives, explained Linhares-Juvenal.

WATCH SESSION VIDEO

Bob Kazungu

LEARN MORE

Potential for Smallholder Planted Forests and Trees to Restore Degraded Mosaic Landscapes in Uganda

Presented: January 24, 2023

BOB KAZUNGU
ASSISTANT COMMISSIONER FOR FORESTRY, ASSESSMENT, & MONITORING, MINISTRY OF WATER AND ENVIRONMENT, UGANDA

Summary by: Raqib Valli

On January 24, 2023, Bob Kazungu, assistant commissioner for forestry, assessment & monitoring at the Ugandan Ministry of Water and Environment, and addressed the Yale Forest Forum on the potential for smallholder planted forests and trees to restore degraded mosaic landscapes in Uganda. Kazungu began by describing Uganda's geographic and demographic context, highlighting its relatively small size and high population density, which affect its land-use and resource-consumption patterns. Amongst other factors, this land-use pressure has been a significant driver of the decline in forested land in Uganda, which has fallen from 24% of the nation's land cover in 1990 to 13% as of 2019. However, this still represents an increase from a low of 10% in 2015.

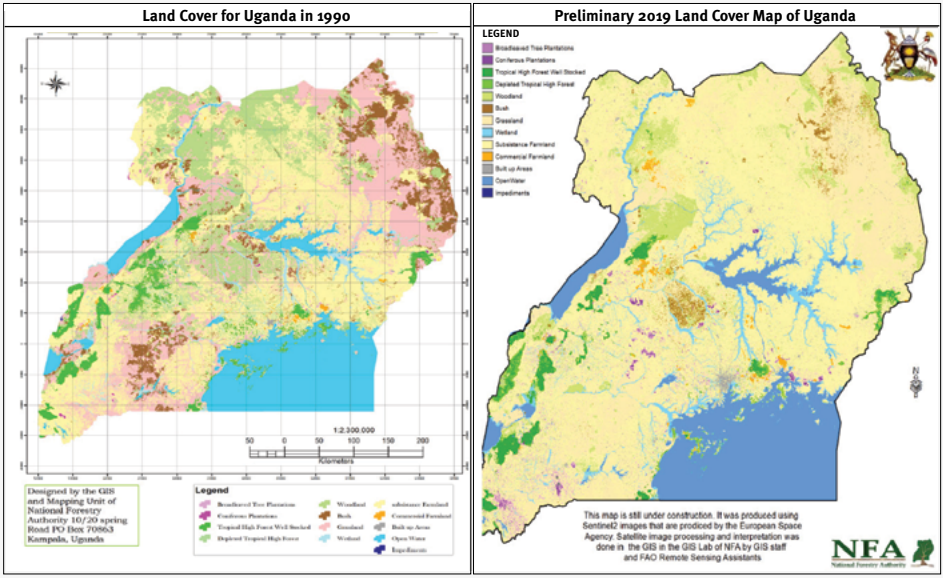
Significantly, this increase has been driven almost entirely by the drastic expansion of smallholder broadleaf and coniferous plantation forestry, which has more than offset the continued decline of Uganda's natural tropical hardwood forests and woodlands, explained Kazungu. As such, plantation forestry represents a crucial aspect of Uganda's goal of restoring forest cover to 24% of its land area by 2040, a target enshrined in its 'Vision 2040' development plan. Smallholder plantation forestry, Kazungu continued, is particularly important and uniquely suited to reconcile this proposed increase in forest cover with Uganda's

continued population growth and economic development for the following reasons:

1. It can help offset declines in natural tree cover.
2. It allows the increasing demand for industrial wood and wood fuel to be produced despite decreased space for growing trees.
3. It allows for balancing food production and energy supply on farmlands via agroforestry.
4. It can help Uganda meet its domestic and international climate change and restoration goals.

Country Situation: Land Cover Map for Uganda

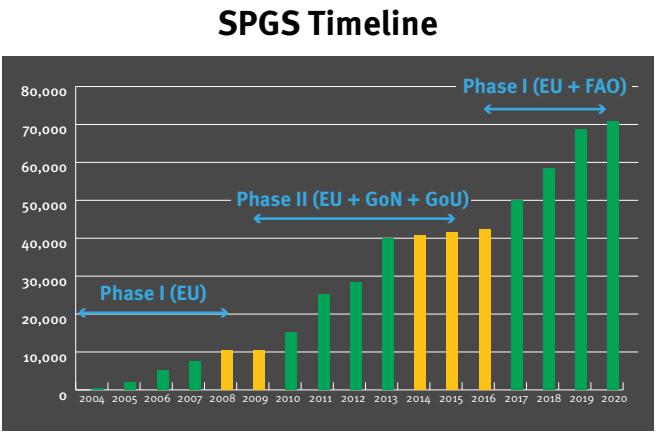
1990 and 2019



Uganda's forest cover has been reduced from 24% of total land cover to 13% in the last three decades. Planted forests and plantations play an important role in reforestation efforts. Figure courtesy of Bob Kazungu.

Crucially, Kazungu stressed the importance of maintaining an ecologically, politically, and legally sound environment to accompany the expansion of plantation forestry in Uganda. For the private sector to play a leading role in developing both commercial plantations and small-scale plantations on farms, the government must support and regulate this development, with particular emphasis on encouraging local participation and ensuring the distribution of economic benefits to women, youth, and people experiencing poverty.

Ugandan women have been traditionally disadvantaged in productive asset ownership and the control of productive inputs and credit. By refuting narratives framing forestry as a male-dominated field and continuing to acknowledge women for their critical contributions in gathering fuelwood, medicinal plants, food, and processing forestry products, Kazungu emphasized the opportunity for smallholder forestry reform to act as a vehicle for correcting historical injustices.



The three phases of the Sawlog Production Grant Scheme (SPGS) harness commercial and smallholder plantation forestry, which planted 81,000 hectares over 16 years to help meet domestic wood demand. Figure courtesy of Bob Kazungu.

Kazungu described an example of a successful multi-lateral funding scheme driven by the private sector that harnessed smallholder plantation forestry to allow Uganda to meet its domestic wood

demand. In 2004, the forestry sector in Uganda received funding from the European Union (EU) through a newly established program, the Sawlog Production Grant Scheme (SPGS), a joint initiative between the Government of Uganda and the EU. The scheme was used to advocate, empower, and build private tree growers' capacity through technical support and a retrospective grant, all while using a commercial, market-based approach. The project has successfully supported the establishment of 81,000 hectares of plantation forestry while providing technical training about tree growth, from establishment to tending and management. In addition, it provided a grant of UGX 850,000/ha (US $340/ha) for growers in the category of 25-500 ha and UGX 600,000/ha (US $240/ha) for growers with 501-3,000 ha. The money from these grants was only paid out after SPGS project staff conducted site visits to ensure the maintenance of high standards.

Despite the positive impact of initiatives such as the SPGS, severe constraints to expanding smallholder plantation forestry in Uganda remain, ranging from insecure land tenure and limited access to finance and markets to a lack of technical support for farmers not enrolled in technical schemes. As such, Kazungu concluded by outlining his prescriptions for the future of the smallholder plantation forestry industry in Uganda to maximize its role in supporting Uganda in achieving its ecological and socio-economic imperatives as outlined in Vision 2040.

Kazungu prescribes:

1. Focusing on value addition and growing the processing industry for both hardwoods and softwoods.

2. Policy improvements to incentivize smallholder planted forestry, primarily through out-grower schemes, as well as marketing and technical support.

3. Broadly adopting and promoting the use of forest certification schemes.

4. Encouraging the creation of cooperatives and associations to support registration, reduce isolation in smallholder forestry, and foster communication and networking opportunities.

Community members care for fruit, fodder, and timber tree seedlings in a nursery in the DRC. Photo: TFD.

WATCH SESSION VIDEO

Research and Innovation: A Review of the Critical Success Factors of Smallholder Poplar Cultivation in Italy

Stefano Bisoffi

LEARN MORE

Presented: January 31, 2023

STEFANO BISOFFI
FORMER SCIENTIFIC AND TECHNICAL DIRECTOR OF THE COUNCIL FOR AGRICULTURAL RESEARCH AND ECONOMICS (CREA) ITALY

Summary by: Ryan Smith

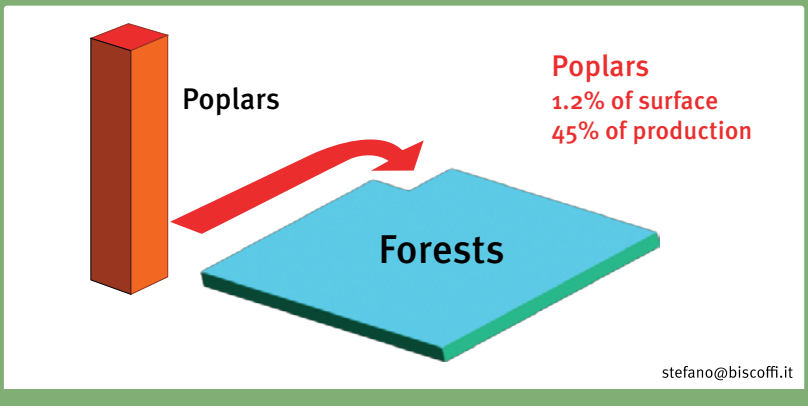
On January 31, 2023, Stefano Bisoffi, former scientific and technical director of the Council for Agricultural Research and Economics (CREA) Italy addressed YFF with a review of the success factors behind northern Italy's smallholder poplar cultivation. He provided an overview of the characteristics that make poplars a unique plantation species, the variety of end uses for poplar in Europe, a background on research and innovation in poplar cultivation, the environmental issues relevant to widespread cultivation, and perspectives on policies that support poplar cultivation in Italy.

Bisoffi began his talk by providing the context for smallholder poplar production in Italy, where poplars are considered an agricultural crop rather than a forest species. As a result, poplars are subject to a different legal status than forest trees, and permits are not needed to harvest them. Most poplar plantations are grown on land suitable for crops including alluvial plains throughout Northern Italy. Across the country, approximately 50,000 hectares are dedicated to poplar cultivation. This adds up to less than 1% of Italy's forested area, although poplar plantations account for 40-45% of the total roundwood grown in the country.

Bisoffi then explained poplar cultivation in Italy. Trees are propagated vegetatively using clones of genetically improved cultivars. Poplar nurseries in Italy are publicly managed. One- to

two-year-old root sprouts are pruned from the nursery stocks and planted on private farms in rows. As trees grow, limbs are pruned up to six to eight meters in height to ensure the quality of sawlogs. After nine to ten years, each tree contains about one cubic meter of timber. About 250-300 trees are planted per acre.

Industrial Roundwood Production in Italy



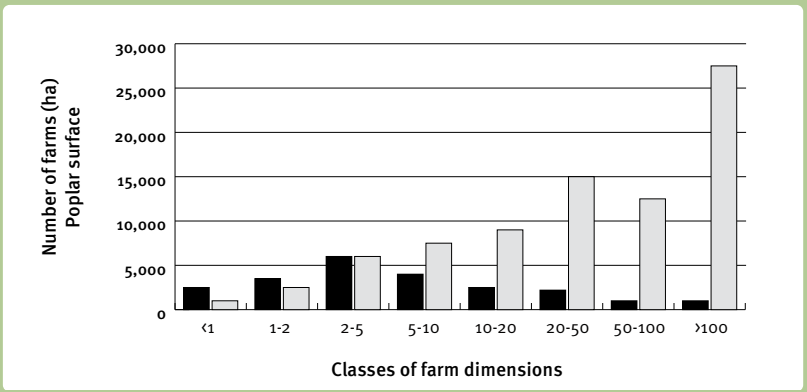
While planted poplar makes up only 1.2% of all forest area in Italy, almost half of all industrial roundwood is produced from poplar. Figure courtesy of Stefano Bisoffi.

Most poplar growers are small family-owned businesses, with less than 20 hectares of trees planted. However, while there are relatively few plantations larger than 20 hectares, they produce most of the volume of poplar grown in Italy. The distribution and orientation of poplar farms vary across regions. In the Piedmont, many farms have small plantations. In the mountainous Lombardy, there are fewer farms, but most of their land is planted with poplar.

Bisoffi explained the variety of end uses of poplar in Italy. Most trees are manufactured into plywood. The white, uniform wood is easy to work, is lightweight, and peels easily, making it an ideal plywood material. Furniture designers often find the engineered, laminated poplar wood an attractive option. Sometimes, poplar is used in particle board and covered with hardwood veneers from oak, cherry, or walnut. While most oriented strand board (OSB) is made from conifers, poplar has a more substantial weight-to-volume ratio, making it a viable option for the product. Sometimes, lesser

quality or small-diameter logs are used for crates and boxes for fruit packaging. Small-diameter logs and the tops of trees can also be used for pulp and paper, primarily in glossy paper, copy paper, and tissues. While the trees can be used for biomass, it is usually not economically profitable due to the high upfront costs of plantation establishment. Structural and laminated timbers continue to be predominantly conifers, although they can be built from poplar, as well.

Number of Farms with Poplars and Surface of Poplar Stands



While there are few large individual farms (20+ hectares) growing poplar in Italy, the majority of poplar stems are grown on those lands. Figure courtesy of Stefano Bisoffi.

Italian farmers decide whether to plant trees based on the number and size of other farms growing poplar, price fluctuations, importation of trees from other countries, and subsidies. When prices are high, many people plant poplars, ultimately contributing to future oversupply and low prices. Industry imports trees from nearby European countries to buffer against this price volatility. Subsidies – significant during the establishment phase of poplar cultivation – can make or break their profitability. During these times, donations can make poplar plantations very profitable. However, a farmer's decision to plant poplar is not based solely on its prices. Poplars are also considered desirable due to their low labor requirements. The decision to plant poplar also depends highly on the prices of alternative crops.

Bisoffi gave the attendees an overview of the history of hybrid poplar breeding. After World War II, seed from the American *Populus deltoides* was sent to Italy and hybridized with the European *Populus nigra*, producing several important cultivars. In the early 1970s, the North American Poplar Council, under FAO's guidance, distributed seeds worldwide for regional breeding and hybridization. Today, over 75 registered clonal cultivars exist, usually considered proprietary by those who developed them. The American *P. deltoids* and its hybrids with *P. nigra* grow best in Italy.

Disease resistance is considered the most crucial objective of poplar breeding programs. Resistance against insect pressure is less easily attained, although there has been some success in breeding resistance to the woolly aphid. Genetic technologies have also been found to be effective in developing clones with desirable characteristics, although public opinion has prevented these from becoming used in Europe.

Bisoffi then went on to describe the environmental services provided by poplar plantations. It is becoming increasingly popular to use poplar plantations in areas of transition between agricultural land and forest or in agroforestry operations. As a riparian buffer species, poplars can help capture nutrients before they reach waterways. They can also be used in soarable applications, planted in rows with annual crops cultivated in between. Poplar plantations also sequester carbon, with a net storage of 76–111 tons of carbon per hectare throughout the plantation's lifetime.

Bisoffi concluded his talk by noting that the economics of production are volatile and ever-changing, and the future of poplar production in Italy is still being determined. Producers must compete with famous growers in France and Hungary, and the Italian wood product industry competes with the Spanish wood products industry. Within Italy, poplar must compete with other crops for arable land. Climate change also poses a threat to poplar production. Poplars need an abundant water supply, and droughts caused by climate change threaten their viability. Despite this uncertain future, for now, Italian poplar plantations remain some of "the most technologically advanced and sophisticated in the world," according to Bisoffi.

WATCH SESSION VIDEO

The Role of Producers' Organizations

Presented: February 7, 2023

Charles Nyanjul

LEARN MORE

CHARLES NYANJUI
CHAIRPERSON, FARM FORESTRY SMALLHOLDER PRODUCERS ASSOCIATION OF KENYA (FFSPAK)

Summary by: Thokozile Changufu

The Yale Forest Forum welcomed Charles Nyanjui, national chairperson of the Farm Forestry Smallholder Producers Association of Kenya (FFSPAK), who outlined challenges, proposed solutions, and discussed meaningful takeaways to improve Kenya's agroforestry strategy. FFSPAK has co-chaired the development of the agroforestry strategy in Kenya, serving as a farm forestry umbrella organization providing quality services to smallholder producer organizations across the country.

Nyanjui began his presentation by sharing the vision for FFSPAK to champion the interests of farm forestry smallholder producers. He provided a list of the FFSPAK goals centering on smallholder farmers and providing benefits:

1. We facilitate the exchange of experiences and information and encourage networking among farm forest producer associations.
2. We support integrating the farm forestry perspective into forest laws, policies, and regulations.
3. We support capacity building for member associations and generate awareness of farm forestry.
4. We promote farm forestry to increase the number of trees per household and sustainable utilization of forests in Kenya.
5. We commercialize farm forestry to increase income levels and improve rural livelihoods.

6. We promote and defend the rights and common interests of farm forest owners.

The success of FFSPAK has included expanding membership from six affiliate associations with 4,500 members in 2013 to 15 affiliate associations and over 45,000 members in 2023. Nyanjui shared how FFSPAK has successfully established six marketing cooperatives with products on the market and is involved in value chains. The group has trained over 30,000 individual smallholder producers and expanded the secretariat from two staff members to eight with key programming in forestry, lobbying and advocacy, marketing, value chain development, and institutional capacity development. He credited existing partnerships as instrumental to the success of FFSPAK. Nyanjui called for enhanced partnerships with various stakeholders/supporters – including the Government of Kenya, FAO, WeEffect, and Agricord – and enhanced North-South cooperation.

Nyanjui described the challenges FFSPAK has faced, including overstretched internal technical capacity and limited support from government agencies. Additionally, he outlined limited gender participation as a challenge and cited the existing land tenure system, which favors men, as a critical factor in limiting gender participation. As a solution, Nyanjui called for shifting local mindsets to transform the perception of tree investment into a family issue. Other obstacles include the unregulated and largely informal market for forest products, limited knowledge of the value of products and marketing systems, poor quality germplasm leading to low productivity, and an unfavorable policy environment for tree growers and investors.

In concluding remarks, Nyanjui discussed how the organization plans to overcome the abovementioned challenges. These include plans to expand membership and organizational capacity to improve services to members. He emphasized that more work will be directed toward enhancing partnerships with government and other partners for better service delivery. He expressed keen interest in partners who are also interested in tree domestication and sustained tree management on farms. Nyanjui strongly believes that building and strengthening partnerships is integral to the future success of FFSPAK. Additionally, FFSPAK will work

Bird's eye view of planted crops and trees in Kenya. Photo: Nils11/Wirestock Creators.

on enterprise development through the promotion of business cooperatives and target underrepresented groups, including women and youth.

Nyanjui hopes to witness the expansion of smallholder producer organizations participating in commercial markets, stronger partnerships to improve service delivery, enhanced livelihood benefits to farmers, and the inclusion of underrepresented groups in forest farms and all parts of the value chain.

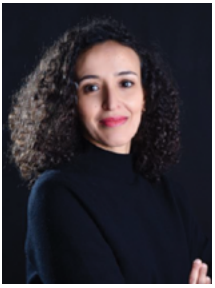
Participants in The Forests Dialogue's convening in Gabon discuss the potential of planted trees on a savanna. Photo: TFD.

Access to Financial Services

WATCH SESSION VIDEO

Presented: February 14, 2023

MARIEM DKHIL
SUSTAINABLE FINANCE SPECIALIST, CRÉDIT AGRICOLE DU MAROC (CAM)



Mariem Dkhil

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Summary by: Thokozile Changufu

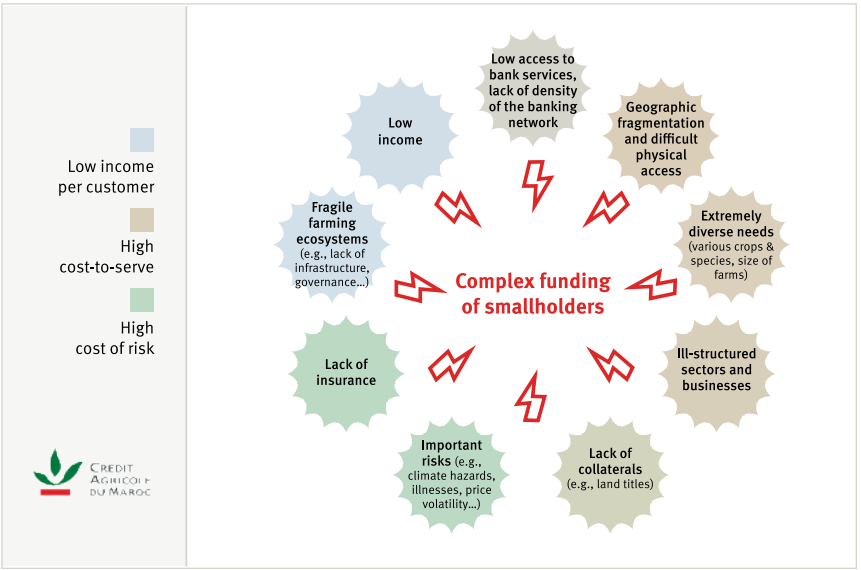
Mariem Dkhil, sustainable finance specialist at Crédit Agricole du Maroc (CAM), joined YFF to share insights to help tackle barriers to financing mechanisms and improve access to financial services for smallholders in Morocco's forest sector.

Created in 1961 with a political and economic mandate to finance agriculture and all activities related to the economic and social development of the rural sector, CAM is one of the oldest agricultural banks in the world. Dkhil highlighted that forests in Morocco are part of the private domain of the state, which affects how banks can support smallholders working in the forest. Moroccan law requires smallholders who live in neighboring forests to be part of a forest cooperative that can utilize and manage the resource. Further, the Water and Forest Agency uses participatory approaches through cooperatives that play important roles in the management, conservation, and development of forest resources.

CAM has developed a perennial model for the forest sector known as the Green Credit Model. Through this model, CAM links its payment cards to a fund. The bank then takes a commission from each transaction processed with a payment card to contribute to conservation and development in the forest sector.

Dkhil posed the fundamental question: why is it difficult for smallholders to get access to finance? To answer this question, she shared the figure on the following page.

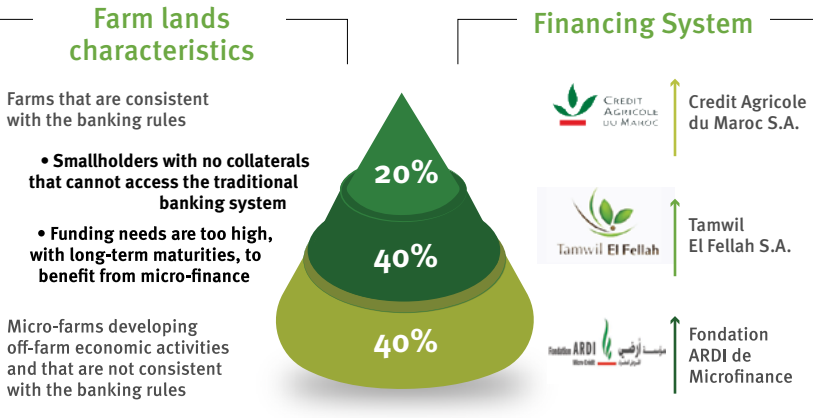
CAM works across the whole institutional ecosystem to overcome barriers to finance by first analyzing the smallholder's positionality within the financial ecosystem. Dkhil uses the pyramid example to



A suite of complex and interconnected factors makes it challenging for smallholders to access financing and funding for activities on their land. This includes low incomes as well as high risks and costs. Figure courtesy of Mariem Dkhil / Crédit Agricole du Maroc.

describe funding opportunities. The top of the pyramid represents a minority group of farmers, who follow the banking rules and are eligible for financing within the traditional banking system. The very bottom represents smallholders, who receive microcredits with short cycles. Then there is the missing middle, whose needs are not compatible with microfinance and who need long-term financing periods. CAM recognizes the missing middle as a place with high innovation potential.

Dkhil shared the importance of understanding how a bank would assess a project. For successful project analysis, CAM requires knowledge of the project holder, project components and rationale, the repayment capacity and indebtedness, and the collateral. CAM also evaluates the value chain in which smallholders are working and adapts financial offers based on the project analysis. The bank needs to make sure the project is viable to issue a green credit, and financial decisions depend on the risk appetite of the banking institution.



The middle 40% of the pyramid – smallholders who cannot access the traditional banking system and have too complex a set of needs to benefit from microfinance – are where Dkhil sees the greatest opportunity for innovation. Figure courtesy of Mariem Dkhil / Crédit Agricole du Maroc.

Dkhil shared a case study on date palm plantations to highlight a successful project financed by CAM. Date plantations often grow over the long-term and need long-term finance. Dates have a grace period of six years on their loans because that is how long it takes to cultivate the first harvest. CAM encourages farmers to intercrop to help finance long-term investment needs and maintenance of the forest. CAM also provides financial support in the value chain to make sure that the products enter the market. Smallholders need to reach a market and get maximum value out of products. CAM encourages smallholders to reach out to economic interest groups and cooperatives – or unions of cooperatives – to support smallholders and provide access to small equipment, transportation, and other resources.

Dkhil then discussed why long-term financing is an issue in developing countries. Challenges with long-term financing are a common theme across the forestry sector in African countries for the following reasons:

1. Long-term loans require long-term resources, and oftentimes, banks have limited deposits affecting the capacity to give loans.
2. Resources from other banks are expensive. High risk associated with central banks, inflation, political and economic instability, and monetary policy all can increase costs.
3. Lack of coordination among smallholders makes it difficult for a bank and other parties to step in. Dkhil briefly discussed blended finance as a solution for African smallholders. However, blended finance requires smallholders to already be organized and have a complete structured value chain, which many do not.
4. Intermediaries control prices and provide short-term finance at high-interest rates. CAM intervenes to provide support to smallholders by providing some operation loans, payment of fees and taxes, and finance for equipment. CAM aims to improve the added value of the product.

To conclude, Dkhil shared that CAM has successfully supported millions of smallholder farmers by helping reduce transaction costs. These efforts have helped increase the incomes of farmers, grown investment capacity, provided financial inclusion through financial literacy programs, and reduced illegal logging in Moroccan forests.

Community members show representative seedlings as part of discussion on smallholder planted forests in the DRC. Photo: TFD.

Unlocking Carbon Farming

WATCH SESSION VIDEO

Presented: February 21, 2023

JELMER VAN DE MORTEL
HEAD OF ACORN AT RABOBANK

Jelmer Van de Mortel

LEARN MORE

Summary by: Katie Michels

Jelmer van de Mortel is the head of Acorn at Rabobank. Rabobank was initially founded by farmers in 1898. Today, Rabobank is a multinational food and agriculture bank headquartered in the Netherlands and working in 38 countries, with programs focused on the food and agriculture transition, climate and energy transition, and the transition to a more inclusive society.

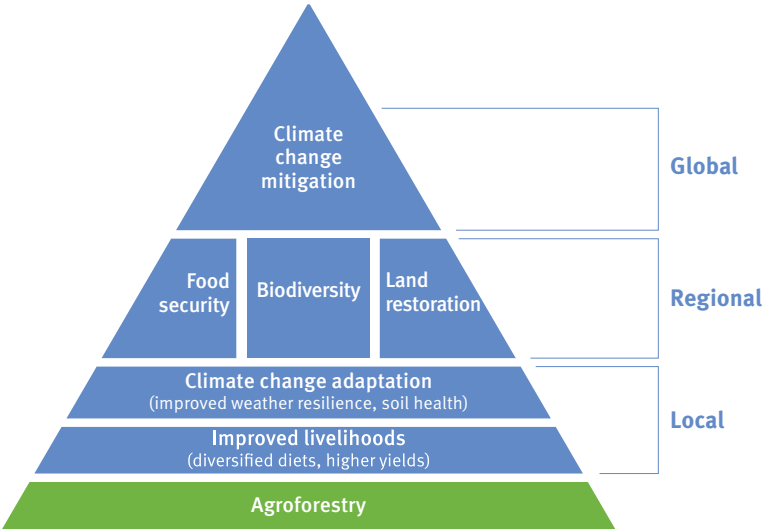
Acorn stands for "Agroforestry Carbon removal units for the Organic Restoration of Nature." Rabobank created this program to support smallholder farmers in the transition to sustainable farming by making carbon markets available and accessible to them. Rabobank identifies buyers, completes cost-efficient certification and monitoring (using satellite-based remote sensing technology), and ensures that credits are high quality and additional based upon their strict additionality criteria. Acorn always works with local partners that support farmers amongst others in the selection of the right agroforestry design, training, and logistics.

This program fits Rabobank's overall goal of supporting small farmers' livelihoods. Van de Mortel described four critical barriers to smallholder farmers' ability to scale up and reach financial viability: access to financing; technology, information, and skills; access to fair, quality markets; and access to quality inputs. Acorn sees agroforestry as a strategy to address each of these gaps to support economic development and smallholder viability. On a regional scale, agroforestry operations can support food security and improved livelihoods by diversifying diets and improving yields.

Acorn also believes that agroforestry practices have the potential to sequester additional carbon while supporting ecological co-benefits. They seek to increase farmer integration of trees into

their crop systems to increase carbon sequestration, mitigate and adapt to climate change, improve soil health and biodiversity, and restore land.

Benefits of Agroforestry

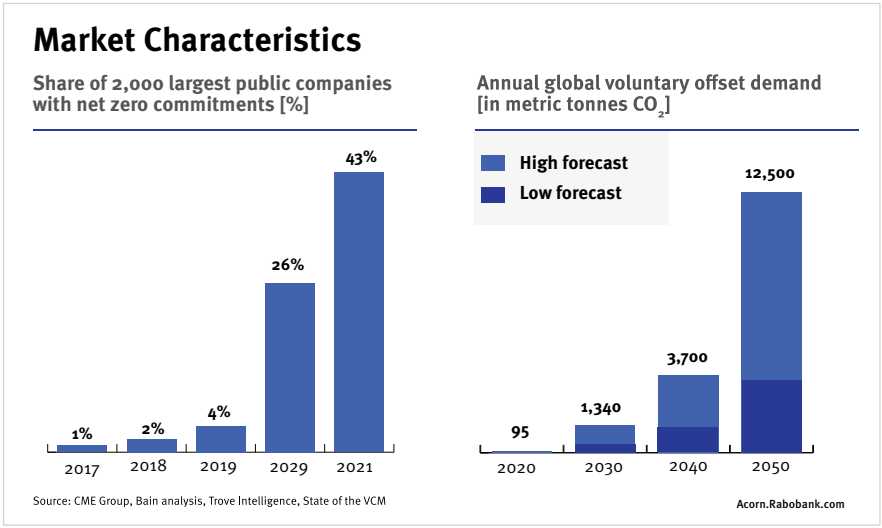


According to Acorn, agroforestry approaches lead to beneficial outcomes at local, regional, and global scales from improved livelihoods to climate change mitigation. Figure courtesy of Acorn, Rabobank.

Acorn uses remote sensing and LiDAR technology to calculate carbon stores on farmers' properties, and the program tracks biomass increases over time. Acorn's program and payments are focused on overall biomass increase rather than the increased size of individual trees. Plan Vivo certifies Acorn's carbon removal units.

Each credit Acorn sells is tied to a specific parcel of land, reducing the possibility of double counting. Credit buyers can visit Acorn's website to see the individual farm plots where their credits come from. Quality and true additionality are essential for Acorn, so they only sell credits based on tracked increases in biomass, according to Van de Mortel.

Local partners support farmer enrollment and adoption of new agroforestry practices. They also ensure the program is delivered in place- and culturally-appropriate ways. For instance, they help farmers pick tree species that integrate well into existing production systems and can be sold into local markets. These partners receive funding from Rabobank to provide technical assistance to farmers to help them sign up and shift practices to comply with the Acorn program.



As more public companies have made net-zero carbon emissions commitments, carbon offsets are becoming an increasingly important tool, supporting Acorn's funding model. Figure courtesy of Acorn, Rabobank.

Acorn's carbon program is administered by Rabobank and financed through the sale of credits: Acorn retains 10% of credit sales, gives 10% to local partners, and distributes the remaining 80% of proceeds to enrolled farmers.

This program builds upon the interest in nature-based solutions to ensure that smallholder farmers can access funding for NBS and carbon credits. Their goal is to support and enroll 10 million farmers by 2030; as of September 2023, they have enrolled over 200,000 farmers in Africa, South America, Latin America, and Asia.

WATCH SESSION VIDEO

Richard Donovan

LEARN MORE

Planted Forests and Smallholder Certification: Fundamentals, Status, Issues, and Opportunities

Presented: February 28, 2023

RICHARD DONOVAN
INDEPENDENT CONSULTANT; FORMER SENIOR ADVISOR, RAINFOREST ALLIANCE

Summary by: Ryan Smith

Richard Donovan, independent consultant and senior forest advisor for the Rainforest Alliance, spoke to YFF about certifications and their abilities to support smallholders. Donovan began his talk by acknowledging that "smallholder" includes diverse definitions. In the U.S., the term "private non-industrial forest owners" is used for forest owners who have around 200 acres or less of forestland. However, smallholders with forest gardens typically have as few as one to two hectares in places like Indonesia. The Forest Stewardship Council, one of the largest certification schemes, uses the term Small and Low Intensity Managed Forests (SLIMFs), specifically defined for each country to address this.

Donovan outlined important attributes of certification systems, including how they work. Certification schemes are typically public standards developed through stakeholder consultations, each with its own set of principles, criteria, indicators, and sometimes means of verification. Over 400 certification schemes exist. Certification is maintained through regular audits by internal actors, external consultants, and finally by a third-party certifying body. The results of audits are made publicly available. Sometimes, groups of smallholders can be audited together using a sampling methodology to distribute the cost of auditing among more producers.

Essential aspects of the certification process include the parties involved in its creation, the design of the certification benefits, and

the cost of an audit. Equitable access to resources, rights, and technology must be maintained.

Technical audit considerations include land tenure and ownership, the species in use, how various kinds of conservation values (environmental, sociocultural, or community needs) are incorporated into certification, the use of chemicals, and the ability to manage based on different carbon conservation or restoration models or other ecosystem services (e.g., water, biodiversity, etc.).

Numerous models exist for certifying smallholders, from individually certifying smallholders to empowering groups or communities. New models include licensing loggers or forest contractors and authorizing entire jurisdictions. Specific models include the Smallholder Access Program (SAP) in the Southern United States and the FSC regional standard for Southeast Asia — both of which are examples of simplified programs for including smallholders in FSC certification.

Donovan emphasized that certification should be seen as something other than a standalone solution. The stated purpose of certification is often to create market-based financial benefits for getting certified. However, while they can help reinforce smallholder and community organizational capacities, certification systems sometimes may be a good strategy for delivering market benefits from sustainable production. Complementary actors may be involved to ensure that benefits are delivered to the smallholders. Certification can be extremely challenging in places like central Sumatra, where farmers grow subsistence and market-oriented crops in forest gardens on one-to-five-hectare parcels. In the U.S. South, most forest owners are smallholders who can be certified to meet the sourcing needs of pulp and paper or packaging companies. Certifications can also happen by aggregating multiple landowners serviced by a logger.

Donovan noted that some think certifications should consider more subject areas. However, in some cases, less can be more. By reducing the number of criteria and indicators considered, more attention can be allotted to the most critical criteria for a specific region.

While not all certifications apply to all contexts, it is advantageous for certification schemes to learn from what has worked in other

contexts and apply the learnings to new systems. For example, forestry has a lot to learn from the certification of agricultural crops. However, sometimes, certification conditions are so unique that learning from each other may not be possible or easy.

Donovan asserted that certification doesn't need to be expensive. Jurisdictional, group, and landscape models can bring down the costs of certification or verification. Certificates need to provide value for smallholders, and there is a need to constantly re-evaluate certification methods to find new or different ways to reduce costs or provide intended benefits and incentives.

Certifications work best when economic players at the demand end (i.e., buyers) are fully vested in the certification model and willing to pay for the costs of certification and certified products. One way to increase the value of certification to smallholders can be for buyers, including retailers, to invest. When FSC was created, some stakeholders were more concerned with ecological sustainability or protecting Indigenous people's rights than market development. A desired outcome for some forestry operations was to use certification systems as a way of gaining credibility as good forest managers – something they couldn't obtain through other means. That said, successful certification systems are those that engage the commercial sector, particularly buyers, to actively compensate, incentivize, and support certified producers.

Donovan told the audience that while sometimes private sector certifications are seen as competing with government, in practice most systems attempt to work as a complement to government tools, policies, and actions, often supporting or reinforcing the application of existing laws. More equitable access to certification or certified markets can be gained through engagement with the government at the appropriate scale, whether on the state, provincial, or national levels. It is essential to identify the opportunities for different actors to collaborate early on, as demonstrated by government-supported forestry certifications in places like Wisconsin, Maryland, Indiana, Gabon, and Guatemala.

Smallholder planted forests are competing with big agriculture, conservation, and other land use interests in Gabon. This is an example of a planted oil palm landscape with ribbons of natural forest. Photo: TFD.

Donovan concluded by stating that, moving forward, certifications must innovate. Some hope forest governance will improve, but private sector companies and brands must complement what the government is doing and demand that their supply chain is accountable. The private sector and governments need to learn from each other and jointly shoulder the burdens, so they do not fall solely upon smallholders. From the beginning, certification systems and their various actors need to be flexible in their approach, identifying and addressing barriers to sustainability and legality, and creating better added value for people and companies to engage. Understanding smallholder needs and motivations is critical for certification success.

Savannas are natural ecosystems in Gabon, but communities discuss the pros and cons of planting agroforestry systems or oil palm plantations on them. Photo: TFD.

WATCH SESSION VIDEO

Technology and Risk Management in Private Forestry

Presented: March 7, 2023

Dianne Staal Wästerlund

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DIANNE STAAL WÄSTERLUND, PhD
SENIOR LECTURER, DEPARTMENT OF FOREST RESOURCES MANAGEMENT, SWEDISH UNIVERSITY OF AGRICULTURE SCIENCES

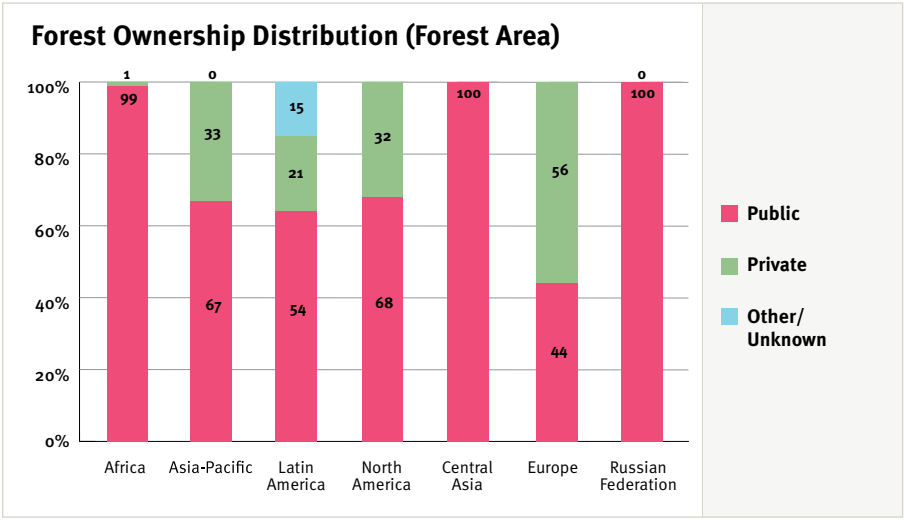
Summary by: Ryan Smith

Dianne Staal Wästerlund, senior lecturer at the Swedish University of Agriculture Sciences, spoke at the Yale Forest Forum about technology and risk management in European smallholder private forests with a focus on Swedish forestry. Trained as a forester, Wästerlund also owns a 23-acre remote forest.

Wästerlund began her talk by providing an overview of the European private forest management context. Most forests in Europe are under private ownership, and most forest properties are less than 50 acres in size.

Europeans own forests for many reasons beyond income generation. For example, forests are often passed down between family members. According to Wästerlund, in southern Sweden, a family would need approximately 500 hectares to support itself, and the number increases to closer to 1,000 hectares in northern Sweden. Forest owners continue to redefine why they hold onto their forestlands and the roles those forests serve in their lives. Today, many forest owners maintain their land for recreational purposes like hunting.

Most private forest owners do not seek professional advice about managing their forests. Few remote forests have management plans or defined management goals, and most landowners learned to manage their land from their parents. When forest owners would like to seek advice, they often must first figure out whom to ask and consider the backgrounds and objectives of those who could advise.



Forest ownership distribution varies by region globally. In Europe, more than half of forestland is privately owned, the highest percentage of any region. Figure credit: Dianne Staal Wästerlund.

Wästerlund described the demographics of European forest owners. Most are male, although sometimes ownership is split between brothers and sisters, and most are over 40 years old, with many older than 60. The age at which forest ownership transitions is becoming increasingly senior, a trend that has important implications for managing forests. Older forest owners are more likely to use technologies that do not rely on great physical strength. Many new forest owners didn't grow up working in forests and don't feel they have the skills or ability to manage their forests. To help them build new skills, they may seek professional help or join forestry organizations.

Wästerlund continued to describe who completes management activities in European private forests. Owners of small forest properties tend to do more work, whereas owners of large and medium-sized forests are more likely to hire contractors. In Eastern Europe, management is often done by the forest owners themselves, whereas in Western Europe work is more commonly done by contractors. In Sweden, forest owners often do precommercial thinning while harvesting firewood for

household use, whereas hired contractors typically do other forest management activities.

What Forestry Work Do Swedish Private Forest Owners Perform Themselves

Activity	Percentage
Final felling	none
Thinning	14%
Felling for household purposes	29%
Terrain transport	10%
Planting	23%
Precommercial thinning	49%
Site scarification	none

Swedish private forest owners tend to contract out much of their forestry work. Many will engage in precommercial thinning or felling for household needs. Otherwise, management is completed by third parties. Figure credit: Dianne Staal Wästerlund / SLU.

Technologies used to manage private forests are generally appropriate to the property's size and owners' strength and skill. Various equipment is available for private forest owners, the most common tools being chainsaws and weed eaters. Forest owners use tractors or other specialized equipment, such as ATVs, snow scooters, towing wagons, and sleds, to take firewood back to the house. Some forest owners even have skidders or tractors, although large equipment is typically not economical nor necessary for most forest owners. However, larger contractors more commonly use large equipment, such as harvesters, skidders, and forwarders.

Forest owners need more training to work with forestry equipment safely. While there are no statistics on the rates of injuries that forest owners endure while working with large equipment, many accidents occur.

Wästerlund acknowledged that it is essential for forest owners to be aware of and manage risks to their forests. These include

natural hazards, such as animal browsing, fires, snow breakage, insects, and fungi, as well as societal risks, such as changes in laws, prices, or taxes, or the risk of the government designating their land as a natural park.

In the case of climate change, forest owners generally are aware of the risks yet do little to mitigate them. They tend to accept risk as part of owning a forest and wait for their own experiences with its impacts to determine how to adapt their management. It is challenging to convince forest owners to mitigate climate risk preemptively. Wästerlund explained that risk management is separate from the forestry culture. In Sweden, forest owners identify a need for additional knowledge, financial limitations, and time constraints as barriers to risk management.

Institutional, technological, and demographic barriers also affect risk management. Supply chains and the demographics of existing stands are currently optimized for certain species, mainly spruce, prohibiting the adoption of more risk-averse species mixtures. The fact that forests are distributed across many small parcels also complicates management. Managing at the landscape scale would be more resilient from a climate risk perspective, but socially, it is not easy to coordinate across many different properties. These barriers make it difficult to adapt new management forms to mitigate modern risks.

TFD dialogue participants talk with a smallholder, who maintains a eucalyptus plantation and intercrops with fodder and cassava in the strip where participants are standing. Photo: TFD.

Wästerlund closed by discussing what it takes to reach forest owners in Europe successfully. The strategies that extension services use to disseminate information must align with how forest owners are accustomed to receiving and making sense of data. Forest owners rarely ask extension services for advice, so agents must proactively share information with forest owners.

WATCH SESSION VIDEO

Resilience to Climate Change

Presented: March 28, 2023

Stephanie Chizmar

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STEPHANIE CHIZMAR, PhD
RESEARCH ECONOMIST U.S. FOREST SERVICE, SOUTHERN RESEARCH STATION

Summary by: Isaac Merson

Stephanie Chizmar, research economist in forest economics and policy at the USDA Forest Service's Southern Research Station invited YFF attendees to think through how small private forestland owners in the U.S. could manage their land now and into the future to minimize risk and maximize resilience as the climate changes. Chizmar's research areas include the economics of natural and human-related forest disturbances as well as forest products markets and trade, while emphasizing policies and programs for forest landowners.

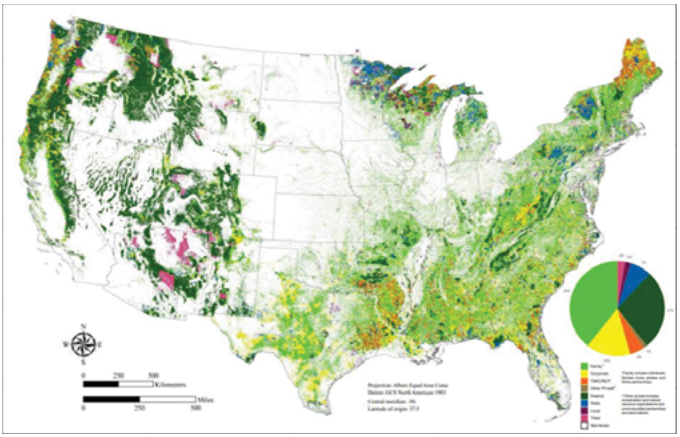
Chizmar's presentation consisted of six interrelated sections:

1. A background on forests in the United States
2. A history of tree plantings in the U.S., particularly those supported by the U.S. government.
3. An introduction to the interrelations of forests and climate
4. Risk and resiliency
5. Current policies and tools
6. Recent initiatives

Together, these elements paint the picture of the USFS's efforts to assist smaller landowners in responding to climate change and mitigating its worst impacts.

A BACKGROUND ON FORESTS IN THE U.S.

Chizmar began her talk by laying out critical background information on U.S. small forestland ownership, defining the differences between the interrelated classifications of forestlands, woodlands, and timberlands using the standards set by the Forest Inventory Analysis in the U.S. and the Food and Agriculture Organization of the United Nations globally. Timberlands are a subset of forestlands capable of producing 20 cubic feet of wood or more per acre per year. The U.S. has 822 million acres of forest and woodlands, 58% of which are privately owned.



Map credit: Sass et al. (2017)

Forests and Woodlands

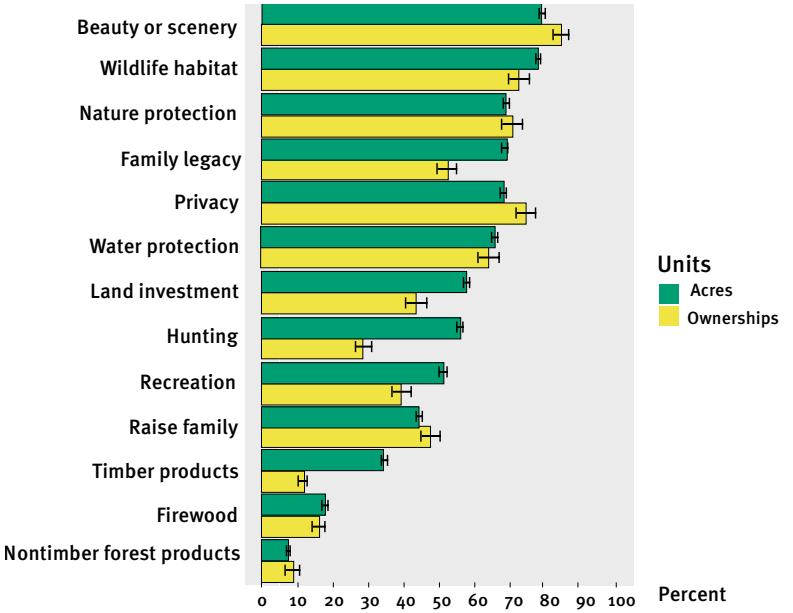
›822 million acres (333 million ha)

58% of forest and woodland is **privately owned**

38% of forest and woodland is **owned by families, individuals, trusts,** and **estates**

Forestland owners in the United States include families, corporations, TIMOs, federal, state, and local governments, and tribal nations. Figure: Sass et al., 2017.

When considering the various forestland owners in the U.S., the family forest owners (FFOs) category (bright green on map) is particularly relevant to smallholders, which include families, individuals, trusts, and estates. 6.6 million of these FFOs own one to nine acres, and 4 million FFOs own more than 10 acres. These forest owners listed beauty, wildlife habitat, and nature protection as their highest priorities, according to the 2018 National Woodland Owner Survey. However, the fourth value of "family legacy" is of particular interest as the climate changes and forestlands come under threat.



Estimated percentage of family forest acres and ownersips (10+ acres of forest land) by reasons for owning forest land, United States, 2018. Values include ownerships who rated reasons as important or very important on a 5-point Likert scale. Error bars respresent 95 percent confidence intervals (i.e., 1.96 standard error [SE]).

Data from 2018 shows the reasons why families own forestland in the U.S. Butler et al., 2021.

Chizmar explained that family forest owners partake in many activities on their land, including invasive plant removals, the creation of wildlife habitat, and timber cuts and sales (Butler et al., 2021) . However, 25% of FFOs did not perform any management. Limited awareness of the federal programs available to support management likely has led to lower participation rates in these programs.

A HISTORY OF TREE PLANTING IN THE U.S., PARTICULARLY THOSE SUPPORTED BY THE U.S. GOVERNMENT

The highest concentration of planted forests occurs in the southeast U.S., Pacific Northwest, and far northeast. In the southeast, the predominant planted species is the loblolly pine.

The history of tree planting in the United States occurred in three phases, as described by Stanturf and Zhang, 2003 :

1. **Initiation (1400s-1945):** From the colonial period through World War II, planting was limited and piecemeal, with little support from the government until the Great Depression.

2. **Acceleration (1945-1976):** Following World War II and preceding the 1976 Forest Management Act, improved economic conditions led to increased demand for pulpwood and fiber, which accelerated the planting of trees, along with a wave of government tax credits and incentive programs.

3. **Steady Growth (1976-1999):** During this time, the timber supply shifted from public to private lands.

One of the critical programs during the Initiation period was FDR's Civilian Conservation Corps following the Great Depression, which planted 3 billion trees and established shelterbelts to mitigate the effects of the Dust Bowl. In the Acceleration period, the Agricultural Act of 1956 created the "Soil Bank Program" to reduce crop production, protect farm income, and reduce soil productivity losses. This program was later re-named the Conservation Reserve Program (CRP), still active today, which compensates for the transition of some cropland to pasture, range, forest, and wildlife habitat.

The CRP was expanded in 1986 and 1996 to further focus on tree-planting, with over 2.3 billion trees planted. It was then bolstered by the 2021 Climate Smart Practice Initiative, which measured that the 21 million acres currently enrolled are responsible for mitigating over 12 million metric tons of CO_2 equivalent. These programs target both forest landowners and agricultural producers.

AN INTRODUCTION TO THE INTERRELATIONS OF FORESTS AND CLIMATE

Climate change can influence forest health by reducing tree resistance to insect damage. Additionally, temperature changes reduce water availability and usability, alter wildlife behavior,

Photo: leungchopan.

cause soil compaction (if forestry best practices are not followed), increase wildfire risks, and increase timber growth, which will be limited by water availability. However, emerging products and forest technologies, such as mass timber and biochar, offer some climate solutions that store or sequester carbon.

RISK AND RESILIENCY

Chizmar defined resiliency as the capacity of a forest to withstand external pressures and return to its pre-disturbance state over time. To this point, plantation forests face more significant risks due to climate change than primary forests due to their lower levels of structural and genetic diversity.

CURRENT POLICIES AND TOOLS

Chizmar explained how Climate-Smart Forestry Practices (CSF) can mitigate these risks and stresses to forests. USDA Climate-Smart Commodities grants reward landowners for practices that follow CSF. These practices include adaptive forest management and sustainable harvesting, which reduce forestry emissions and improve forest resiliency. These actions involve thinning and harvesting to limit over-crowding of trees, applying prescribed fire, planting diverse species or genetic traits, and site-preparation practices such as bedding or herbicides.

Other Farm Bill programs, such as the Conservation Stewardship and Environmental Quality Incentives Programs, offer funding to buy conservation easements on private land and cost-sharing programs for landowners, Chizmar explained. Emergency Forest Restoration Program funding allows landowners to respond to natural disasters like wildfires and hurricanes.

These federal programs are bolstered by state-level programs to incentivize best practices through cost-sharing, reduced property taxes, or required soil, water, and air quality protections such as stream buffers.

Finally, several private certification programs support small landowners: the American Tree Farm System, the Forest

Longleaf pine planted and studied by the U.S. Forest Service in Louisiana. Photo: USFS.

Stewardship Council's Small Forest Program, and the Sustainable Forestry Initiatives Small Lands Group Certification Module. Additionally, the USDA has Climate Hubs in each region of the U.S., offering education on climate mitigation and adaptation and the USFS Climate Change Resource Center.

Some challenges to these programs include a lack of participation due to a lack of awareness, challenges of technical capacity at the scale of small landowners, and the challenges of pursuing integrated systems such as agroforestry, which might not fit neatly into existing property-tax reduction programs focused explicitly on either agriculture or forestry. In a five-state pilot study, agricultural programs were more willing to welcome mixed uses.

RECENT INITIATIVES

Finally, recent initiatives include the American Forest Foundation and The Nature Conservancy's Family Forest Carbon Program, which pays landowners for CSF practices. Other recent initiatives include an influx of funding from the Infrastructure and Inflation Reduction Acts, which include an investment of $20 billion in current programs. These include the Climate Smart Commodities Program, which supports forestry and agricultural pilot projects' access to markets as well as technical and financial support for implementation, with a second pool of funding targeting small landowners. Additionally, this funding includes $550 million for competitive grants to forest landowners, with a preference for underserved and small forest landowners, and an additional $1.5 billion for state and private forestry prioritizing wildfire risk reduction and ecosystem restoration.

CONCLUSION

Chizmar emphasized that small forest and woodland owners have a significant role in adapting to and mitigating climate change. They can build from the long history of government technical and financial support for tree planting and forestry as well as the growing suite of resources available through recent initiatives outlined in the presentation.

WATCH SESSION VIDEO

Challenges in Landscape Fire Management for Smallholders: Why? What? When? How?

Kobsak Wanthongchai

LEARN MORE

Presented: April 4, 2023

KOBSAK WANTHONGCHAI, PhD
ASSISTANT PROFESSOR, DEPARTMENT OF SILVICULTURE, FACULTY OF FORESTRY, KASETSART UNIVERSITY, THAILAND

Summary by: Ryan Smith

Kobsak Wanthongchai, assistant professor in the Department of Silviculture at the Faculty of Forestry at the Kasetsart University in Thailand, joined the Yale Forest Forum to discuss fire management in northern Thailand. Wanthongchai began his talk by acknowledging that many people are aware of the negative impacts of fires. These include greenhouse gas emissions, ecosystem degradation, soil erosion, and biodiversity loss. However, Wanthongchai continued, the careful and intentional use of fire can also be an essential tool for land management.

In Thailand and other Southeast Asian countries, land managers use fire for agricultural purposes such as controlling weeds, preparing land for planting, and promoting edible non-timber forest products (NTFPs) like herbs and mushrooms. Fire has always been used to convert land from forest to agriculture, which can positively and negatively impact ecosystems and the environment. The pervasive opinion that all fire is destructive and "all ecosystems must remain unburned" has resulted in deeming fire as a tool for forest management illegal for any reason.

Wanthongchai then gave a brief overview of fire management, forest plantations, and forest management in Thailand. Three factors influence fire behavior:

1. Fuel properties, including fuel particles, fuel beds, and fuel moisture.

2. Weather and climate conditions such as temperature, relative humidity, and wind.

3. Topography, including slope, aspect, elevation, and other characteristics.

Most fire managers focus on fuel management to mitigate fires. Fuel reduction practices such as prescribed burning or utilizing fuel for other purposes reduce fire intensity and potential hazards. Fuel isolation practices such as firebreaks cut down on fuel continuity, limiting the ability of fire to spread. Methods that change the fuel quality, such as species with a higher moisture content that act as fuel breaks, can also slow or stop the spread of fire.

The most common species grown on Thai smallholder plantations is rubber, grown on 30-year rotations and used for furniture. Following rubber is eucalyptus, developed in short courses for pulp and paper; teak, the most valuable plantation species, grown in 30-year cycles and used for furniture and interior decorations; and acacia.

Wanthongchai then discussed the importance of employing a landscape approach when managing fire. A landscape is a large-scale mosaic of interconnected or repetitive units of larger forest patterns. When multiple land uses occur in the same landscape, fire can quickly spread from one area to another. For example, while burning one place for NTFPs, fire can escape and damage rubber trees nearby. Owners of rubber trees must create firebreaks to prevent escaped fire from burning their trees. On the other hand, forest policies preventing the use of fire can have unintended consequences for different land uses. The exclusion of fire from teak plantations can decrease timber quality and productivity.

Wanthongchai noted that transition zones between land uses can have conditions that differ from adjacent land use, such as lower relative humidity or higher wind speeds. These transition zones within the landscape matrix can impact the landscape's fire vulnerability. By considering the landscape as a larger unit rather than separate individual land uses, managers can more effectively mitigate the risks of using – or not using – fire as a management tool.

Eucalyptus trees in Paradise Park Farm, Koh Samui, Thailand. Photo: Hgalina.

Given current trends in extreme weather conditions and changing land uses, landscapes are more vulnerable to wildfire. With increased burning comes an increased risk of fire escaping. However, fire is necessary for some types of land management in Thailand, and if fire is going to be used, that risk must be adequately mitigated.

To mitigate fire risk at the landscape scale, all vulnerable areas – including agriculture, plantations, natural forests, and other regions – must be addressed. Different areas of the landscape require different strategies for managing fire. Wanthongchai stated that fire is managed through three main methods:

1. Participatory fire prevention programs, including firebreaks, fire risk mapping, and fire detection.

2. Prescribed burning, which is the intentional use of fire under controlled weather and fuel loads to achieve specific management objectives.

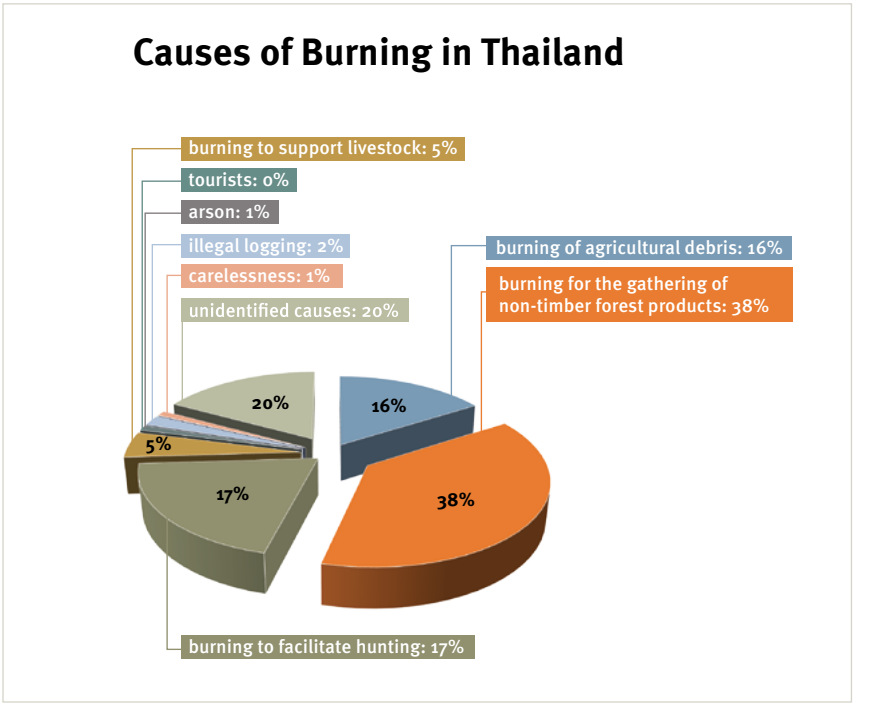
3. Integrated fire and water management, which could provide essential benefits to communities, including potential new income sources.

Fire detection programs involve people actively scanning the landscape for signs of smoke and fire. Now, satellites are used to detect fires in remote areas, enabling responders to arrive before small fires become large.

Wanthongchai described cases in which prescribed burning is used in Thailand. These include reducing fire hazards, preparing agricultural land for planting, controlling insect pests, promoting NTFPs, maintaining forest ecosystems, and improving cattle grazing land and wildlife habitat. More scientific support is needed to explore the full range of applications of prescribed fire in Thailand.

Many locals use fire to promote NTFPs, such as mushrooms and edible herbs, but scientific support is needed to verify that the benefits exist. Many villagers say that burning promotes mushroom production and that mushrooms from burned areas taste better than mushrooms from unburned regions. However, this has yet to be confirmed through scientific research.

Burning forest to collect mushrooms in Chiang Mai District of Thailand. Photo: Yulia.



While far more than half of all burning in Thailand is conducted with an agricultural or forest management purpose, arson and other illegal or harmful activities make up a notable percentage of fires. Figure credit: Kobsak Wanthongchai.

In teak plantations, prescribed fire is used to control pests. The teak beehole borer, the most significant pest, damages teak stems and decreases sawlog values. The borers have a one-year life cycle, with adults emerging between February and March. Burning teak plantations in April can kill young larvae. Education about the timing of burning for pest control in teak plantations is critical.

Wanthongchai closed by discussing challenges for fire management in the landscape. Changing climate and land uses affect fire conditions, increasing ignition risk. Additionally, fire management is sometimes in conflict with public health policies. Fires emit air pollution and haze in tiny particles smaller than 2.5 micrometers, known as $PM_{2.5}$. These tiny particles can cause severe human

health problems when inhaled. The impacts of smoke on people in urban areas have led to policies banning all fires. However, since land managers sometimes must burn their land, a methodology is needed to decide when burning should be allowed. Improved precision meteorology could help predict weather conditions during which burning should be allowed. The participation of local communities, including traditional knowledge and fire ecology, is critical for fire management to be successful.

In conclusion, burning has positive and negative impacts on local areas in Thailand. Balancing fire's benefits with potential adverse effects is challenging, and much more work is needed to solve conflicts related to uncontrolled wildfire and air pollution. However, landowners must address these challenges to continue to successfully manage their lands in Thailand.

Smallholders use fire to clear land and plant rubber trees, an economically important crop. Photo: TFD.

A Global Assessment of Tropical Reforestation Organizations

WATCH SESSION VIDEO

Presented: April 11, 2023

MEREDITH MARTIN, PhD
ASSISTANT PROFESSOR, DEPARTMENT OF FORESTRY AND ENVIRONMENTAL RESOURCES, NORTH CAROLINA STATE UNIVERSITY

Meredith Martin

LEARN MORE

Summary by: Ryan Smith

Meredith Martin, assistant professor in the Forestry and Environmental Resources Department at North Carolina State University, joined the Yale Forest Forum to discuss her research on assessing tree planting programs worldwide. Martin began by introducing the global interest in planting trees. Much of this interest has been focused on planting trees in tropical forests, which contain half of global aboveground carbon stocks and sequester up to 15% of global anthropogenic emissions, despite only covering 3.6 % of earth's surface. Tropical forests are exceptionally diverse, including approximately 50,000 tree species. However, tropical forests are also rapidly being deforested and degraded. An estimated 50% of tropical forests remain worldwide.

A global sense of urgency has been building around the need to protect remaining tropical forests and restore those lost. Several ambitious targets have been set. The United Nations launched the UN Decade on Ecosystem Restoration beginning in 2021. Countries have committed to restoring forests, public excitement has been building through the One Trillion Trees Initiative, and money has been pouring in from donors. However, there is still some pushback, with critics noting that these narratives are often oversimplistic and overestimate what trees can do.

Martin's research objectives were to analyze this global tree-planting landscape, answering who is planting trees, where they are being planted, how many, what species, with what methods, and toward what objectives. Martin and collaborators used Google searches,

online charity navigators, and NGOs such as tree-nation.org, which help organizations engage with charitable work, to compile a list of 174 organizations that are planting trees. Martin then compiled data for this research using publicly available information on the tree-planting organizations' websites.

Martin noticed a dramatic increase in the number of organizations planting trees in the last few decades. Most were founded after the 1990s, have headquarters in the Global North, and implement projects in areas with high tropical forests and deforestation in the Global South. The organizations claimed to have planted 1.4 billion trees since 1961. Based on this number, Martin estimates that it would take approximately 1,000 years to plant 1 trillion trees.

After analyzing what tree-planting organizations are self-reporting, Martin noted that, in general, organizations need to share more information about their practices. About 50% of the organizations do not specify their methods beyond stating they were planting trees. About 50% of organizations focused on agroforestry, and very few used natural or assisted natural regeneration (ANR) approaches. In total, almost 700 unique species were being planted. However, half of the organizations reported planting fewer than five species. Cacao, teak, moringa, coffee, mango, mahogany, and avocado were the most commonly reported species. These commercially important species were widely planted beyond their native ranges, potentially homogenizing future tropical landscapes.

Martin then analyzed rhetoric in mission statements and organizational goals, noting that many organizations aim to hit multiple objectives with their plantings. For example, rhetoric included the trees' contributions to "saving lives," capturing carbon, serving wildlife, and enhancing biodiversity, economic development, food security, and more. The most used words in mission statements related to people and communities, although words like trees, forests, and biodiversity were also used. Overall, organizations are planting trees to achieve many diverse objectives.

Martin asserted that tropical reforestation can and will achieve multiple benefits, but it is essential to recognize that there are tradeoffs with the species chosen to be planted. For example, focusing on utilitarian species such as coffee, cacao, avocado, and

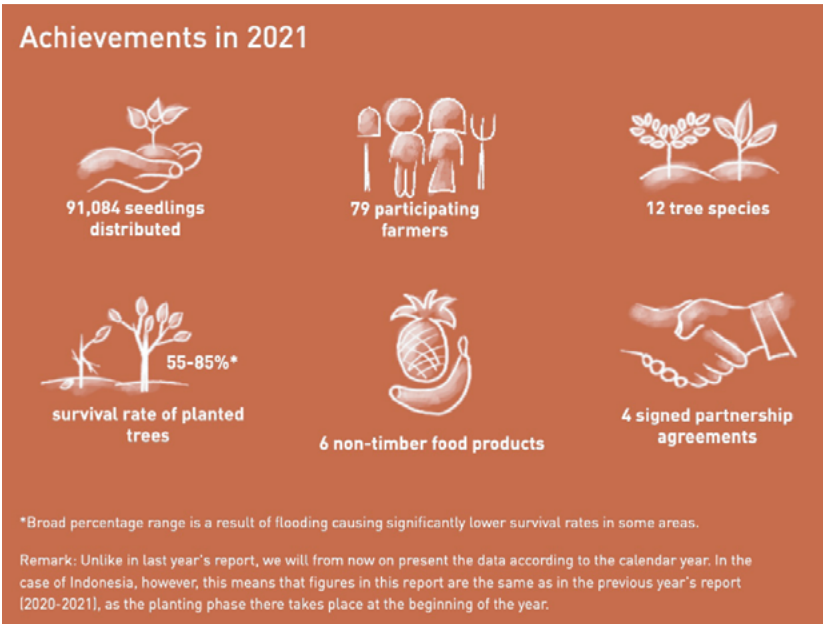
Teak tree.

other small-statured trees provides less carbon storage, wildlife habit, or biodiversity benefits. Martin says this does not mean economically essential species should not be planted. Still, one should acknowledge that when choosing one species over another, there are tradeoffs in the ecological and economic services they provide.

Species	Projects	Countries	Primary Use	Countries where Planted
Theobroma cacao	30	20	Fruit	Benin, Bolivia, **Brazil**, Burkina Faso, Cameroon, **Colombia**, Cote d'Ivoire, Democratic Republic of Congo, Dominican Republic, **Ecuador**, Ethiopia, Ghana, Guatemala, Indonesia, Mali, Nicaragua, Panama, **Peru**, Senegal, Togo
Tectona grandis	25	18	Timber	Bolivia, Brazil, Colombia, Costa Rica, Ecuador, Ghana, Haiti, **India**, **Indonesia**, Madagascar, Nepal, Nicaragua, Panama, Philippines, Sri Lanka, **Thailand**, Togo, Uganda
Moringa oleifera	24	17	Food / vegetable	Australia, Bolivia, Brazil, Burkina Faso, Democratic Republic of Congo, **India**, Kenya, Madagascar, Malawi, Mali, Nepal, Nicaragua, Nigeria, Peru, Tanzania, Togo, Uganda
Mangifera indica	22	13	Fruit	Bolivia, Ethiopia, Haiti, **India**, Indonesia, Kenya, Madagascar, Malawi, Senegal, Tanzania, Thailand, Togo, Uganda
Coffea arabica	16	10	Fruit	Colombia, Cote d'Ivoire, **Ethiopia**, Guatemala, Indonesia, Madagascar, Nicaragua, Panama, Peru, Tanzania
Swietenia macrophylla	15	10	Timber	**Bolivia**, **Brazil**, **Colombia**, Ghana, India, Indonesia, **Panama**, **Peru**, Timor Leste, Togo
Persea americana	10	7	Fruit	Cameroon, Ethiopia, Kenya, Panama, Peru, Rwanda, Tanzania

The most popular species in tree-planting operations are often fruit or timber producing species. These trees are planted throughout the tropics, often outside of their native ranges. Figure: Meredith Martin.

Martin then noted that very few organizations are monitoring tree survival. Only about 18% mention monitoring, and 5% mention survival rates. This is important because, while it is attractive to say many trees were planted, if only a small number survive, the results are very different than what would be seen if all grown trees survived. For example, one study in Sri Lanka found that less than 10% of planted mangrove seedlings survived. According to Martin, this lack of monitoring is also a missed opportunity to learn which methods are successful.



Fairventures Worldwide reports precise annual numbers, including the number of seedlings and species planted as well as survival rates. Figure courtesy of Meredith Martin / Fairventures Worldwide.

Martin then highlighted several case studies demonstrating the range of tree planting organizations. The few organizations focusing on natural regeneration are generally small local NGOs, which she suspected has to do with more significant donor pressure to plant placed on more prominent NGOs. For example, Samantha, a local NGO in Andhra Pradesh, India, had a focus on natural regeneration and much transparency in their reporting.

The organization's annual report included how many seedlings were raised and trees planted for the afforestation initiatives. It focused on utilitarian fruit, fodder, or commercial species for economic development.

Fairventures Worldwide, a mid-sized NGO based in Germany, works in Indonesia and Uganda. They included a specific count of 91,084 seedlings planted. Several farmers had emphasized livelihood benefits, and they were among the rare few to report 55-85% survival rates. The non-profit also demonstrated an increasingly popular structure with an associated for-profit partner, Fairventures Social Forestry. This for-profit company used the same rhetoric and was nearly indistinguishable from the not-for-profit entity.

A Peruvian farmer walks TFD dialogue participants through his small planted landholding, which includes a living hedge. Photo: TFD.

One Tree Planted is a large international NGO that fund their partners to plant trees. They also report precise numbers in their impact report. In their advertising, they focus on multiple benefits from restoration, such as economic and social impacts, carbon, biodiversity, water, and wildlife. They highlight tree planting for its ability to provide many benefits, yet they still need to recognize the tradeoffs in species chosen and types of projects implemented.

In the case of large NGOs like One Tree Planted, their relationship with partner organizations, including who is planting on the ground versus funding the planting, takes a lot of work to tease apart.

Large organizations tend to communicate their work by highlighting specific projects that are charismatic, such as promoting the potential for agroforestry to solve economic development issues while functioning as a restoration technique, taking pressure off forests. Martin emphasized that while these narratives are familiar, the automatic assumption that projects will deliver those benefits is not guaranteed. Planting agroforestry species must be coupled with investments in supply chains or market development. If no infrastructure is in place to safeguard against market booms and busts, agroforestry projects often fail to provide economic gains and ultimately lose smallholder or community support.

Many NGOs recognize that including smallholders and local people is essential, but the details of effective smallholder engagement and supply chain development still need to be included. Ecotierra, a for-profit, Canadian B-Corp working with coffee agroforestry and carbon projects in Peru and Colombia, was a rare exception that does publicly share specifics of their investments into markets. They built a state-of-the-art coffee mill co-owned by coffee cooperatives in their region.

Martin noted that tree-planting NGOs could play a significant role in homogenizing tropical flora worldwide. A critical bottleneck that must be addressed is the lack of available native species in local nurseries. There is extensive publicly available knowledge on the germination and propagation requirements of common species like teak and cacao, while information about many other native species in tropical areas is severely lacking. There is excellent potential to increase the capacity of local nurseries to diversify the pool of trees planted.

Finally, Martin concluded by acknowledging that there must be more connections between global organizations promoting tree planting, mid-level organizations funding tree planting, and on-the-ground communities doing the work. The tradeoffs of investments in and the benefits of tree planting should be made more explicit. Martin believes conveners such as the Yale Forest Forum are essential for connecting on-the-ground work with science and donors.

Mangrove forest in Sri Lanka. Photo: Sergey.

Areas of Conservation and Sustainable Use: A Conservation and Restoration Approach

WATCH SESSION VIDEO

Carolina Toapanta

LEARN MORE

Presented: April 18, 2023

CAROLINA TOAPANTA
PRESIDENT, FUNDACIÓN BOMACO (BOSQUES, MARES, Y COMUNIDADES)

Summary by: Ryan Smith

Carolina Toapanta, president of Fundación BOMACO, joined the Yale Forest Forum, outlining her organization's work to establish local areas of conservation and sustainable use in an ecologically threatened region of coastal Ecuador. Much of the landscape in which she works is owned by smallholders.

Toapanta first provided viewers with the context for conservation in Ecuador. BOMACO works in the dry forests of the Manabí province, the largest coastal province and third most populated in the country. Ecuador's dry forests have high endemism and are the ecosystem with the least remaining natural area in the country. They are also one of the most threatened forest ecosystems in the world, classified by the IUCN as critically endangered. Less than 10% of the area is protected, 70% of the forest is highly fragmented, and the government cannot provide significant economic support for protected lands in the region. Most conserved forests sit in private reserves, key biodiversity areas, and four inland protected areas. The government hopes to improve the conservation of natural areas in Ecuador. Still, most protected areas are in the Amazon, some are in the Andean region, and very few are on the coast.

The primary threats facing Ecuador's dry coastal forests are forest fragmentation, land use change for agriculture, and water and soil contamination. During the COVID-19 pandemic, poverty migration into the region's rural areas increased. There is a general lack of

enforcement of environmental laws, and local municipalities do not have authority over environmental control. Although agricultural use is legally prohibited in these areas, deforestation is still increasing. The government continues to promote irrigation and give out deforestation permits in conservation areas. The main crop driving deforestation in Manabí is dragon fruit, most of which is exported to the United States. Shrimp and corn also drive land conversion, and cattle ranching complements agricultural expansion. Forests in northern Manabí have many endemic birds, mammals, and reptiles, as well as Ecuador's most threatened forests.

BOMACO works with smallholders and local governments because they believe that for conservation to occur, it is most effective if efforts for protection come from lower levels of government to upper levels of government. They do this by promoting sustainable use, establishing private reserves, restoring forests, and protecting water sources in critical areas of coastal Ecuador.

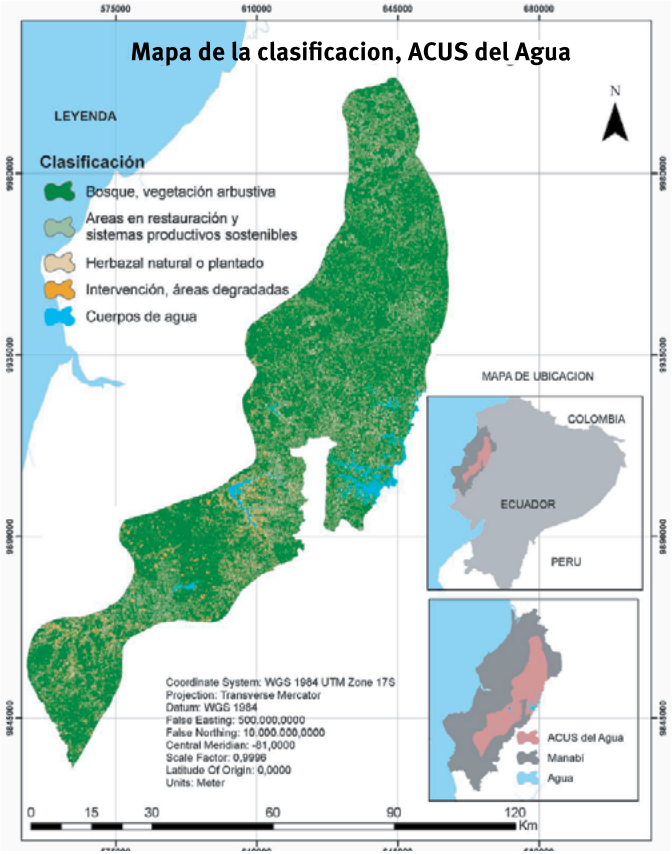
BOMACO also builds capacity by helping smallholders process and commercialize their crops to complement the conservation of other land areas. They map farms, designating areas of human activity, crop production, forest conservation, and passive and active restoration. Through their work, BOMACO teaches smallholders about living in a high conservation area, linking smallholders with others who can help them support forest conservation, navigate government programs, and obtain tax benefits for their work. BOMACO actively brings women into their trainings, which is essential because men own 80% of the land in the area.

BOMACO also works with associations of sustainable cacao, rice, and crab producers. They have identified and mapped 43 regional bio-entrepreneurships, most of which are currently selling in Ecuadorian markets. They are helping some of these enterprises reach international markets and are working to develop a brand for areas of sustainable use to inspire sustainable entrepreneurship and management in the region.

BOMACO assists organizations in first defining their sustainable agroforestry or organic agriculture objectives and then commercializing their products. For example, they connect smallholder cacao associations with chocolate producers willing

Smallholders in Brazil plant vegetables with papaya trees. Photo: TFD.

to pay higher prices to farmers who implement sustainable and organic practices or conserve forests on portions of their properties. They also work with an organization that trains rice producers to integrate ducks into their pest management, which also helps to provide increased soil fertility and supplementary income.



This map denotes areas that will stay as native forest (dark green), degraded areas in need of restoration (orange), and areas in which restoration and sustainable production take place (light green) within the ACUS del Agua in the Manabí Province of Ecuador. Figure courtesy of Carolina Toapanta.

BOMACO partners with local governments, helping them understand the importance of connectivity and how small protected areas can help achieve landscape connectivity. They took local government

leaders to COP-27 in Egypt, assisting policymakers to understand the broader significance of local environmental work. The trip enabled municipalities in Manabí to join the Governor's Climate and Forest Task Force, a collaboration of 43 state or provincial governments from 11 countries which share resources. Participation in the GCF taskforce helped link the Manabí government with a donor who helped them to establish a new area of sustainable use and watershed protection.

BOMACO helps local municipalities create Areas of Conservation and Sustainable Use (ACUs) through access to land use planning tools. Local landowners, governments, decision-makers, and organizations come together to identify water sources and critical natural areas to conserve and restore. The process informs the design of municipal ordinances and builds local organizational support for conservation and restoration. Municipalities are also trained to use remote sensing tools to identify early warning signs of land conversion. Creating ACUs helps exchange knowledge, establish zoning, and educate landowners and municipalities on environmental issues.

BOMACO's work enables smallholders to be seen by the Ecuadorian government and facilitates access to funding for conservation and restoration within areas of conservation and sustainable use. They help municipalities map locations with drones and sign conservation and restoration agreements with local smallholders. BOMACO's partners have identified at least 80 endangered species in the areas and have helped over 111 smallholders gain land tenure.

Toapanta noted that BOMACO demonstrates that ongoing institutional, legal, and political work can help promote the conservation and restoration of Ecuador's dry forests in Manabí. With 60% of Ecuadorian agricultural areas owned by smallholders, generating $820 million for the economy, existing measures must be strengthened to support smallholder economies and land use planning. Local municipalities show the most significant potential for implementing local change. Giving smallholders better commodity prices, improved traceability, land tenure, tax benefits, and formalized farm plans effectively changes land use in Ecuador's coastal dry forests.

Photo: donyanedomam.

Silvopastoral Systems: An Agroecological Approach to Sustainable Cattle Ranching

WATCH SESSION VIDEO

Presented: April 25, 2023

ZORAIDA CALLE
PROGRAM COORDINATOR, ELTI COLOMBIA; RESEARCHER, CIPAV

Zoraida Calle

LEARN MORE

Summary by: Ryan Smith

Zoraida Calle, program coordinator for the Environmental Learning & Training Initiative (ELTI) Colombia and researcher at the Center for Research on Sustainable Agriculture (CIPAV), spoke to YFF about applying the agroecological approach of silvopastoral systems (SPS) to ranching in Latin America.

Calle stated that cattle ranching occurs on more than 600 million hectares in Latin America, mainly in grass monocultures, which are inefficient in milk and meat production per hectare. Cattle ranching is the leading cause of environmental degradation, pollution, and greenhouse gas emissions in Latin America, and it causes numerous social problems, too. Calle asserted that by incorporating trees and shrubs into these low-productivity grazing lands, a practice known as silvopasture, society can address many of these problems associated with cattle ranching.

Calle explained silvopasture in simple terms. Cows evolved to eat the leaves of trees and shrubs as well as grass. This fact is evident by the extraordinary measures people take to prevent cows from eating leaves off the trees they plant. Silvopasture integrates trees and shrubs with grasses and herbs, returning cattle to the forested systems in which they evolved. This shift can provide many benefits including improved animal nutrition.

Silvopasture can take on many different typologies: scattered trees in a pasture, the most common system; living fences; mixed fodder banks that are cut and carried to feed livestock; and

intensively managed silvopasture systems (ISPS), in which the cattle directly graze plants such as nitrogen-fixing shrubs . Animals graze ISPS at high densities for short periods of time, followed by extended recovery periods. A single paddock may only have cows on it for 16 days a year and be in recovery for 349 days a year. Nitrogen-fixing shrubs can access deep water and nutrients unavailable to grasses and replenish soil nutrients lost as they drop to the ground or are excreted in animal manure. In Colombia, the common trees and shrubs planted in ISPS include *Leucaena leucocephala*, a nitrogen-fixing tree managed as a shrub; *Tithonia diversifolia,* an efficient phosphorus solubilizer; and *Guazuma umifolia*, a resilient, native fodder tree with a high concentration of nutrients, protein, and sugars.

Calle then shared the many benefits of SPS over treeless pastures, citing numerous studies in Colombia. Specifically, SPS in Latin America can significantly improve beef or milk productivity. When the El Hatico farm transitioned from conventional treeless pastures to SPS in the 1990s, it gradually increased milk yields from less than 8,000 to over 18,000 liters per hectare per year. Results improved so much that they stopped using fertilizer and irrigating. Production eventually stabilized at around 15,000 liters per hectare per year. El Hatico estimates that if they had never transitioned to silvopasture, they would be losing approximately $27 per hectare per month. Instead of operating at a loss, El Hatico is profitable and sells its products in organic markets. Another farm, Lucena, formerly used 450-500 kg of fertilizer per year, supported 3.5 cows per hectare, and produced 9,000 liters of milk per year before transitioning to silvopasture. After silvopasture implementation, the farm stopped using fertilizer, supported 4.5 cows per hectare, and produced an average of 15,000 liters of milk annually. Milk production even remained stable through years of irregular rainfall.

Silvopasture can also provide many benefits to climate, as emissions from cows grazed in silvopastoral systems can be reduced compared to those fed purely on grass. One study found that cows grazing *Leucaena* produced 30% less methane per kilogram of dry matter than those grazed on grass alone; much of the remaining emissions from cattle are offset by the carbon stored in woody biomass and soils. Another study found that soil carbon increases beneath tree crowns and outside the crown areas.

Activities on a silvopastoral farm in Guaviare, Colombia. Photo: CIAT/Neil Palmer, 2017.

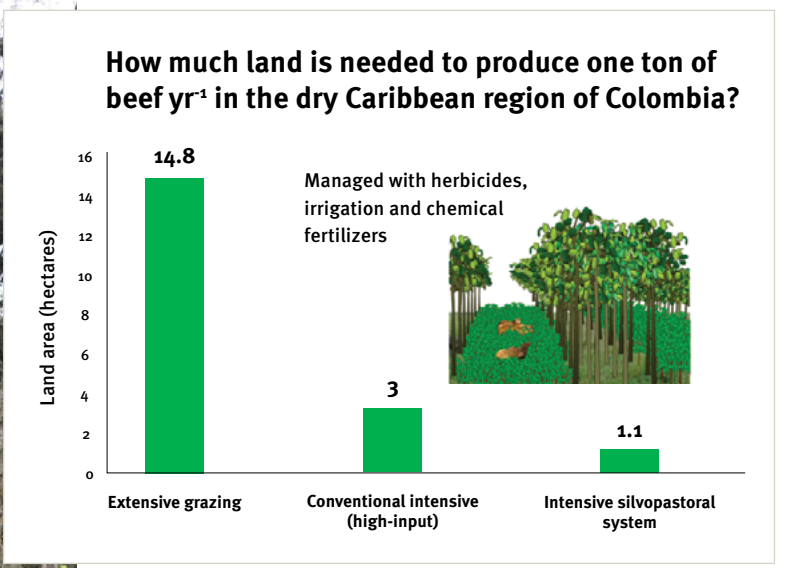
Trees and shrubs can improve animal well-being, too. They provide shade from the hot tropical sun and a habitat for dung beetles, which can bury manure in less than four days, interrupting the life cycle of cattle parasites. Silvopastoral systems benefit wildlife by providing more complex habitats than treeless pastures and other competing land uses such as sugar cane fields. This allows the silvopastoral systems to serve as corridors for wildlife to travel between patches of native forest.

According to Calle, the increased efficiencies of silvopasture are apparent. The ranching paradigm in tropical forests must shift to increase the adoption of SPS in tropical Latin America. Producing beef may require 15 hectares in dominant grazing systems, three hectares in intensively managed conventional methods, and only 1.1 hectares in organic or agroecological intensively managed silvopastoral systems. Improving agroecological efficiencies is what increases productivity. The inputs into the system are natural processes themselves – increased photosynthesis produces more biomass, bacteria in shrub roots add nitrogen, and the shrubs accumulate nutrients in soils. Calle hopes farmers can release marginal lands for ecological restoration by transforming farms, raising yields, and improving ecosystem services using agroecology.

Calle asserted that while many technological tools exist to assist restoration, building trust with landowners is critical. Extension workers must be able to relate to farmers. They must be aware of how gender, age, and cultural issues influence learning. They must also be able to sit down with farmers and rethink land use to achieve the desired change in livestock production. However, Calle said, these skills are not typically taught in Latin American universities. Projects must allocate funding to extension because much of the change that needs to occur is cultural.

Calle highlighted the Colombian Sustainable Cattle Ranching Project (CSCRP), the most significant effort to scale silvopastoral systems in Latin America. The program established pilot farms and supported farmer-to-farmer training on silvopastures in five regions of Colombia. The pilot farms were carefully chosen. The farmers had to have a strong sense of belonging to the land and be innovative, curious, familiar with risk, and open to sharing knowledge with other farmers. They also were required to share

investment in implementation, engage in participatory research, demonstrate commitment to innovation in sustainable livestock ranching, and participate in transparent intergenerational knowledge exchange. Many of the farmers were women.



The land area required to produce one ton of beef per year in conventional systems versus ISPS. ISPS requires substantially less land area to produce beef while also using far fewer inputs. Figure courtesy Zoraida Calle.

Monitoring revealed that the CSCRP provided many benefits to farmers. The program reached 4,100 families and created over 13,000 ha of living fences, over 1,900 ha of paddocks with planted trees, over 18,000 ha with regenerating trees, and over 4,240 ha of ISPS. The carrying capacity on farms increased by an average of 26%, milk production increased by 29%, and 1.5 million tons of CO_2 were sequestered. The cattle birth rate increased, and ISPS proved to be the most profitable system.

An economic analysis found that simple silvopastoral systems, such as living fences or scattered trees, cost $500-$618 per hectare to implement. More sophisticated ISPS, fodder hedges, or fodder banks cost $1,206-$1,530 per hectare to implement, including the costs of electric fencing and water distribution systems.

The project measured positive impacts on biodiversity, too. ISPS with large trees supported over 60% of the dung beetle species found in nearby forests, and 275 bird species have been recorded in the silvopastoral systems.

Enabling its success, the Colombian Sustainable Cattle Ranching Project employed the following strategies:

1. **Strong foundations:** Promoting a standard set of principles and values around SPS.
2. **Building knowledge:** Breaking down the grass monoculture paradigm by bridging scientific and traditional knowledge.
3. **Action:** Designing and implementing complex and profitable systems.
4. **Successful examples:** Establishing a network of pilot farms across scales and ecosystems.
5. **Influencing society:** Including policymakers, government agencies, and consumers, and promoting international cooperation between actors.
6. **Economic, environmental, and social monitoring:** Continuously improving sustainable farming systems.
7. **Incorporating new challenges:** Climate change, evolving markets, changing values, etc.

Calle closed by acknowledging that sustainable cattle ranching is a complex problem that requires complex approaches. To be successful, we must embrace biodiversity and complex management, strengthen the relationship between agroecology and restoration, and integrate human values into food production. We must also continuously empower and engage women and youth and support intergenerational knowledge exchange through this process.

CIPAV silvo-pastoral system in Colombia. Credit: Alliance of Biodiversity International and CIAT.

Conclusion

By: Wyatt Klipa and Arun Dayanandan

Throughout the Yale Forest Forum speaker series on "Smallholder Planted Forests and Trees for Climate, Restored Landscapes, and Livelihoods," global leaders and stakeholders in the field of smallholder planted forests addressed the state of these global forests and their needs. In doing so, the speakers highlighted the nuanced approaches required in forest policy, markets, and technology. By bringing together researchers, practitioners, and the general public, the Yale Forest Forum served as a catalyst for the continued collaboration of stakeholders in smallholder planted forests, both for short-term gain as well as in addressing future global concerns. Smallholders face many challenges in keeping their forests as forests, including a changing climate, volatile markets, unclear land titles, and financial pressure. However, smallholder planted forests also stand to provide essential environmental services, carbon sequestration, food and wood production, and stable livelihoods for rural communities.

The spring 2023 speaker series explored the future of smallholder planted forests, the tools that can help support smallholders and their land, and the myriad ecological and economic benefits that smallholder planted forestry can produce. Linhares-Juvenal outlined the various challenges faced by smallholders globally and the potential for planted forests to have an impact on the global bioeconomy, ecological systems, and carbon sequestration. Kazungu explored the way in which smallholder planted forests can contribute to the restoration of the forest mosaics in Uganda and policy approaches that may enable smallholder contribution to these efforts. Bisoffi noted that technological innovation has enabled smallholders in Italy to get ahead in poplar production. Nyanjui identified producers' associations as an effective forum for collaboration, knowledge sharing, and capacity building for smallholders. Dkhil shared that smallholders often have challenges accessing finance due to unclear land title, low incomes, unique

Moorland Vegetation in Rwenzori Mountains Uganda. Photo: Dedan.

needs, and high risks to their assets. Van de Mortel concluded that the international carbon market can be used as a tool to financially support smallholders engaging in agroforestry operations. Donovan shared that while achieving a certification can come with a high upfront cost for the smallholder producer, certain approaches, such as group certifications or passing the prices on to consumers willing to support certain practices, can make certifications a financially viable and beneficial option.

Wästerlund noted that across Europe, many smallholder forest owners tend to not adapt their management until they experience the impacts of climate change themselves. Chizmar presented the challenges that smallholders in the United States have in adapting to climate change, including a lack of access to information, limited capacity to adapt practices, and inflexible tax-incentive programs that only allow for either agriculture or forest land and not blended approaches. Wanthongchai shared that smallholder fire management is often limited in practice by environmental policy, both in Thailand and beyond. Martin explored the ways in which tree-planting organizations do – or do not – monitor and report the impact and scale of their work and identified a need for more transparency. Toapanta shared that incentives from local municipalities can be most effective in helping smallholders to restore and conserve threatened ecosystems. Calle shared that in many circumstances, a transition from a traditional cattle ranch to a silvopastoral system with planted trees can increase farm productivity and provide an array of other environmental benefits.

As natural forest degradation increases globally, planted forests – especially those managed by local community members – will continue to play an increasingly important role in the state of forestland globally. We hope that this *YFF Review* may serve as valuable knowledge on the state of smallholder planted forests today and a guide to the future of these lands and communities.

Acknowledgements

Thank you to our collaborators at the Food and Agriculture Organization of the United Nations. We also send a gracious thank you to all the speakers who participated in this series, for lending their time and knowledge so that we may more deeply understand the issues that smallholders with planted forests face and the ways in which these types of lands and people can be best supported. We are also grateful to each of the student seminar attendees who authored summaries of each speakers' session.

This community-developed nursery's purpose is to get trees onto farmers' land, where trees may not have been previously incorporated. The cost of seedlings is often subsidized. Photo: TFD.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