

Coconut roadmap summary

The road to sustainable coconut growing [2024-2034]



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The coconut palm, *Cocos nucifera* L., is a monocotyledon of the family Arecaceae. Coconut palms can be split into two groups: tall and dwarf varieties, from which a large number of hybrids have been bred. Coconut is generally grown on relatively infertile coastal sands that are not suitable for any other crop, but can adapt to a range of soil types. However, it is primarily found in coastal parts of subtropical Asia (Philippines, Indonesia, India, Sri Lanka, Thailand, etc) and Oceania. Such zones account for 90% of the 11.3 million hectares planted worldwide. Some 96% of the coconuts produced globally come from small family farms (0.5 to 4 ha), but there are still a certain number of industrial plantations, often inherited from colonial times, in Southeast Asia (Indonesia and Malaysia), West Africa (Ivory Coast, Ghana) and East Africa (Mozambique), where coconut is grown as a monoculture on hundreds of hectares. Average yields have increased gradually over the past 40 years, from 3.7 to 5.6 t of coconuts/ ha/year, with huge disparities between countries and continents. In South America (Brazil), production and yields have rocketed since 1996, albeit due to large-scale planting of dwarf varieties for the drinks

The coconut palm is the ultimate tropical plant. It can adapt to hot climates with high water stress and saline soils, and in many regions, it is part of a sustainable, circular economy. CIRAD has been working for decades to support the value chain, and has produced an ambitious roadmap for this major asset for rural communities in tropical countries.

market (coconut water), whereas yields across Africa, which still produces coconuts for the oil or fresh fruit markets, remain below the global average.

Numerous outlets...

The coconut value chain has a very specific structure, due to the range of uses for the plant and the duality of how it is produced. The main outlets for palms grown on industrial plantations are copra and the oil that is extracted from it, which are still the main products handled by export circuits. When grown as a food crop, coconut provides coconut milk, sugar, coconut water, fibre, fuel, virgin oil for cooking or cosmetic use, and construction materials. On family farms in Asia and Oceania, coconut palms are often just one element in complex agroforestry systems. The value chain has changed significantly over the past 30 years, from an export-oriented oil crop (copra oil market) to one grown for its high added-value products, which have rapidly conquered global markets. Coconut water, virgin oil and sugar have benefited from consumers' current quest for well-being and for healthy products, which therefore have significant development potential.

... and numerous challenges

The main challenges facing the value chain relate to its sustainability and to the fact that both plantations and growers are ageing. However, it also faces several genetic erosion issues. Climate change is a challenge: the new conditions in which coconut is being grown call for more suitable varieties and integrated pest and disease management procedures. Climate is also a threat to the long-term future of diverse agroforestry systems including coconut, which supply ecosystem services and have considerable potential in terms of ecotourism and carbon capture. Lastly, smallholders' lack of structuring and of market know-how are a real challenge, which requires building value chains based on equitable markets that respect product traceability and quality. By virtue of its primarily family-based production system, the value chain provides jobs for large numbers of rural households. As coconut growing methods have changed little for decades (except in Brazil and India), farms can easily be converted to organic farming, thus contributing to sustainable, rational development of the value chain.



| Dwarf coconut palm in Tahiti

© A. Garaivo Guyot, CIRAD



| Transporting harvested nuts by canal in Indonesia, in a coconut plantation on a peat soil

© L. Olivier, CIRAD

Promoting the coconut sector of the future: three ambitions to frame operations

IRAD's coconut research, appraisal and training activities go back many years. It has built up vast expertise in the value chain since the mid-20th century, initially via its oils and oilseed crops institute, IRHO (from 1941 to 1984), relying on field stations devoted to the species in West Africa (Benin, Ivory Coast) and the South Pacific (Vanuatu, French Polynesia). A group of researchers from various fields, primarily based in Montpellier and in the Caribbean, is now in charge of coconut research and appraisal operations. They are spread across CIRAD's three departments – Biological Systems (BIOS), Tropical Production and Processing Systems (PER-SYST), and Environment and Societies (ES) – and four joint research units.

Ambition 1

Produce knowledge for resource management and coconut genetic improvement

CIRAD has globally recognised expertise in developing new methods and tools to improve the efficiency and cut the cost of coconut breeding operations, and aims to maintain and consolidate its position. The biology and morphology of this tree crop make conventional genetic improvement long and costly, but genome (re)sequencing and the omic sciences to identify markers linked to genes of interest have brought hope of substantial progress on a number of breeding criteria. In addition to yields, it is now possible to work on adaptation to biotic stress (lethal yellowing disease, first and foremost), and abiotic stress, and a wider range of quality criteria, in response to demand from rapidly expanding markets for increasingly diverse, high added-value products. This ambition will encompass two main objectives: (i) optimise genetic resource conservation and

management, and (ii) significantly improve breeding methods and disease-free seed production operations.

Ambition 2

Help coconut producers achieve agroecological transition

The aim is to rehabilitate coconut plantations while restoring biodiversity and ecosystem services. To this end, CIRAD is working to re-establish agroforestry systems with lower densities of coconut palms, to diversify the crops grown and help rural communities achieve food self-sufficiency. This will mean making use of agrobiodiversity, service plants, by-product recycling, soil health and ecosystem services, to ensure sustainable production and better wages for family farmers. It will also entail assessing the sanitary risks surrounding biological invasions and emerging diseases linked to trade and to climate change. There are also plans for research into cropping and production systems, to support changes in practices through participatory modelling approaches, innovation monitoring, multi-criteria assessment tools and innovation platforms.

Ambition 3

Consolidate knowledge and know-how, to design the sector's future

CIRAD's teams will be working to build on the know-how and knowledge acquired over the past 70 years, to pass it on by providing training in database management, sustainable production and innovative processing techniques, among others, in the form of MOOCs or in any other form suited to the target audience. The digital resources developed as a result of this roadmap will adhere to the principles of FAIR (findability, accessibility, interoperability, and re-use) and CARE (collective benefit, authority to control, responsibility and ethics), to benefit players in the value chain. The future of the value chain will be designed by means of an inter-sector foresight exercise involving not just scientists but also certain key stakeholders from those sectors. The cocoa, oil palm and horticulture value chains, on which teams from CIRAD are also working in partnership, could be the ones most concerned. ■



| Shelling coconuts in a plantation in Vanuatu

© A. Prades, CIRAD

Details

Why work on coconut genetic improvement? How can we help family farms with the agroecological transition? What are the main levers for guaranteeing the future of the value chain? We look at the key points in the coconut roadmap with CIRAD coconut value chain research coordinators Andrea Garavito Guyot, a coconut geneticist and genomics specialist, and Laurence Ollivier, an entomologist specialising in coconut pests.



How does coconut genetic improvement help to boost its resilience?

Andrea Garavito Guyot: Coconut has been the object of a good deal of research since the 1940s, but has been somewhat neglected in recent years. However, it is interesting in many respects. As well as its many uses, it is a plant with remarkable morphological and genetic variability. Understanding that variability better allows us to identify and make use of the most appropriate genetic resources to address the challenges facing the

sector. We can work on improving disease resistance, productivity, fruit quality, and so on. One of the most serious diseases affecting coconut palms is lethal yellowing, which can wipe out entire plantations. CIRAD is also focusing on adapting the crop to various forms of abiotic stress. The resilience of coconut palms and the coconut sector depends on our capacity to make use of modern genetic improvement tools developed when studying other plants. For instance, among other things, genomic breeding should serve to make this emblematic tropical crop both more sustainable and more competitive.

How can we help family farms with the agroecological transition?

Laurence Olivier: Smallholder and industrial coconut plantings cannot be regenerated without taking account of biodiversity and ecosystem services.

Coconut is a tree crop that fits perfectly into agroforestry systems and provides shade. For instance, it works very well when intercropped with cocoa, banana and food crops such as pineapple. It is commonly used in such systems, particularly since it is a source of income for growers. Among the obstacles currently facing the sector, lethal yellowing is continuing to spread, while dead coconut palms serve as breeding sites for *Oryctes spp.*, a large beetle that causes considerable damage in young plantings. As things stand, there is no satisfactory

way of controlling this pest, which is found across the entire coconut distribution zone, apart from chemical control. Informing growers about these threats, providing them with knowledge and training them to address the challenges they face are all part of CIRAD's mandate.

What are the main levers for the future of the value chain?

A.G.G.: Training local scientists is crucial. Transferring knowledge from one generation to the next does not seem to be an easy business: there is very little academic training available, and transmission is almost exclusively from peer to peer. CIRAD has positioned itself at the interface between producers and processors, to allow them to work together to build a sustainable future for the value chain.

L.O.: Training is part of CIRAD's remit. We strive to build on the historic knowledge generated by coconut research, and disseminate that knowledge at grassroots level and via our publications. Another of the original levers in this roadmap is the determination to pool resources. Several tropical agricultural value chains (eg cocoa, oil palm, and horticulture) face the same issues: ecosystem services, plantation regeneration, and agroecological studies. Multiplying the interactions between value chains will also multiply the resources devoted to coconut. ■

Find out more: coconut@cirad.fr



| Coconut nursery in India combined with growing pepper on the stem (trunk) of adult coconut palms



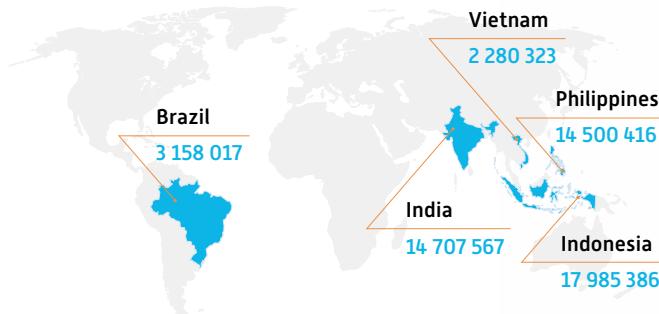
| Producing charcoal from coconut shells in Indonesia

Inventing the sustainable coconut sector of the future

CIRAD is addressing the challenges facing the value chain

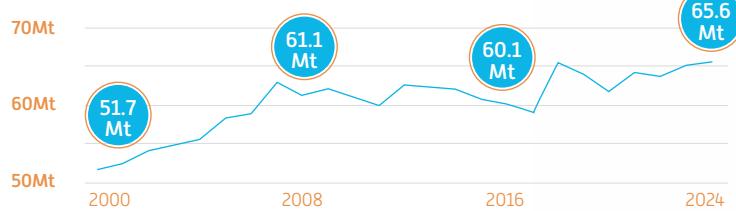
Changes in production worldwide*

- Asia is the leading producer



Coconut production by the five leading producing countries in 2024 (tonnes)

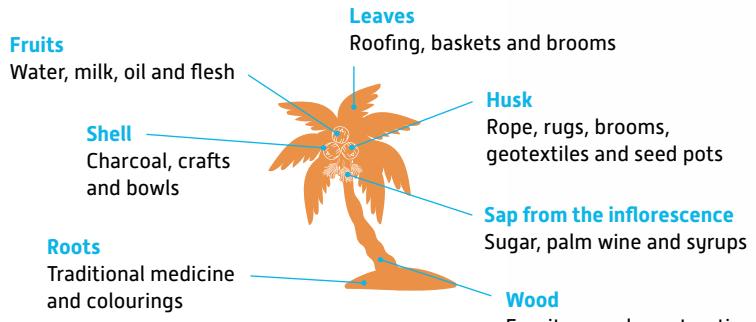
- Fluctuating yields



Coconut production worldwide in tonnes, from 2000 to 2024

New uses

- The coconut palm is the tree of life



- The boom in alternative products

Product	Total export value**	
	2012	2023
Copra	115	68
Oil	1431	1411
Sugar	1018	3403
Water	1951	3908

Our ambitions...



Produce knowledge for coconut genetic improvement and resource management



Help coconut producers with the agroecological transition



Consolidate knowledge and skills to plan the future of the sector

... in partnership

CIRAD works with the International Coconut Community (ICC) and the COGENT*** network, which associates 39 coconut producing countries representing more than 98% of global output.



It has partnerships with various research centres and universities in the global South [CNRA [Ivory Coast]; CRI CATAS [China]; EMBRAPA [Brazil]; CicY [Mexico]; University of the Philippines Los Baños; Kasetsart University [Thailand], etc].

Our means and resources

3

research units

5

disciplines involved, from sociology to genomics

490

publication references from 2005 to 2025

2017 and 2021

CIRAD helped to sequence the coconut genome

Partnerships, the core of CIRAD's research

CIRAD currently has a large number of very diverse partners within the cocoa value chain, spread across the world. In particular, they include national agricultural research establishments (both public and semi-public) in producing countries (VARTC in Vanuatu, KIK in Papua New Guinea, PCA in the Philippines, CPCRI in India, OPRI in Ghana, CNRA in Ivory Coast, CRI-CATAS in China, CIB in Jamaica and EMBRAPA in Brazil), universities (KU in Thailand and UPLB in the Philippines), and public administrations (MAFF in Timor Leste, DAG in French Polynesia). These partnerships, some of which date back many years, have changed over time, notably thanks to CIRAD's involvement in the COGENT network (now a programme headed by the International Coconut Community or ICC), primarily through the activities of the International Thematic Action Groups (ITAGs). ■



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| Working with the MAFF partner to pinpoint sites for predator releases against coconut scale in Timor Leste

A word from our partners



Interview with
Jelfina C. Alouw,
Executive Director,
International Coconut
Community (Indonesia)

What is the history of your partnership with CIRAD?

It's built on a long history of collaboration in key areas such as genetic resource conservation, agronomy, including phytopathology and entomology, and technology development for the global coconut sector. Over the years, we have benefited immensely from CIRAD scientists and leaders, research programmes and publications which have contributed significantly to global knowledge and also innovation in the coconut value chains. Scientists were central to COGENT's development when COGENT was still under Bioversity International before formally becoming part of ICC in 2019. That support was instrumental in strengthening our R&D for the global coconut sector. So this longstanding scientific synergy between CIRAD and ICC led to the signing of the principal MOU, which covered the period 2019 to 2023.

What do you think about the CIRAD roadmap for coconut's main objectives?

One that really goes to the heart of the global strategy for coconut sustainability is the objective of coconut genetic improvement. Firstly because we face a major crisis with ageing coconut plantations that are in desperate need of replanting. 20% of the total population in the world are senile. We are also dealing with increasing global threats, including epidemics and the intense pressure of climate change. Furthermore, the global market for coconut products is diversifying, creating massive opportunities and dictating the need for genetic improvement. CIRAD expertise in molecular tools and genomics is all the more critical as traditional breeding cycles are extremely slow. The second objective about the agroecological transition is also a highly relevant equation because our farmers are often trapped by low yields and single crop rates. By integrating food crops, the agroecological approach provides a crucial path for our members to build stronger, more resilient farm ecosystems, and address nutritional insecurity right on the farm and escape poverty. Eventually, the ICC's objectives align perfectly with CIRAD objective no. 3, "consolidating knowledge and expertise to imagine the future of the sector". We'll provide the critical knowledge on sustainable production methods that we, the ICC, can potentially post out to our member countries. Most of the sector is stuck with low value copra and CNO, coconut crude oil. Let's work on innovative processing that directly fits our programmes, helping us teach the MSME how to create profitable products. The fair and care principles, I think, could solve the huge challenges of data inaccessibility, and guarantee that research is no longer locked away, that it is ethically managed and available to every scientist, policymaker, and smallholder. I think that's critical for us. ■



Interview with Wayne Myrie,
Director of Research and Development, Coconut Industry Board (Jamaica)

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What is the history of your partnership with CIRAD?

This history is linked to the history of coconut diseases in Jamaica. In the 1960s, early 70s a phytoplasma was identified to be the cause of the disease. And we have been working with international agencies since then. When we found the disease was actually controlled by resistant varieties such as the Malayan dwarf, many institutions walked away from the research because they felt that the problem was solved. The Coconut Industry Board continued the research because coconut here is a very important crop to us. We continued to look at the disease and to do research work surrounding the variety. In 1998-1999, we started to have some problems with the disease again in various areas, and this is when we started working with a CIRAD researcher, Michel Dollet, and many other international experts. At the time we were going through a transition, upgrading our labs, and CIRAD helped us so that we could make identification of the disease here in Jamaica. They offered to train persons from here and so I was one of the first persons from the Coconut Industry Board to be fortunate enough to be trained at CIRAD. We worked

on the disease together and that is where the collaboration between CIB Coconut Industry Board and CIRAD started.

What do you think about the CIRAD roadmap for coconut's main objectives?

I think that the first one, "improving genetic material", is important because we were the first country in the world to have been working on improving the genetic material. We did a commercial cross between the Panama tall and the Malayan dwarf to produce the maypan coconut palm in 1974. We have developed many processes over the years, as have many other institutions elsewhere in the world. And that's an objective that we would readily agree with. The second objective is also very important, about the impact of what we're doing on our farmers, in terms of agronomic practices that will help to maximise any improvement in the genetic diversity. Because without those two things coming together hand in hand properly, you may have the best variety in the world but if you don't have the accompanying measures, agronomic practices that farmers will be encouraged to use, then the variety or the hybrids won't perform as they should. To improve the human resource, you can see that you have an ageing scientific population, it's very important to get young people. And to give them the opportunity to be trained to be able to replace the persons who will no longer be there in another five years or so. Otherwise, how do you continue the research work? Coconut is a major crop. People might say it's not important, it's not as important as wheat or corn or soya. But for a large percentage of the countries in subtropical and tropical regions it is one of their mainstays and helps improve the economic lives of their farmers. So, it's a very important crop to pay attention to. We have to have a cadre of scientific persons coming up behind the scientists who are there now to be able to continue future research work and to have sustainable coconut production. ■



| Coconut fibre planters in a shopping centre in Jakarta, Indonesia

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| Utensils made from coconut wood and shells

© A. Garavito Guyot, CIRAD



CIRAD is the French agricultural research and international cooperation organisation working for the sustainable development of tropical and Mediterranean regions.

CIRAD works with its partners to build knowledge and solutions and invent resilient farming systems for a more sustainable, inclusive world. It mobilises science, innovation and training in order to achieve the sustainable development goals. Its expertise supports the entire range of stakeholders, from producers to public policymakers, to foster biodiversity protection, agroecological transitions, food system sustainability, plant, animal and ecosystem health, and sustainable development of rural territories and their resilience to climate change.

CIRAD is a public establishment (EPIC) under the joint authority of the Ministry of Higher Education and Research and the Ministry for Europe and Foreign Affairs.

CIRAD hopes that multi-stakeholder partnerships and alliances will discuss, share and support its three ambitions for sustainable coconut growing.

Contact us to find out more: coconut@cirad.fr

Working together for tomorrow's agriculture

Find out more about
the coconut value
chain at CIRAD



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