



RESEARCH  
PROGRAM ON  
Forests, Trees and  
Agroforestry

FTA HIGHLIGHTS OF A DECADE  
*2011-2021*

# Food Security and Nutrition

Ten years of  
forests, trees and agroforestry  
research in partnership for  
sustainable development



## About the FTA Highlights series

This publication is part of a series that highlights the main findings, results and achievements of the CGIAR Research Program on Forests, Trees and Agroforestry (FTA), from 2011 to 2021 (see full list of chapters on the last page).

FTA, the world's largest research for development partnership on forests, trees and agroforestry, started in 2011. FTA gathers partners that work across a range of projects and initiatives, organized around a set of operational priorities. Such research was funded by multiple sources: CGIAR funders through program-level funding, and funders of bilateral projects attached to the programme, undertaken by one or several of its partners. Overall this represented an effort of about 850 million USD over a decade.

The ambition of this series is, on each topic, to show the actual contributions of FTA to research and development challenges and solutions over a decade. It features the work undertaken as part of the FTA program, by the strategic partners of FTA (CIFOR-ICRAF, The Alliance of Bioversity and CIAT, CATIE, CIRAD, Tropenbos and INBAR) and/or with other international and national partners. Such work is presented indifferently in the text as work "from FTA" and/or from the particular partner/organization that led it. Most of the references cited are from the FTA program.

This series was elaborated under the leadership of the FTA Director, overall guidance of an Editorial Committee constituted by the Management Team of FTA, support from the FTA Senior Technical Advisor, and oversight of the FTA Independent Steering Committee whose independent members acted as peer-reviewers of all the volumes in the series.

FTA HIGHLIGHTS OF A DECADE 2011-2021

### Food Security and Nutrition

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FTA HIGHLIGHTS OF A DECADE  
*2011-2021*

# Food Security and Nutrition

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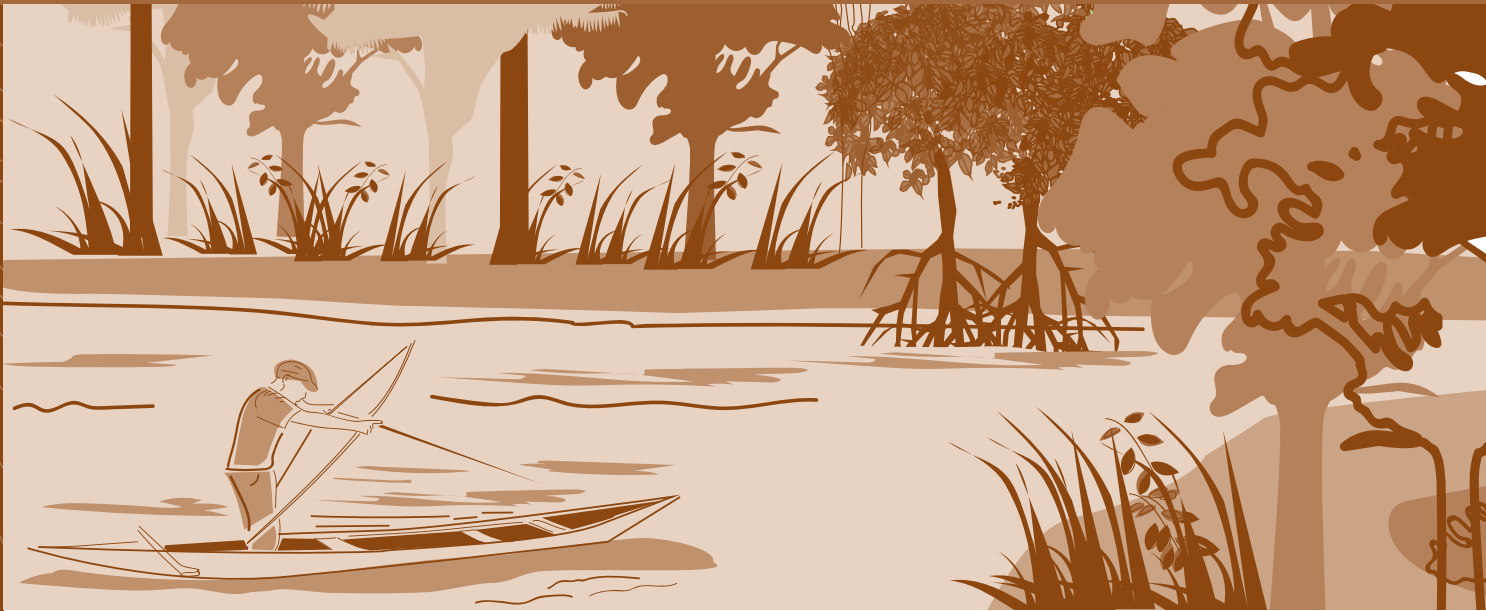
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## List of acronyms

ACIAR	Australian Centre for International Agricultural Research
ADA	Austrian Development Agency
CFS	Committee on World Food Security
DFID	Department for International Development (UK)
FAO	Food and Agricultural Organization
FTA	CGIAR Research Program on Forests, Trees and Agroforestry
IFAD	International Fund for Agricultural Development
PES	Payment for environmental services
REDD+	Reducing Emissions from Deforestation and Forest Degradation
SDG	Sustainable Development Goal
SESYNC	National Socio-Environmental Synthesis Center
TPP	Transformative Partnership Platform



## Executive summary

FTA's research provides strong evidence of how forests, agroforestry systems and other multifunctional landscapes contribute to food security and nutrition. They contribute a diversity of nutritious foods, ecosystem services that support agriculture, and income to smallholders. Evidence shows that greater tree cover is associated with greater dietary diversity. Wild and planted trees provide important foods, and forests are key habitats for wildlife and sustain healthy rivers providing fish, both of which also are important for diets. Trees are also an important source of animal fodder. Forests, agroforestry and trees provide resilience and stability in the face of climate and other food system shocks. Despite these important contributions, food trees remain an underutilized resource, ecosystem-level functions of forests and trees to sustain agriculture are often not fully taken into account in land management, and land-use change has a profound impact on diets. FTA has generated scientific findings on all of these contributions of forests and trees to food security and nutrition. It has also shared this knowledge with a range of stakeholders, including local communities, national governments and the international scientific and policy-making communities. This has informed global strategies and discourses on food security and nutrition; global policies on food, particularly through the Committee on World Food Security (CFS); and global discussions and policies on sustainable food systems. This publication provides examples of FTA's forest- and tree-based solutions and how their implementation on the ground supports better nutrition. FTA's work on food and nutrition provides evidence for promoting the roles of "polycultural" landscapes in contributing to healthy diets, sustainable food systems and broader planetary health.



## 1. Introduction

Forests, trees and agroforestry make essential contributions to local and global food security and nutrition. However, until recently their significant roles were not widely appreciated and were rarely acknowledged. This was likely due in part to the prevalence of old discourses that focused on staple food production as the main pathway towards food security, and to the absence of a comprehensive, system-wide approach to characterize and explain the roles of forests and trees (HLPE 2017).

During the last 10 years there has been a significant evolution in global discourses related to food security, nutrition and food systems (Gitz et al. 2021). Greater emphasis is now placed on malnutrition, on the environmental impacts of food systems, on their capacity to sustainably produce healthy diets for all, and on their resilience to climate change and other risks.

Within this movement, research by the CGIAR Research Program on Forests, Trees and Agroforestry (FTA) has been pivotal in recognizing the contributions of forests, trees and agroforestry to food security and nutrition. This has been achieved through collaboration with partners and with other initiatives, resulting in a compelling evidence base that has started to resonate with major policy-oriented panels, including those behind the Global Forest Expert Panel (GFEP) report (Vira et al. 2015) and the High-Level Panel of Experts' report on food security and nutrition (HLPE 2017).


The growing international attention to nutrition has broadened the policy focus from insufficient calorie intake to other problems of malnutrition, including overnutrition and micronutrient deficiencies. While close to 700 million people remain undernourished, the number affected by micronutrient deficiency probably exceeds two billion (FAO et al. 2020). At the same time, excessive calorie consumption continues to rise globally, with 39% of all adults now considered overweight or obese (DIPRL 2020). It is now well recognized that the causes of these nutrition trends are linked to the evolution of food systems. Globally, only 15 crops, grown mostly in low-diversity production systems, now provide 90% of humanity's energy intake (Antonelli et al. 2020); rice, maize and wheat together account for 48% of average daily calories (FAO 2018). Furthermore, there is insufficient production of nutrient-rich foods to provide healthy diets for all people (Siegel et al. 2014).

At the same time, food production and consumption are among the leading causes of environmental damage (UNEP 2010). Agriculture is a major driver of deforestation, land degradation and the loss of habitat and biodiversity; it also depletes natural resources and contaminates air, soil and water (IPBES 2018; Whitmee et al. 2015). It accounts, for example, for 70% of global freshwater withdrawals (FAO et al. 2017), with impacts on river flows and groundwater. Food systems also account for about one-fourth of anthropogenic greenhouse gas (GHG) emissions (Vermeulen et al. 2012). These environmental impacts of the global food system create a negative feedback loop that threatens the very capacity of ecosystems to produce enough healthy food in the future (Godfray et al. 2010; Whitmee et al. 2015; FAO 2011).

For these reasons, the sustainability of food systems and of the ecosystem services that support them are increasingly prominent in debates on food security and nutrition, and in discussions on climate change, biodiversity and other global environmental issues. Yet, despite the importance of forests and other tree-based systems to food security and nutrition, the landscapes that provide tree products and services are changing rapidly, and are being lost even before their roles are fully understood. Considering the global challenges associated with the current dominant food systems that lead to unhealthy diets and environmental degradation, it is now more important than ever to better understand and emphasize the contributions of forests, trees and agroforestry to food security and nutrition.

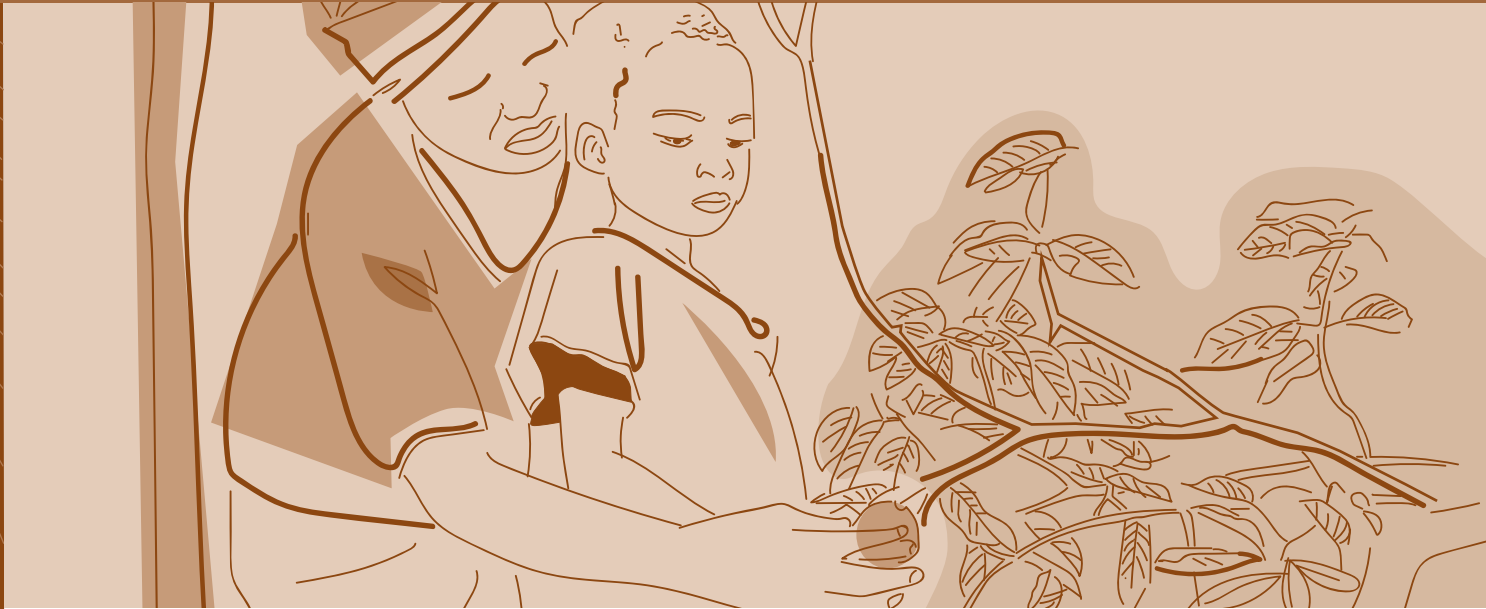


FTA's work provides evidence of how forests, agroforestry systems and other multifunctional landscapes contribute a diversity of nutritious foods that directly support healthy diets, and of how they indirectly contribute to food security and nutrition through ecosystem services that support agriculture. This publication features FTA's contributions: first, to knowledge generation; and second, to the sharing of this knowledge to inform strategies and policies through broad dialogue. Third, it provides examples of FTA's on-the-ground implementation of forest- and tree-based interventions to support nutrition. It shows how FTA's work on food and nutrition provides evidence for promoting the roles of "polycultural" landscapes in contributing to healthy diets, new sustainable food systems and broader planetary health.



Example of a polycultural landscape from Mt Kenya.

Photo by Neil Palmer/CIAT



## 2. Contributions to science

### 2.1 Understanding the roles of forests and trees in directly contributing to healthy diets

#### *Greater tree cover is associated with greater dietary diversity*

FTA researchers in 2014 published the paper, *Dietary Quality and Tree Cover in Africa*, that integrated data from demographic health surveys on the diets of children from 21 African countries with information on tree cover and with other geographic variables (Ickowitz et al. 2014). The dataset used was very large, with more than 90,000 observations of children between the ages of 12 months and 60 months. After controlling for other important variables, the research found that children living in areas with a greater density of tree cover had more diverse diets than those living in areas with less tree cover.

FTA scientists used similar methods in a study that focused on links between diets and tree-based systems in Indonesia (Ickowitz et al 2016). Data from Indonesian demographic health surveys on diets were combined with information from the Indonesian Ministry of Forestry on the type and density of tree cover. This study focused on the frequency of consumption of various food groups among children ages 12 months to 60 months. The study looked not only at the density but the type of tree cover – timber plantations, tree crop plantations, natural forests and swidden (shifting cultivation)/ agroforestry. A key finding was that children living in the province with

Forest foods in market  
in the village of  
Minwoho, Lekie, Center  
Region, Cameroon.

Photo by Olivier Girard/CIFOR



the highest density of trees in swidden cultivation and agroforestry, more frequently ate from the following nutrient-rich food groups: fruit, legumes, green leafy vegetables and meat.

FTA scientists and colleagues have also used data on household consumption taken from CIFOR's Poverty Environment Network (PEN)<sup>1</sup> dataset to explore the relationship between forests and food. More than half of a sample of 7,569 surveyed households across 24 tropical countries were found to consume foods that they had collected from the forest (Rowland et al. 2017). And for the top quartile of forest food users, forests contributed 15% of the amounts of fruits and vegetables recommended for a healthy diet by the World Health Organization, although this value varied widely by country and site. In more recent related work, FTA scientists partnered with FAO in a study of forest food use in Zambia (Ickowitz et al. 2021a). They surveyed 209 rural households across all agroecological zones of the country and found very high use of forest foods across all sites. In particular, the rates of collection and consumption of wild fruits were high, with individual intake equivalent to about 80% of average national fruit consumption.

<sup>1</sup> <https://doi.org/10.17528/CIFOR/DATA.00021>.

Local man fishing  
in the lake using a  
traditional net in Situ  
Gunung, Sukabumi,  
West Java, Indonesia

Photo by Ricky Martin/CIFOR



### *Forests provide habitat for animal-source foods*


Forests not only provide plant foods, but also are a habitat for animals that are important for human consumption. FTA researchers have shown that some forest dwellers rely heavily on these animal foods for enriching dietary quality. Fish are known to be the most important animal-source food in many rural communities, and many of them come from wild-capture fisheries from rivers and lakes. Using data from the World Bank's Living Standards Measurement Study<sup>2</sup> in Nigeria, combined with data on land cover, FTA scientists found that tree cover in areas surrounding rivers close to villages was positively associated with fresh fish consumption (Lo et al. 2020).

FTA scientists and colleagues also carried out a systematic review of the scientific literature exploring the relationships between forests and fish quantity and quality in the tropics, to collate evidence on associations and better understand potential causality (Lo et al. 2020). From an analysis of 61 studies, they concluded that fish diversity was higher where there was more forest cover, likely due to the greater heterogeneity of resources in forested environments that can support a wider range of species. Studies quantifying fish abundance (or biomass) showed mixed relationships with forest cover, depending on species and habitat preferences.

<sup>2</sup> <https://www.worldbank.org/en/programs/lsms>.

Forest/meat and forest/fish relationships are extremely important to food security and nutrition; as shown by another review led by FTA scientists, wild meat and fish can account for up to 85% of animal-source foods in the diets of rural communities in developing countries (Powell et al. 2015). Insects are also an important part of diets in some cultures and contexts, and can provide income when there are local markets for such foods (FAO 2013). However, there are limited studies reporting the consumption of insects as compared to other foods and FTA's work on this topic also has been limited (Powell et al. 2015).

For more information on the extensive research work on wild meat conducted within FTA, see Highlight No. 6 in this series (Nasi et al. 2021).



Fishermen in West Papua, Indonesia fishing in rivers surrounded by forests.

Photo by Balitbangda, West Papua






### ***Planted trees provide important foods***

Planted trees in agroforestry systems and plantations provide fruits and nuts that make an enormous contribution to healthy food availability globally (FAO 2016). Agroforestry in particular produces a diversity of nutritious human foods, including tree foods and the annual vegetables, pulses and staples that are intercropped with them (Jamnadass et al. 2013). Tree foods are able to fill hunger gaps in diets, and FTA researchers have designed an innovative “food tree portfolio” approach, whereby a diverse set of tree species (with complementary vegetable, pulse and staple crops) provides nutritious fruits and leaves across all seasons (McMullin et al. 2019; see more below, including Figure 1). Developing these portfolios starts with building a better understanding of the nutrient composition of tree foods, embracing not only well-known species but indigenous and underutilized ones that can be particularly nutrient-dense. Unfortunately, however, food composition data are often lacking for these species, which means they can be overlooked by programmes and policies.

Where composition data are available for some indigenous species, their nutritional values for certain micronutrients has been found to be superior to those of exotic species. For the African species *Adansonia digitata* (baobab), *Sclerocarya birrea* (marula), or *Sorindeia madagascariensis* (grape mango), their vitamin C content can be up to five times higher than for *Citrus sinensis* (orange), which is commonly used as a reference source high in vitamin C (Stadlmayr et al. 2019; McMullin et al. 2020). An FTA-related study that looked at the variation in the nutritional composition of baobab across different sites in Kenya found that tree-to-tree differences for all nutrients

were higher than variations due to locations (Stadlmayr et al. 2020). These findings are relevant for informing the selection of trees for inclusion in domestication programs. There is a need for systematic approaches to identify high-potential indigenous and underutilized species that could be used to successfully diversify local food systems and FTA's work on portfolios takes these approaches forward (Termote et al. 2021).

The current gap in food composition knowledge for indigenous and underutilized species (Stadlmayr et al. 2013) has been addressed in part by FTA scientists' development of the Priority Food Tree and Crop Food Composition Database (Stadlmayr et al. 2019). This compilation and standardization of food composition data is useful for devising food tree portfolios, dietary assessments, education and training, and national food-based dietary guidelines, and for selecting potential tree species for domestication, among other uses. The database illustrates just how nutrient-dense tree foods can be, and thus how important their contributions to nutrient supply are. A recent study by FTA scientists and partners, across sites in seven tropical countries, reinforced this point, finding that while on average tree-sourced foods provided only 11% of daily food intake by weight, they accounted for 31% of the average daily intake of vitamins A and C (Jansen et al. 2020).



Baobab fruits are nutrient-rich fruits commonly consumed across east, west, and southern Africa.

Photo by Ollivier Girard/CIFOR



Goats getting their own fodder from trees in Gorom, Cameroon.

Photo by Daniel Tiveau/CIFOR

### *Trees are an important source of animal fodder*

FTA has also documented how trees in and outside of forests provide animal fodder that enables people in farm and forest communities to keep livestock that provides them with nutritionally important milk and meat (Dawson et al. 2014). In a case study from Ethiopia, FTA scientists — in collaboration with researchers from CGIAR’s Water, Land and Ecosystems (WLE) research program — found that farmers living close to forests were able to keep more livestock because of fodder from the forest. Furthermore, the manure from these livestock increased the likelihood that these farmers would use their gardens to produce fruits and vegetables (Baudron et al. 2017).



### *Wild forest foods and food trees as underutilized resources*

Biodiversity researchers affiliated with FTA have explored the extent to which wild forest foods are effectively used, showing that they are sometimes not used to their potential. This was found, for example, in communities living around Lama Forest in Southern Benin: 90% of households reported that they collected wild plant foods from the forest, but few forest foods were actually found in peoples' diets and then only in very small quantities. This was assessed by a quantitative 24-hour recall survey conducted on two non-consecutive days in the lean season (Boedecker et al. 2014). This may have been due in part to the fact that only half of the wild foods known to the local women were in season at the time of the survey; also, some women explained that they had difficulties accessing the forest where the foods were found. A study of communities living in and around the Congo Basin rainforest in Tshopo District, DR Congo, had similar findings (Termote et al. 2012). Both studies showed, however, that when people did consume wild edible foods, they had greater dietary diversity and met more of their nutrient needs than people who did not consume them. This points to the untapped potential of forest foods within these communities.

There are often context-dependent reasons why wild foods from forests or forested lands are not used to their full potential (see also Sunderland and Vasquez 2020), such as the distance to walk to collect certain species in primary forest, the workload to collect and prepare the food, and lack of awareness of the excellent nutritional qualities of many wild foods (Termote et al. 2012). One way to encourage the food use of forest species may be to bring them into cultivation, especially if this results in easier access, increased yields, increased profits from sales and the like. To this end, a key domain of work of FTA relates to the domestication and improvement of a diversity of food trees, including neglected and underutilized “orphan tree crops.”<sup>3</sup> To support these efforts, FTA has partnered through ICRAF with the African Orphan Crops Consortium (AOCC)<sup>4</sup> to develop knowledge and better manage the genetic resources of 101 annual and perennial orphan crops. The plants are genetically sequenced and characterized, and this information is made available to breeders and domesticators (Jamnadass et al. 2020). Half of the crops on the AOCC list are foods from perennials, most of which are trees indigenous to Africa.

<sup>3</sup> Orphan crops are neglected or overlooked plants; in general, research has not been carried out on them, as compared to other crops.

<sup>4</sup> <http://africanorphan crops.org>.

## 2.2 Understanding how forests and trees indirectly contribute to food security and nutrition

### *Forests and trees provide income*

Forests and trees also contribute indirectly to food security and nutrition through the income they generate for individuals and communities that is used to purchase food. This includes income earned from employment in the logging and timber industries, the sale of wild-collected and cultivated foods, fuelwood and other products, and ecotourism. Income may also be earned from protecting forests and watersheds, such as through payment for environmental services (PES) from the Reducing Emissions from Deforestation and Forest Degradation (REDD+) programme (Duchelle et al. 2018). For more information on research work on REDD+ conducted within FTA, see Highlight 11 in this series (Martius and Duchelle 2021). FTA researchers quantified these benefits in CIFOR's Poverty and Environment Network (PEN) study, finding that income from forest products contributed an average of around 22% of household income at surveyed sites (Angelsen et al. 2014). Another study using the same dataset showed how the sale of forest products was an essential source of cash income in some cases, for women in particular (Sunderland et al. 2014).



Forest foods in Zambia are diverse and nutrient rich. At a food fair in Luwingu, Zambia, women display dishes that they prepared from foods that they collected and cultivated.

Photo by Joe Nkadaani/CIFOR

It is well known (Gitz et al. 2021) that a multitude of tree products contribute to the income of smallholder farmers, including from the sale of fuelwood, timber, medicines and fodder, as well as foods, improving livelihoods and the environment. For more information on research work on Trees on Farms (TonF) conducted within FTA, see Highlight 7 in this series (Somarriba et al. 2021); and for more information on research work on biomass, bioenergy and biomaterials conducted within FTA see Highlight 8 in this series (Baral et al. 2021). Some of the world's most frequently traded perennial agricultural commodities, including cocoa and coffee, are produced widely by smallholder farmers, often in agroforestry systems (Prabhu et al. 2015). FTA's work has also helped to show that indigenous fruit and nut production and associated value chain activities in southern Africa contribute significantly to the livelihoods of rural communities (Omotayo and Aremu 2020; Cemansky 2015; Kehlenbeck et al. 2013).

As well as contributing to income, the use of forest foods can reduce the costs of buying nutritious food. FTA scientists from Bioversity International illustrated this by modelling the costs of hypothetical diets for women and children in a rural area of Kenya (Termote et al. 2014). They found that the cost of an "equivalent" diet in terms of nutrients could be reduced by up to 70% by substituting wild fruits and/or vegetables for purchased foods. The costs used in that study did not include the opportunity costs of collecting these foods, which could be important and is worth further investigation.

### ***Forests and trees supply biofuels for cooking***

Highlight 8 in this series (Baral et al. 2021) reviews the extensive work that FTA has carried out on fuelwood and charcoal with its partners over the last decade, and the contributions that these make to household income. These resources are not only important sources of income, however. For many people in developing countries access to them can determine the foods that they can eat, and thus affects the quality of their diets when alternative cooking fuels are not available. Wan et al. (2011) pointed out that shortages of fuelwood can result in people skipping meals and/or substituting meals of lower nutritional quality to reduce cooking times. In places where alternative sources of fuel are not available, fuelwood and charcoal are also important for destroying food-borne pathogens and purifying water.



### ***Forests, agroforestry and trees provide a broad range of ecosystem services***

Forests and trees also affect food availability through the ecosystem services they support, such as bio-control of pests, prevention of erosion, pollination, wind abatement, nitrogen fixing, and water and nutrient cycling (Kuyah et al. 2016). FTA researchers have studied the importance of these contributions and quantified some of their benefits. They have, for example, emphasized the importance of forests and trees in water management, from local to continental scales (Ellison et al. 2017; Creed and van Noordwijk 2018).

In a systematic review led by FTA scientists exploring the evidence for the roles of forests and trees in farmland in sustaining agricultural food production (Reed et al. 2017), 47% of the studies analyzed showed net positive effects on food crop yields or yield proxies. In 36% of cases, however, a negative effect was recorded, indicating the context specificity of production benefits. Negative effects were observed when there was competition for resources between trees and crops; for example, for water or for pollination services. Interestingly, when Reed et al. (2017) expanded the outcomes of interest in their review to look at the impacts of trees on livelihoods more broadly, they found a much lower percentage of negative outcomes (down to 16% compared to 36%) among the catalogued studies.

A significant part of ICRAF's research on ecosystem service provision by trees and shrubs has traditionally focused on the use of nitrogen fixing "fertilizer trees" for replenishing soil fertility. This work has demonstrated that crop yields increase under a variety of agroforestry technologies that integrate fertilizer trees, including fallowing, tree-crop intercropping, and biomass transfer (Rosenstock et al. 2014). ICRAF scientists have also shown that trees in agroforestry systems can favourably alter microclimates at the field scale, resulting in the increased growth and yield of crops due to reductions in temperature and evapotranspiration (Rosenstock et al. 2019).

### ***Forests, agroforestry and trees can provide stability and resilience to diverse types of food system shocks***

Forests, agroforestry and trees are known to play an essential role in buffering food systems from economic and political shocks; they provide key ecosystem services that stabilize production; and they make key contributions to climate change mitigation and adaptation, which in turn are key to food systems' resilience. In a recent review, FTA scientists outlined the multiple pathways by which agroforestry influences human health in sub-Saharan Africa, including

through effects on food and nutrition security (Rosenstock et al. 2019). The same review also took a broader look at planetary health issues, including the relationships between agroforestry, the spread of infectious diseases, and human migration.

Tree crops can add resilience to overall food production in the face of changing and more unpredictable weather events that are driven by climate change. This is because trees generally survive adverse weather conditions better than annual crops, due to their deep and extensive root systems. In addition, trees have a cooling effect that can contribute to the adaptation of both cropping and livestock systems. As a result of the multiple benefits of trees in addressing negative climate change impacts, numerous countries promote tree planting in and outside farming systems as part of their national adaptation plans (Meybeck et al. 2020). FTA has supported the development of software to optimize shade management; see Highlight 7 (Trees on Farms) in this series (Somarriba et al. 2021). As the climate changes, food tree planting materials need to be matched to new planting environments; FTA scientists have generated suitability maps for food tree species in future climates to support this (along with maps for trees of other functional uses; see e.g. de Sousa et al. 2017). For more information about work on adaptation to climate change conducted within FTA, please see Highlight No. 12 in this series (Meybeck et al. 2021).



Food tree and crop diversity on a farm in Kitui West, Kenya.

Photo by Alice Karanja


FTA scientists have contributed evidence demonstrating the important role of foods from forests in supporting “lean-season” diets, in part because of their resilience and the timing of their availability (Powell et al. 2013, 2015; Lachat et al. 2018). In a study of income-poor households, it was found that extracting more “environmental resources” (most of which were from forests) ranked second as an income generating coping strategy during periods of hardship, after seeking wage labour (Angelsen and Dokken 2018). FTA has also shown (see also above and below) that growing a broad portfolio of tree foods with different seasons of production and with valued nutrients is a way of achieving year-round nutritional security (McMullin et al. 2019). These functions, and the adoption of a diverse range of tree foods, are important for building resilience to climate-based increased weather variability; if adverse weather conditions mean that one tree fails to fruit in a given season, then another may still produce and ensure supply (Dawson et al. 2019b).

### ***Land-use change has a profound impact on diets***

CIFOR’s Agrarian Change Project, which ran between 2013 and 2015, used an integrated landscape approach to explore the livelihood and food security implications of land-use change and agrarian change processes in multifunctional landscapes in seven tropical countries in Africa, Asia and Latin America. The project documented the historical and political drivers of land-use change in the focal landscapes, and outlined the potential social and economic, as well as the biological/environmental, outcomes (Deakin et al. 2016; Sunderland et al. 2017). The work showed that food systems were becoming simplified, with loss of access to forest- and tree-based resources, and that environmental services were also being lost, with negative implications for local communities’ well-being. FTA scientists have also investigated the connections between landscape change and dietary change in Indonesia. Using panel data they found that as agricultural diversity among farming households declined between 2000 and 2015 (as the cultivation of cash crops increased), so too did the dietary diversity of households and their consumption of several nutrient-rich food groups such as fruits and vegetables (Mehraban and Ickowitz 2021). In another study, in West Kalimantan, Indonesia, that compared the diets of traditional Indigenous households with those of households who converted their land to oil palm, they found that those who converted to oil palm relied more on purchased foods and that their consumption of micronutrient-rich fruits and vegetables declined. However, their consumption of dairy and eggs increased. Thus there appeared to be dietary benefits and costs of these changes (Purwestri et al 2019).

In 2021, FTA scientists and colleagues edited a special issue of *Frontiers in Sustainable Food Systems* titled *Impacts of Tropical Landscape Change on Human Diet and Local Food Systems* (Ickowitz et al. 2021b). This assembled research from a range of disciplines, countries and contexts to illustrate the heterogenous, but important, effects of land-use change on various aspects of diet.

One important issue noted by Sunderland and Vasquez (2020) is the importance of access to forests for the “right to food” particularly, but not exclusively, for Indigenous Peoples. Their paper discusses some of the complexities around conservation and protected areas and the risks that they can pose to the food security and nutrition of local communities, if they restrict access to areas used for food collection. Nurhasan et al. (under review) investigated some of the tensions between conservation and food security among Indigenous Peoples in West Papua. They report results that come from focus group discussions with local stakeholders. The stakeholders voiced concern over how the local government’s intentions to conserve forests and protect them from agricultural development by private and government actors might also restrict local communities’ access and thus impinge on their food security.



Women collecting foods in the forest in Kapuas Hulu, West Kalimantan, Indonesia.

Photo by Icaro Cooke Vieira/CIFOR

### *Managing trade-offs*

FTA has done research to better understand trade-offs and the biophysical and socio-economic factors that must be considered and managed to optimize the contributions of forests and trees to food security. There is potential competition for resources: light, water, nutrients and labour need to be assessed and managed. FTA supports farmers' choices by providing them with information derived from modeling the effects of introducing different types of trees into farming systems, and through collection and analysis of knowledge on traditional systems. The Shade Tree Advice tool facilitates choosing appropriate shade trees according to local conditions, needs and the preferences of smallholder farmers while maximizing ecosystem services from plot to landscape level. It is based on the collection of local agroforestry knowledge through farmers' interviews and rankings of tree species with respect to locally perceived key ecosystem services. Originally developed for the coffee and cocoa systems of Uganda and Ghana it is now being extended to other farming systems and geographical areas (Van der Wolf et al. 2019).

The competition of plants for water resources can be limited through combining species that develop at different times of the year or have different root depths. Trees can contribute to the stabilization of moisture by facilitating infiltration and by repumping water and diffusing it through evapotranspiration. Different tree species have different water needs depending on their phenology and crown architecture, and different access to soil water depending on their root system (Creed and van Noordwijk 2018). This is why FTA has developed, and applies as a key element of its research methods, an "options by context" approach for incorporating trees (Sinclair and Coe 2019).

Farmers allocate labour to various activities both on and off farm depending on season, available employment opportunities and commodity prices. The labour, land and other resources for growing trees are allocated by farmers as part of their overall livelihood strategy. For instance, smallholder rubber producers can interspace food crops while rubber trees are growing, providing food and a source of income (Déo-Gratias et al. 2018). Numerous crops are combined depending on country and local markets; they include rice, tubers, chili, pineapple, sesame, cocoa, coffee and fruit trees, as well as livestock. Farmers have developed various strategies for inter-cropping rubber trees with perennial crops and trees, including cocoa, coffee, tea and fruit trees. Such systems are also more resilient to price volatility in the case of rubber (Stroesser et al. 2018; Gitz et al. 2020). The example of rubber shows the need to take into account not only the yield of the major crop but also



the combined economic return and its stability. Other examples related to economic return and use of labour can be found in Highlight 7 in this series (Somarriba et al. 2021). And for more information about work conducted within FTA on improving rural livelihoods through supporting local innovation at scale see Highlight No. 9 in this series (Sinclair et al. 2021).




### 3. Contributions to global strategies, discourses and policies

#### *Global strategies and discourses on food security and nutrition*

FTA has increasingly been recognized as a global leader in developing information about the roles of forests, agroforestry and trees in food security and nutrition, expanding on the earlier work of CIFOR and its partners. In 2008, CIFOR scientists led the publication of the book *Human Health and Forests: A Global Overview of Issues, Practice and Policy* (Colfer 2008). This took a broad view of the many facets of the relationship between health and forests, with discussions of the nutritional roles of forest plants as well as the diets of forest-dwelling communities (Vinceti et al. 2008; and Dounias and Colfer 2008, respectively). In 2011, CIFOR scientists and associates built on this book with a special issue of the journal *International Forestry Review* titled “Forests, Biodiversity and Food Security” (Arnold et al. 2011). This special issue included case studies on the topic from around the world, as well as an overview (Sunderland 2011) which identified the ways that biodiversity and forests are linked to food security and nutrition. In 2013, CIFOR went on to publish the discussion paper, *Food Security and Nutrition: the Role of Forests* (Sunderland et al. 2013), which summarized the state of knowledge related to linkages between forests and food security and outlined a research framework.

In 2019, FTA scientists and colleagues published a paper challenging the view that agricultural intensification and specialization leads to increased food security and better diets (Ickowitz et al. 2019). Another recent publication led by FTA scientists reviewed 28 modelling studies that looked at a range of scenarios for feeding the global population by 2050 and the implications for forests (Bahar et al. 2020). Contrary to widely held beliefs, not all of these models implied a necessary decline in forest cover, with about one-third of them showing that sufficient food production can be attained without additional loss of forests.

In 2013, with FTA's support, the Food and Agricultural Organization (FAO) hosted the first-ever international conference on Forests for Food Security and Nutrition, in Rome. It centred on the various and diverse contributions of forests and trees to both diets and agricultural production in the form of ecosystem services. The conference was the impetus for the generation of a great deal of evidence related to the topic of forests and food security, and provided a roadmap for future work in this direction. To showcase FTA's work on food and nutrition, a side event was organized on nutrition-sensitive landscapes. Subsequently, scientists from FTA helped to organize a National Socio-Environmental Synthesis Center (SESYNC) working group on landscape diversity and dietary diversity in 2017–18. A key paper published from that work introduced a conceptual framework that outlined four pathways connecting forested landscapes to dietary diversity: direct, agroecological, energy and market (Gergel et al. 2020).



Brazil nut fruits ready to be hacked open to extract the nuts.

Photo by Marco Simola/CIFOR



Forest foods in Zambia are diverse and nutrient rich.

Photo by Joe Nkadaani/CIFOR

FTA scientists subsequently played a major role in contributing, with IUFRO scientists, to drafting the fourth global assessment of the Global Forest Expert Panel (GFEP) of the Collaborative Partnership on Forests (CPF) (Vira et al. 2015). This report focused on the role of forests, trees and landscapes for food security and nutrition, and was the first high-level report to bring these contributions to the international stage. FTA scientists were lead authors in every chapter of the report, which was directed mostly at the forestry community to raise awareness of the need to pay more attention to the links between the sector and food and nutrition.

Increasing awareness within the forest sector of its food and nutrition contributions has continued to be an important part of FTA's work. CPF has developed a Global Core Set of 21 forest-related indicators for countries and international organizations to measure the contribution of sustainable forest management to the 2030 Agenda for Sustainable Development, to the United Nations Strategic Plan for Forests 2030, and to other international agreements

(UNDESA 2019). FTA prepared with FAO a first methodological proposal for constructing and assessing indicator 14 — “contributions of forests and trees to food security and nutrition (FSN)” — that was discussed and endorsed by the Expert Workshop hosted by FAO in 2019 on the forest-related indicators (CPF 2019).

Mirroring the task of sensitizing the forest sector to its food and nutrition roles, FTA scientists have been active in food security and nutrition forums, including international conferences, workshops and networks, where they have put forests and trees “on the map” of global discourses on food security. In addition to international events, FTA scientists have also engaged in discussions at local and national levels to channel strategies and frameworks across scales.

CIFOR, ICRAF and Bioversity International are all founding members of the Global Hub for Indigenous Peoples Food Systems.<sup>5</sup> This is a collaboration of Indigenous and non-Indigenous experts and researchers who are bringing together evidence on the contribution of Indigenous food systems to local diets, and on their potential to contribute to solving some of the world’s nutritional and ecological challenges. A team of FTA researchers and scientists from 13 research organizations also produced a thematic study on the contributions of biodiversity to the sustainable intensification of food production to inform FAO’s flagship publication *The State of the World’s Biodiversity for Food and Agriculture* (Dawson et al. 2019a).

Through FTA, the important evidence generated by CIFOR and ICRAF on the roles that forests and agroforestry play in food security, nutrition, income generation and the environment has led to the emergence of Nutriscapes.<sup>6</sup> This is a Transformative Partnership Platform (TPP) that promotes a tree-based landscapes and livelihoods approach to addressing nutrition challenges. The platform will extend FTA’s work on food and nutrition into the wider food system, to support the broad availability of a wide diversity of nutritious foods. The platform provides a structure for merging and consolidating FTA advances on the topic, bringing in other partners, and continuing to raise the profile of the importance of forests and agroforests to food and nutrition. It will provide evidence to deliver sustainable solutions to the food and nutrition challenges faced by many tropical countries across multiple scales, integrating insights from ecology, agronomy, nutrition and economics.

<sup>5</sup> <https://www.fao.org/indigenous-peoples/global-hub/en/>.

<sup>6</sup> <http://apps.worldagroforestry.org/projects1/timeline-nutri-scapes/>.

### ***Global policies on food security and nutrition***

A primary intention of FTA in engaging in these discourses has been to influence policies on food security and nutrition in order to make them effectively recognize and promote the important roles of forests, agroforestry and trees in supporting healthy diets that are environmentally sustainable. FTA scientist Terry Sunderland led the team that prepared the High Level Panel of Experts (HLPE) report on Sustainable Forestry for Food Security and Nutrition commissioned by the UN's Committee on World Food Security (CFS). The report (HLPE 2017) informed the debate of the CFS at its 44th plenary session, where policy recommendations were agreed upon.<sup>7</sup> This process was the first major initiative to bring the contributions of forests and trees into global policy-making debates on food security and nutrition.

FTA engaged with CFS as part of the consultations for the development of the committee's Voluntary Guidelines on Food Systems and Nutrition (CFS 2020). FTA actively participated in the negotiation process, and was among the few parties and observers who made written proposals to both the first draft of guidelines and to subsequent versions. FTA organized an international workshop on its nutrition priority to analyze the research needs and demands of the international community, and how to address them, at Bioversity International in Rome in a three-day meeting in July 2019. During the first day, representatives of international organizations and CFS participated in the discussions; the last day of the workshop was devoted to the preparation of a collective contribution of FTA to the CFS process. Most of FTA's proposals were retained in subsequent deliberation. Among these were the need to enlarge the scope of food systems to include natural resources, the importance of recognizing diverse contexts, the need to more explicitly integrate forestry and fisheries, the importance of promoting agroecology and agroforestry, and the need to have equity and inclusiveness as objectives. Bringing all of this together, FTA scientists recently delivered a comprehensive brief outlining the multiple contributions of forests, trees and agroforestry to improved food security and nutrition, articulated along the four dimensions of food security: availability, access, utilization and stability (Gitz et al. 2021).

### ***Global discussions and policies on sustainable food systems***

As shown above, FTA has played an important role in increasing the awareness that, in order to ensure the sustainability of food systems, the leveraging of the contributions from forests and trees is a necessary condition. At the same time, the international community is considering the importance

<sup>7</sup> <http://www.fao.org/policy-support/tools-and-publications/resources-details/en/c/1142481/>.

of action on food systems to achieve all the Sustainable Development Goals (SDGs). The objective of the UN Food Systems Summit of 2021 (UNFSS), for example, was to “launch bold new actions, solutions and strategies to deliver progress on all 17 (SDGs), each of which relies on healthier, more sustainable and more equitable food systems.”<sup>8</sup>

FTA scientists engaged in the preparation of UNFSS through multiple activities and outputs to inform the summit. They are now engaging in initiatives and actions to implement some of its recommendations. The summit was organized around the objective of providing a set of “game-changing solutions,” and FTA proposed a set of 11 such solutions that cut across the five action tracks of the summit.<sup>9</sup> FTA researchers participated in multiple UNFSS dialogues (Box 1) and made proposals in the summit’s action tracks, starting from the entry points of biodiversity, agroecology and livelihoods. A game-changing solution titled *Delivering healthier diets and restoring degraded land through tree-based food production* was included in Action Track 3 (“Boost Nature Positive Production”) as part of the Agrobiodiversity Solution Cluster.

### Box 1. FTA participation in UN Food Systems Summit dialogues

High-level Expert Seminar on North American Indigenous Peoples’ Food Systems, towards the 2021 UN Food Systems Summit, 15 December 2020, <https://summitdialogues.org/dialogue/22034/official-feedback-22034-en.pdf?t=1626902379>

Indonesian National Food System Dialogues, 27 April 2021, <https://summitdialogues.org/dialogue/12406/>

Pathways for the future of food systems in the Mediterranean 27 April 2021, <https://summitdialogues.org/dialogue/6814/>

Dialogue d’engagement thématique transdisciplinaire francophone sur les interventions de développement liées aux systèmes alimentaires 4 May 2021, <https://summitdialogues.org/dialogue/2509/>

Boost Nature Positive Food Production for People and Planet, 11 May 2021, <https://summitdialogues.org/dialogue/16265/>

<sup>8</sup> <https://www.un.org/en/food-systems-summit/vision-principles>.

<sup>9</sup> <https://foreststreesagroforestry.org/wp-content/uploads/pdf/FTA-11-Game-Changing-Solutions-for-UNFSS-DEF.pdf>.

FTA organized several events oriented to the UNFSS and its implementation, including the launch of the Agroecology TPP (running in parallel with the Nutriscaples TPP) in a side event to the CFS 48 plenary that adopted the policy recommendations on agroecological and other innovative approaches, which were informed by an HLPE report led by FTA scientist Fergus Sinclair. A workshop was organized in July 2021 by the Agroecology TPP on agroecology policies that emphasize the importance of food systems approaches. A side event to the pre-summit conference that took place in July 2021 in Rome, Tomorrow's Food Systems Need Trees, was hosted by FTA and partners. FTA scientists also participated in the scientific group of the UNFSS, which prepared a background brief on fruits and vegetables and the related food system research and action priorities (Harris et al. 2021). Contributions were also made to another background brief focusing on the safeguarding and use of fruit and vegetable biodiversity (van Zonneveld et al. 2021). FTA also commented officially on the UNFSS scientific group paper, *Science and innovations for food systems change: opportunities for the UN food systems summit*, with comments retained in the final version of the paper. Finally, FTA, with the Kunming Institute of Botany, Chinese Academy of Science, and the Research Institute for Resource Insects, Chinese Academy of Forestry, organized an international conference in Kunming, China, on 22–24 June 2021, on the theme of forests, trees and agroforestry for diverse sustainable landscapes. The conference identified a set of concrete, actionable solutions to scale up biodiversity mainstreaming to achieve more sustainable food systems.<sup>10</sup>

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<sup>10</sup> [https://www.foreststreesagroforestry.org/wp-content/uploads/2021/07/FTA\\_Kunming\\_Conference-OutcomesRecs\\_vDEF.pdf](https://www.foreststreesagroforestry.org/wp-content/uploads/2021/07/FTA_Kunming_Conference-OutcomesRecs_vDEF.pdf).





## 4. On-the-ground implementation

FTA has not only succeeded in bridging the divide between forests and food security at the conceptual and scientific levels, but has worked with partners to break down policy divides at the national level. Projects funded by Austrian Development Agency (ADA) and the UK's Department for International Development (DFID) (now known as the Foreign, Commonwealth & Development Office) and led by CIFOR in Burkina Faso and Ethiopia, for example, intentionally, explicitly — and often, as never tried before — brought together national policymakers from forestry and conservation, and from nutrition and health. These meetings led participants to realize, often for the first time, that they had common interests. Measuring the impact of these meetings on actual policy is difficult, but Ethiopia later became the first country where the relevant forestry ministry (the Ministry of Environment, Forestry Development and Climate Change) explicitly integrated policy and planning measures related to nutrition. In Zambia, CIFOR organized a national stakeholder meeting on wild foods in December 2019 with participants from both the Forestry Department and the Ministry of Health, as well as academics from both nutrition and forestry. Organizers received very positive feedback from participants, who indicated that discussion of food and nutrition issues between the two sectors was very useful and something that they had not previously done. Both groups reported that they hoped to continue to meet and to formalize collaborations.

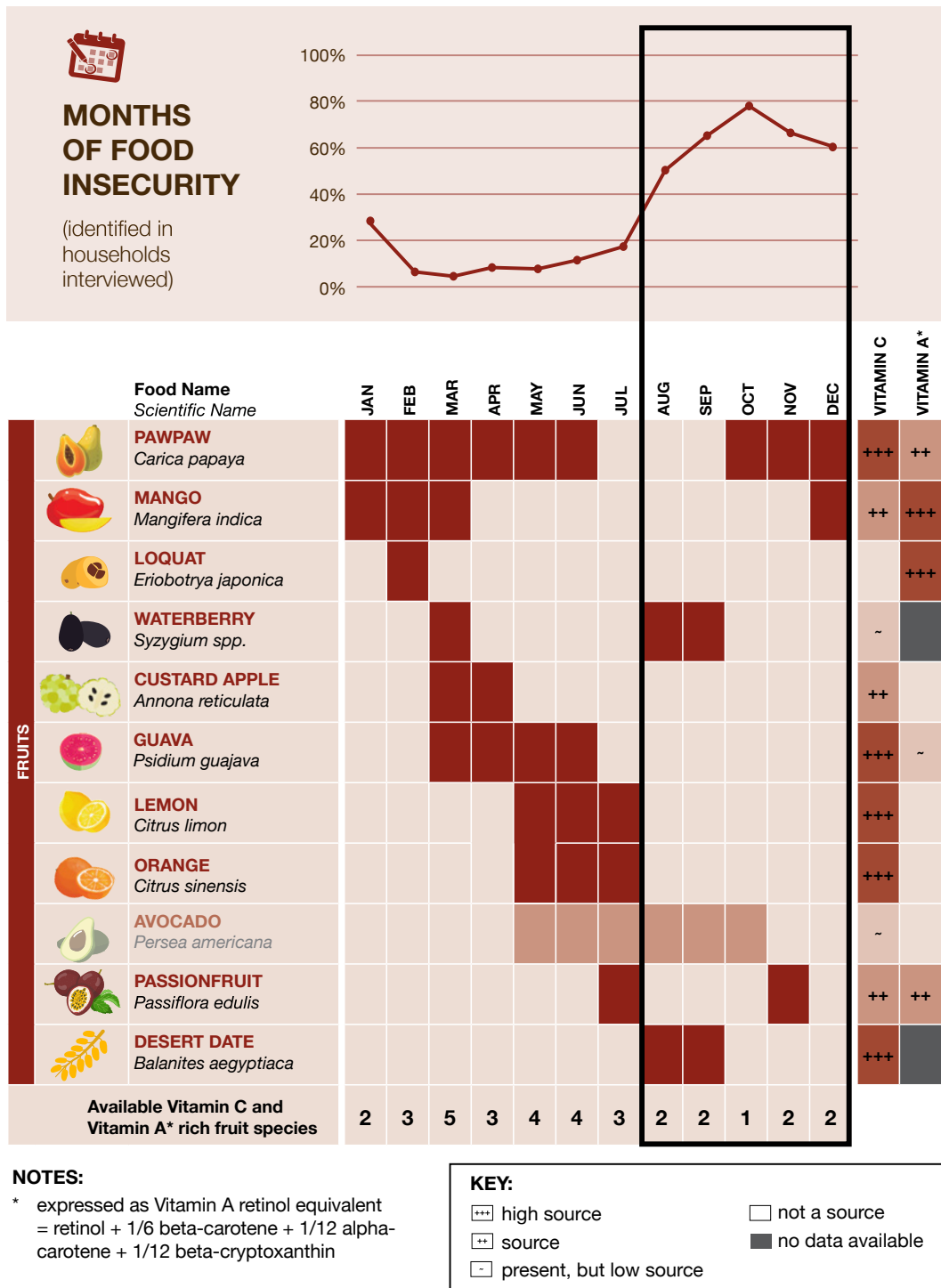


FTA supported projects have prioritized the sharing of results back with communities as part of the process for delivering suitable recommendations for the contribution of forests and trees to food security and nutrition.

Photo by Joe Nkadaani/CIFOR

As part of the impact pathways of FTA, scientists work with national and provincial governments to support their capacity to incorporate science to better trigger and inform action on the ground to bring together forest preservation and food security objectives. In Indonesia, for example, FTA scientists have been leading a capacity-building training program for the Research and Development Agency of West Papua Province. This location is of particular interest because it has declared itself a conservation province and is covered by forest that is more than 80% intact. The program is intended to improve the capacity of agency staff, especially in conducting research on the links between forests and food security.

In East Africa, the fruit/food tree portfolio approach introduced above has been scaled up and scaled out in multiple locations with FTA and European Commission/International Fund for Agricultural Development (EC/IFAD) support. The portfolio approach is an innovation with the dual advantage of addressing livelihood and nutrition outcomes (Neufeld et al. 2021). For each location, attention is given to the seasonality of food production and food nutrient profiles (Stadlmayr et al. 2019) to address key micronutrient needs and to understand how these needs can be met through tree portfolios that provide year-round nutritional security (McMullin et al. 2019). See Figure 1.



McMullin et al. 2019. Fruit Tree portfolios. Food Security. <https://doi.org/10.1007/s12571-019-00970-7>

Contact: s.mcmullin@cgiar.org

**Figure 1.** An example of a *fruit tree portfolio* developed for Machakos County, Kenya. Ecologically suitable fruits are selected based on their complementary months of harvest and their nutritional contributions for target nutrients: vitamins A and C. Harvest periods of vitamin-rich fruits are indicated by shaded boxes, with the peak months of food insecurity (as identified by households) being August to December. Source: Adapted from Kehlenbeck K and McMullin S. 2015.

So far, 17 location-specific portfolios that recommend a diversity of food tree species — with complementary vegetable, pulse and staple crops — have been developed (IFAD 2020). FTA scientists have digitized these portfolios and made them available online in an interactive decision support tool.<sup>11</sup> These customized portfolios are promoted to communities through agroforestry innovation hubs and school programs, where agronomic and nutrition information is shared and where access to quality planting material is facilitated (McMullin et al. 2020).

Similar approaches have been used by partners at Bioversity International through the Biodiversity for Food and Nutrition Project, which focuses on the nutritional value, cultural significance and market success of local agrobiodiversity (Hunter et al. 2020). Through projects across Kenya, Uganda and Ethiopia, scaling up the portfolio approach has reached 6,000 farmers directly with training, half of whom were women. In addition, 1,800 smallholder households received a diversity of food tree species seedlings based on the portfolios, and a further 11,000 farmers were reached through various outreach events such as farmer field days.

The topic of germplasm delivery — how to get tree seedlings for planting to growers — is covered elsewhere in this highlights series; delivery is a common bottleneck in reaching impact, including for desired food security and nutrition outcomes (Lillesø et al. 2011, 2018). For more information about work on tree seeds and seedling systems conducted within FTA, please see Highlight No. 2 in this series (Graudal et al. 2021). To summarize in brief some of the information presented in that highlight, however, it is useful to consider a couple of examples of FTA's work. In Central and West Africa, a diverse range of fruit trees has been promoted using the Rural Resource Centre concept that was developed by ICRAF in the region (Asaah et al. 2011). In Indonesia, FTA has promoted a Nurseries of Excellence (NOEL) approach to provide farmers with high-quality seedlings of food and other tree species (Roshetko et al. 2013). In Vietnam, ICRAF and its partners developed the cultivation of the Son tra apple (Box 2).

<sup>11</sup> <https://patspo.shinyapps.io/FoodPortfolios4Africa>.



Diversity of tree foods displayed at a Diversity Fair in Uganda.

Photo by S. McMullin/CIFOR

## Box 2. The development of Son tra apple cultivation in North Vietnam

The Son Tra District is a mountainous area with a high level of poverty. Cultivation of corn on slopes results in high erosion and loss of soil fertility and water quality. As part of the FTA program researchers from ICRAF have conducted a participatory research initiative. It builds on a project initiated with the Vietnamese Academy of Forest Sciences and the Australian Centre for International Agricultural Research (ACIAR) in 2005 to promote the cultivation of the Son tra tree (*Docynia indica*) to reduce erosion and improve livelihoods. Son tra, or the H'mong apple, is an indigenous fruit of South and Southeast Asia. In Vietnam, it is valued for multiple uses for dessert, wine, vinegar and tea making. The project included selection/domestication of the tree for yield and quality, a market analysis, and the development of value chains for fresh fruits and transformed products. The improved genetic material, as well as the development of market opportunities, help support adoption as part of agroforestry systems that contribute to reduce soil erosion in sloping areas and improve the incomes and livelihoods of smallholders in the Northern Vietnam region. A study comparing agroforestry systems with Son tra or Longan (*Dimocarpus longan*) to monocultures over a period of seven years confirmed that the agroforestry systems generated higher average annual income while enhancing ecosystem services, control of surface runoff and erosion, soil fertility, and resilience to extreme weather events (Hung et al. 2020).



The importance of local or cultural seed-saving and exchange of planting material approaches for conserving farmer independence and agricultural diversity and sovereignty as strategies to support production were noted in a recent UNFSS Scientific Brief supported by FTA scientists (Harris et al. 2021). Beyond ensuring access to planting material as a key success factor in the adoption of fruit tree crops, FTA has explored many other aspects that influence adoption, and identified a number of future research areas, such as assessing how production and consumption factors interact in the successful mainstreaming of food crops, and exploring producers' and consumers' behaviours and preferences in relation to production incentives, and demographic and cultural backgrounds (McMullin et al. 2021).



## 5. Conclusion

Research by FTA over the last decade has contributed substantially to global scientific progress in providing evidence of the multiple ways by which forests and trees contribute to food and nutrition security both directly and indirectly, while sequestering carbon, enhancing biodiversity, reducing runoff, and preventing and mitigating flooding. These findings were shared in various forums and have begun to critically influence relevant discourses and policies, both nationally and globally.

In order to maximize the potential contributions of forests, trees and agroforestry to sustainable food systems the following seven actions are recommended:

1. Public investment in agricultural production research should be reoriented from its current dominant focus on the breeding of a few staple crops towards improving the quality and productivity of a broad range of nutrient-rich foods, especially fruits, leaves, nuts, vegetables and legumes. A very important subset of these crops will be tree-based foods.
2. Public and private investments for scaling tree-based innovations up and out are needed. On the supply side, for example, this will require the upgrading of seed delivery systems to ensure that improved tree planting material developed by breeders and researchers can actually reach smallholder farmers.

3. Incentives need to be reoriented towards the production and consumption of nutrient-rich foods and away from a few major staples. For example, production subsidies over the last few decades for staple crops have been one reason for a decrease in their price compared to other nutrient-rich food and hence for their overconsumption. Instead, subsidies and other financial and policy mechanisms should be used to promote dietary diversity and the consumption of healthy foods that are currently under-consumed in many countries, including tree foods such as fruits, nuts and vegetables. More broadly, further research is needed on the socio-economic factors driving food trends that can be influenced to support healthy diets integrating tree foods.
4. Government ministries, including those responsible for land-use planning and forest protection, should explicitly consider the direct food and nutrition benefits of forests and other wooded lands, and the ecosystem services that these environments provide that support agricultural production when making land-use decisions. Currently, for example, forestry departments often consider only the standing timber value of forests when deciding whether or not to protect or remove trees. This needs to be altered so that food and nutrition values for local and more distant communities are part of the decision processes.
5. There is a need to support the right to access forests, trees and tree products. Forests should be protected in such a way as to ensure that this does not infringe on the rights of local communities to sustainably harvest foods for their own consumption, but supports these rights. Policies are also required that promote long-term tenure security for cultivated lands to ensure that farmers have the appropriate incentives to invest in tree food assets such as fruit that may not be realized until several years after tree establishment.
6. Better integration of the forestry and environment sectors in inter-governmental programming and discussions on food and nutrition policy is needed. Over the last decade, many countries have started to expand inter-ministerial working groups and committees for food and nutrition security beyond the health ministry, to include representatives from other sectors such as agriculture, women's affairs, and water. This should be further encouraged. It is also important, however, that representatives from the forestry sector be included to ensure that the role of forests is properly considered and not overlooked.

7. Food and fodder trees should be integrated in land and forest restoration projects. Pledges by various institutions and governments to restore hundreds of millions of hectares of degraded lands with trees and forests have often focused on the carbon storage benefits of trees. Consciously considering food production benefits in the restoration of even a small fraction of global targeted areas with food and fodder trees owned by local communities could not only provide undersupplied nutritious foods, but give local people an additional interest in ensuring the success of restoration projects.



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# Food Security and Nutrition

Over the last decade, the CGIAR Program on Forests, Trees and Agroforestry (FTA) has undertaken innovative basic and applied research across different scientific disciplines on how forests, agroforestry systems and other multifunctional landscapes contribute to food security and nutrition by providing a diversity of nutritious foods, ecosystem services that support agriculture, and income to smallholders. This publication presents key FTA outputs on food security and nutrition from 2011 to 2021.



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