



Tree genetic resources



The CGIAR Research Program on Forests, Trees and Agroforestry (FTA) works on tree genetic resources (TGR) to bridge production gaps and promote resilience to provide solutions for the more effective safeguarding, domestication and delivery of these resources by and to farmers, foresters and other stakeholders. This leads to diversified and more productive options for farming systems, to more varied diets and improved nutrition, to strengthened value chains for tree products, and to increased smallholder farm incomes. Importantly, the right TGR management decisions play an important role in enhancing the adaptive capacity of farm and forest ecosystems to cope with climate change and in countering landscape degradation.



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Opportunities and challenges

Trees are key for the provision of important products such as fodder, food, fuel, medicine and timber, services including soil health and fertility, and carbon sequestration. Appropriate management of TGR is key to devising productive and sustainable landscapes, including for forest restoration, as articulated in the Bonn Challenge. Bringing appropriate wild trees into farms for production, with appropriate market development, has tremendous potential to increase food security and nutrition, improve the agroecology of farming systems, reduce pressure on wild resources and raise agricultural incomes. Integration of trees into farms thus has an important role for sustainable intensification and more resilient agricultural ecosystems, and as such supports the Global Action Plan for Agricultural Diversification.

Yet, this potential is often far from being tapped. This is because species are often considered as monolithic units without proper consideration of the adaptive and productive genetic variation within them. In many places, trees are cultivated that are not matched to context, with poor yields and low-quality traits. This has led to inadequate results in

preventing landscape degradation. In other places, agricultural intensification based on a few crops has paved the way for the simplification of landscapes and diets. This could have been prevented if more attention had been given to making food trees more productive, to support their integration into cropping systems. TGR management and use, in many countries, suffer from inadequate models and implementation tools, and lack support mechanisms for effective testing and upscaling.

Important knowledge gaps, which are critical for the impact pathways, include where TGR hotspots occur, how to value TGR, how to best design and implement conservation strategies for these resources in the face of multiple threats, what tree domestication approaches best fit environmental and stakeholder contexts, and the effects of domestication on the sustainability of farming landscapes. Gaps in knowledge and in the application of knowledge also include how to ensure that growers can access the right tree planting material to meet their needs, using efficient, equitable and adaptable methods to do so.



FTA's role in tree genetic resources and key questions

Due to fundamental biological, ecological, economic and legal reasons, TGR management systems present similarities as well as important differences with respect to annual crops' genetic resources.

Considering these factors, FTA works to improve TGR management by acting on three essential dimensions:

1. Safeguarding TGR in the wild and in anthropized forest and farm systems, exploring how to best preserve diversity and ensure its continued availability for use
 - Where are key locations for TGR conservation, based on richness in diversity, option values for use, and the threats faced by the resources?
 - What are effective ways to conserve these TGR in different socioecological, legal/governance and production system/ landscape contexts?
 - How can appropriate safeguarding approaches be mainstreamed into wider conservation strategies for forests and trees?
2. Tree domestication, identifying promising wild tree species and bringing them into cultivation, as well as improving the performance of already domesticated trees
 - What are appropriate methods to bring trees into cultivation for the first time, or to allow for wider cultivation when already domesticated?
 - In domestication, how can participation by, and the benefits to, local communities and the first users of trees be effectively ensured?
 - When trees are domesticated, how can some of the pitfalls observed with annual crop domestication, with potential to lead to the homogenization of production systems and reduced sustainability, be avoided?
3. Tree planting material delivery, investigating how to ensure that the right material reaches growers efficiently
 - How can approaches for delivery of tree planting material be more efficient, cost-effective and equitable, and how can this be properly assessed?
 - How can planting material delivery systems be made more adaptable to changing grower requirements and altering environmental conditions?



What is FTA researching in TGR?

Safeguarding diversity

This research includes the genetic and phenotypic analysis and spatial mapping of patterns of tree genetic diversity. It also includes finding out how the availability of tree genetic diversity conditions the wellbeing of rural people in forest and farm landscapes. Research seeks to reexamine the current mainstream theory governing TGR conservation practice, such as the contested assumption that the cultivation of trees for timber and commodities is sufficient to safeguard the related genetic resources. FTA seeks to determine the conditions when such current conventional wisdom holds and when it does not, based on particular production systems,

landscapes and tree biologies. FTA also performs economic analyses to determine the option value provided by TGR for the future production of key tree products and services, to more adequately assess the value of land use for safeguarding of wild relatives of tree crops. In addition, combining varied information sources on the location and value of, and threats to, TGR allows FTA to develop and out-scale spatially explicit safeguarding tools, such as online maps that indicate conservation priorities. Safeguarding research involves women in setting priorities based on their particular knowledge and future needs.

Domestication

Given the objectives of production and/or environmental service provision, determination of priority tree species to target for domestication, this requires an inclusive approach with a wide range of stakeholders along the value chain. FTA develops the procedures that can be applied to undertake this species prioritization in different contexts, as well as, within the prioritized species, identifying the traits to focus on. Research gives full attention to the involvement of women and youth in setting values, species priorities and traits for selection, particularly for tree foods that have a clear role in supporting family nutrition and the incomes of women.

FTA also analyzes the utility of different methods, including advanced genomic and participatory approaches, for tree domestication, and finds out which methods work best in which context and for different objectives (such as to enhance production, increase profitability, improve farm-level resilience or better support landscape restoration). The full engagement of women in participatory domestication approaches and in business opportunities in value addition is supported through testing approaches that address the structural constraints that limit their participation. FTA provides a small range of well-worked pilot examples of domestication pathways that can serve as models for other tree species in similar contexts. FTA also provides a range of guidelines, training tools, online

databases and maps to support tree domestication, which through promotion networks spread best practices globally.

Domestication covers the processes involved in bringing new trees into cultivation, as well as in the further enhancement of cultivation of trees already on the domestication pathway. This involves genetic selection, may involve formal breeding, and includes research to understand a tree's biology, in order to effectively propagate and manage it. From a genetic perspective, the level of improvement that is possible through selection and/or breeding depends on the trait for improvement, the way the tree is propagated, and the production context and method of evaluation. Genetic gains can be high for trees because of their large gene pools and their limited (or no previous) histories of domestication. High variation in yield and food quality is, for example, observed in indigenous food trees such as *Allanblackia* species in Africa. Domestication work in FTA is linked to support for value chain development: for instance, through the development of a novel public–private collaborative platform to support domestication and market integration that has involved FTA and a wide range of partners, oil from the seed of the *Allanblackia* tree has now been incorporated into margarine production in Europe.



What are FTA's impact pathways on TGR?

FTA research on safeguarding research outlined above supports the availability of TGR that are the raw materials for tree domestication activities. Safeguarded TGR are also important sources of site-matched planting material for restoration activities. The supply of these is supported through research on the more effective development of delivery pathways. Domestication research also supports the development of superior planting material for delivery. These three elements interact within and beyond the time scale of individual phases of the FTA program and with the ongoing work of partner institutions.

FTA's research on TGR is crucial for supporting the impact of its other research areas. Close interaction with the livelihood system and landscape research domains is mediated through the better provision of tree planting material well matched to production and landscape contexts. These interactions relay positive effects to FTA's value chain and climate change research domains.

Through coresearch and the codevelopment of decision-support tools and by capacity building, stakeholders will better define priorities, select methods and improve and implement practices and policies for TGR safeguarding. Through the adoption of model domestication pathways and decision-support tools, stakeholders will more widely and more effectively promote and apply new approaches to tree genetic improvement in combination with well-established existing methods. This realises faster, more targeted and better sustained genetic gains for a wide range of tree species.

More efficient and inclusive tree planting material delivery options and support tools, developed through coresearch and through engagement with stakeholders, result in the upgrading and commercialization of input suppliers, including small and medium enterprises (SMEs) involving women and youth. These suppliers more effectively provide growers with a range of more productive, diverse and/or site-matched tree planting materials that provide for greater profitability and/or resilience.



Who does FTA work with?

- To develop improved methods and action plans for TGR safeguarding, FTA partners with conservation organizations and networks that work at national, regional and global levels, such as national planning agencies, the International Union for Conservation of Nature (IUCN), the Latin American Forest Genetic Resources Network (LAFORGEN) and CacaoNet, as well as with intergovernmental actors, such as the United Nations Food and Agriculture Organization (FAO).
- To set domestication priorities, access genomic and information resources, and help drive impact in new tree product markets, FTA works with the private sector, including Mars Inc. and Unilever at the global level and SMEs at the local level.
- The development of tree domestication methodologies requires work with public breeders in national agricultural, forestry and horticultural research institutions, and with private breeders.
- Partnerships with advanced research organizations, such as the University of California, Davis, allow access to newly developing domestication methods.
- To develop and understand the implementation of appropriate planting material delivery options, FTA works with a range of national tree seed centers, national and international development non-governmental organizations, including VI and World Vision, government extension services, and commercial companies, such as Mars Inc.
- FTA also operates directly with SMEs to understand and develop their role in delivery systems.
- FTA works with FAO, the Organisation for Economic Cooperation and Development (OECD) and others to develop and support the implementation of policy changes that are supportive of tree planting material delivery.
- To provide strategic research direction, facilitate negotiations with intergovernmental actors on policies and certification, and to develop key decision-support tools for delivery systems, the TGR research domain includes scientists from the University of Copenhagen, the center of expertise globally on tree planting material delivery approaches among international advanced research organisations.



△ Many farmers have increased their incomes by growing superior varieties of indigenous fruit trees like the African plum. Photo by C. Pye-Smith/ICRAF

Cover: A woman holds *Garcinia Indica*, a local fruit in Western Ghats, India, that can be used to make syrup and other products. Photo by E. Hermanowicz/Bioversity International

The CGIAR Research Program on Forests, Trees and Agroforestry (FTA) is the world's largest research for development program to enhance the role of forests, trees and agroforestry in sustainable development and food security and to address climate change. CIFOR leads FTA in partnership with Bioversity International, CATIE, CIRAD, ICRAF, INBAR and TBI.

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