

Oil palm roadmap summary

The road to sustainable oil palm growing [2023-2033]



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Oil palm accounts for 36% of the vegetable oils and fats produced worldwide, yet occupies less than 10% of the area planted with oil crops. Despite its exceptional potential yields across the intertropical zone, the value chain faces a range of challenges. To address those challenges, CIRAD has produced a ten-year roadmap to help farmers and industrial plantations along the road to more sustainable production operations. ■

Oil palm originated in the Gulf of Guinea, and has been grown there for thousands of years. Following on from that tradition, 75% of oil palm plantations in many West and central African countries still belong to smallholders. In these countries, palm oil is still largely produced on a small scale and is not refined prior to consumption. This unrefined oil, called “red palm oil”, accounts for up to 25% of the vegetable oils consumed by local households, but palm oil is also now used worldwide. In 2022, some 79 Mt were produced, primarily by Indonesia (59%) and Malaysia (24%), mainly for food use (68% of the total produced) and in refined form. The main consumers are Indonesia (17 Mt), India (8 Mt), the European Union (7 Mt) and China (6 Mt). Demand for vegetable oils is set to double by 2050, in view of the current global population growth rate, and oil palm’s exceptional yields per hectare mean that it will inevitably have a major role to play in satisfying that demand.

From industrial plantations to family farms, a wide range of cropping systems

In 2022, there were 24 Mha of productive palm oil plantations, split between South-east Asia (73%), Africa (20%), the Americas (6%) and Oceania (1%). Oil palm is grown by agroindustrial groups, agricultural firms and family farms. Industrial plantations and side-by-side plantings belonging to large numbers of growers sometimes form very specialized agricultural

landscapes, as is the case in Indonesia in particular. These production models are under attack for their ecological impact, primarily because of deforestation but also on account of the water pollution and biodiversity erosion they cause, and for social reasons such as non-respect of workers’ rights, and land grabbing. Oil palm plantings scattered throughout an agricultural landscape, on the other hand, can contribute to rural development, thereby benefiting local people, and participate in biodiverse landscape mosaics, if grown alongside other crops.

Many advantages, but a growing number of difficulties

Despite the fact that palm oil prices depend on global markets and are thus highly variable, oil palm generates remarkable returns: although palm oil is cheaper than other vegetable oils, growing oil palm is still profitable. Oil palm generates income for between six and 12 months a year, for at least 25 years. The palm oil in the crop’s fruits (drupes) is generally extracted industrially, at high-capacity mills, and subsequently refined, although in Africa, industrial extraction coexists with small-scale extraction units. Refined, fractionated palm oil has many advantages. The highly oxidation-stable and temperature-resistant part that is solid at ambient temperature is of interest to the food industry, while the part that is fluid at ambient temperature is a cheap vegetable oil rich in oleic acid. The unrefined red oil, for its part, is known for its exceptional

provitamin A and vitamin E content. Its low price makes it a key element in the food security of African households.

Despite the above, the value chain faces a number of challenges. The first is its environmental impact, as a result of the massive, highly specialized expansion of oil palm growing over the past 60 years. In response, industrialists and NGOs founded the Roundtable on Sustainable Palm Oil (RSPO) in 2004, to limit deforestation and help farmers change their practices. However, despite the undeniable successes this research-backed initiative has had, there are still substantial environmental issues in many areas. The second major challenge is the age of a large proportion of plantations. The oil palms of the future will need to do better in terms of yield, resistance to emerging pests and diseases, and resilience to climate change. The third challenge is social aspects, such as land grabbing, unfair revenue distribution and the attractiveness of agricultural jobs, which could jeopardize current economic production models. ■



Promoting more sustainable oil palm growing: four ambitions to frame operations

Over the past 80 years, CIRAD has contributed to a range of decisive advances in terms of knowledge of oil palm, mastery of cropping systems, and varietal innovation. Its operations have been marked by partnerships in producing countries across three continents, allowing it to achieve scientific results and make substantial progress on supporting farmers by means of expertise and training. To enable it to press on and address the challenge of sustainable oil palm growing, CIRAD released a roadmap in 2023, centring on four main ambitions.

Ambition 1

Achieve the agroecological transition to more sustainable oil palm plantations that help restore landscapes

CIRAD's research includes both building innovative agroecological systems and adapting existing systems. It follows three main lines: (i) restoring degraded landscapes by reintroducing biodiversity into oil palm production zones, (ii) promoting biodiverse, zero-deforestation oil palm plantations, and (iii) developing a range of knowledge and tools that serve the agroecological transition (AET), in various cropping situations. The aim is for CIRAD and its partners to roll out multidisciplinary approaches and multi-criteria assessments of oil palm plantation environmental, economic and social performance, to contribute to the AET within the value chain.

Ambition 2

Promote a move within the sector towards greater sustainability, inclusiveness and attractiveness, by means of new development models

CIRAD is working to foster the establishment of more sustainable, inclusive value chains at a time when producing countries wanting to become self-sufficient might be tempted to reproduce the agroindustrial development model of the past, despite its numerous adverse social and environmental effects in many countries. The aim is to integrate oil palm plantations into territories and landscape mosaics and ensure that they provide decent jobs and fair incomes for all producers, and capitalize on the efforts of those players who invest in sustainable production, with innovations that can be shared with each and every stakeholder. To this end, CIRAD is working along two main lines: (i) identifying the conditions for establishing more sustainable, inclusive development models, and (ii) supporting producers by means of a transdisciplinary approach.

Ambition 3

Generate and share knowledge to develop the oil palms of the future

Expectations are high for the oil palms of the future, which will have to satisfy the sustainability targets set for the sector while producing consistently high volumes of quality fruits. To this end, CIRAD will be continuing its innovative oil palm genetic improvement operations by stepping up the production and sharing of knowledge of oil palm biology and diversity, working

along three main lines: (i) taking a fresh look at ideotypes, in other words the oil palm characteristics of interest to the various players in the value chain, (ii) identifying, characterizing and conserving natural or cultivated oil palm genetic diversity, and (iii) understanding the genetics of characters of interest, to optimize breeding operations. This will enable CIRAD to define ideotypes that address both farmers' agronomic issues in terms of diseases, environmental stresses and new cropping practices, and consumer demand as regards nutritional value and culinary use. For CIRAD, this will mean developing innovative phenotyping or data analysis methods and sharing them within the scientific community.

Ambition 4

Foster the development of red oil consumption, for sustainable food systems in Africa

CIRAD's ambition is to support red oil supply chains. Until now, breeding programmes had not looked at oil composition, and in some cases, the fruits of today's commercial varieties have much lower fat-soluble vitamin contents than those of non-selected palms. This ambition centres on three lines of research: (i) evaluating, understanding and making use of existing biodiversity to improve red oil fatty acid composition and vitamin content, with oil palm varieties that satisfy farmers' and consumers' requirements, (ii) assessing the merits and feasibility of alternative planting material improvement strategies, and (iii) pinpointing the advantages, weaknesses and impacts of red oil supply chains and short supply chains, in social, economic and environmental terms. ■

Details

What about the agroecological transition, sustainable development models, genetic improvement, red oil? We look at the oil palm roadmap with CIRAD oil palm research coordinators Fabienne Morcillo, a plant genomics researcher, and Sylvain Rafflegeau, a systems agronomist.



RR

How does the agroecological transition apply to family plantings as well as industrial plantations?

Sylvain Rafflegeau: Some of the players in the sector have embarked on the agroecological transition, either of their own accord or in line with legislation. Those committed players include industrial plantation firms, which have built skills in terms of organic fertilizers and service plants that improve soils and may also attract natural enemies. These firms have also changed how they treat the waste water produced by their oil mills, in line with new environmental standards. Farmers, for their part, are beginning to include other crops in their oil palm plantings, either temporarily or permanently. Introducing biodiversity into plots in this way, and the additional income that biodiversity generates, is helping plantations and small-scale farms to make the agroecological transition. In small-scale oil mills, efforts are focusing on extracting more oil and reducing fuel-wood use. Lastly, agroindustrial firms and farmers are allowing livestock to graze their plots, and also sometimes using them

to transport oil palm bunches. CIRAD is involved in the above operations, providing the various players concerned with scientific support and encouraging them to share their experiences with one another, as well as with other stakeholders who have not yet embarked on the agroecological transition.

How can we design new, more sustainable development models? Are there already some examples?

S.R.: In the past, the dominant agroindustrial development model meant industrial oil mills and plantations, sometimes surrounded by smallholder oil palm plantings. Industrial plantation firms seeking out stretches of land without any people, covering several thousand hectares, were given largely unpopulated forest concessions. To plant oil palm, players cleared the forest around industrial oil mills. Seen from the air, industrial plantations are clearly hyperspecialized zones, “seas of oil palms”, with very little biodiversity within the landscape. Conversely, when farmers plant their own land, they create landscape mosaics that maintain biodiversity. To build more sustainable oil palm plantations, CIRAD suggests moving away from the agroindustrial model, set up on forest land, and instead helping farmers to plant oil palm on agricultural land and encouraging agroindustrial multinationals to build mini-oil mills scattered across those agricultural areas. In Latin America, the social model of partnerships between investors and farmers, in which farmers co-own the oil mills and which gives farmers social and economic benefits and allows them to participate in decision making, is an example of this new sustainable development model.

What role could genetic improvement play in tackling the challenges facing the value chain?

Fabienne Morcillo: The breeding programme being conducted by CIRAD, alongside its subsidiary PalmElit and its partners across three continents, is backed by more than 80 years of work. The programme

is now being adapted and modernized, to take account of the challenges faced and tackle a new range of breeding criteria. For example, the gaps observed between potential yields and actual yields in the field suggest that there are ways of increasing oil palm plantation productivity even further, by breeding for characters such as disease resistance, suitability for specific soil and climate conditions, and certain biological characters that favour high yields, such as vertical growth rate, reduced fruit fall, or bunch weight and size.

CIRAD's multidisciplinary teams, backed by their partner network, are building innovative breeding approaches, notably based on genomics and on high-speed phenotyping methods. CIRAD and its subsidiary are also switching to more participatory research approaches and disseminating genetic progress at grassroots level.

What does the future look like for red oil in Africa?

F.M. and S.R.: CIRAD and its partners have shown that red oil vitamin contents and fatty acid compositions vary considerably depending on planting material origin. This natural biodiversity can be used to encourage local production of red oil that is particularly rich in fat-soluble vitamins, to tackle nutritional deficiencies, particularly in sub-Saharan Africa. However, adopting new varieties also means satisfying demand from farmers in terms of agronomic performance and from consumers in terms of oil fluidity and colour, which depend on fatty acid composition and carotenoid content respectively. To this end, CIRAD intends to build interdisciplinary research projects with its partners in Africa, to improve knowledge of (i) farmer and consumer expectations, (ii) the molecular determinism of red oil characteristics, and (iii) the effect of the environment and cropping practices on oil nutritional quality.

Find out more: oilpalm@cirad.fr

The Trails project, working for sustainability

On the island of Borneo, in Southeast Asia, the expansion of oil palm monoculture has caused substantial environmental damage, due to massive deforestation. The Trails project is being implemented by a group of complementary partners from academia, NGOs, and private- and public-sector players. The aim is to re-establish links between oil palm plantations, agroforestry plots, riverside forests and biodiversity reserves,

to rebuild sustainable, unbroken landscape corridors in the Kinabatangan River basin. Agroforestry systems are a valid climate change mitigation-adaptation strategy in response to climate events caused by El Niño and their dramatic impacts on both humans and wildlife. Trails is setting up oil-palm-based agroforestry systems using novel planting schemes, with the intention of comparing the performance of traditional and agroforest

systems, and of understanding the main characteristics of climate resilience, by closely monitoring the main environmental services (photosynthesis and soil health). It is also analysing the socioeconomic impact of the agroecological transition from monospecies plantations to agroforestry systems.





Find out more:



Inventing the oil palm sector of the future

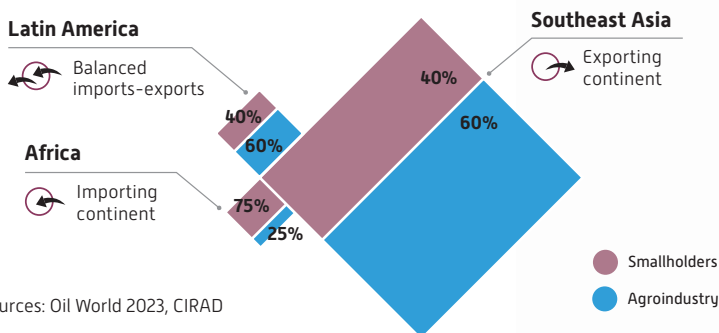
CIRAD is addressing the challenges facing the value chain

Oil palm is the leading vegetable oil crop across three producing continents

Main oil crops	Area harvested (Mha)	Vegetable oil production (Mt/year)	Average yields (t vegetable oil/ha)	Area required to produce 1 t of vegetable oil (ha)
 Oil palm	24	90	3.15	0.28
 Soybean	140	59	0.42	2.39
 Rapeseed	39	30	0.76	1.32
 Sunflower	30	21	0.70	1.44

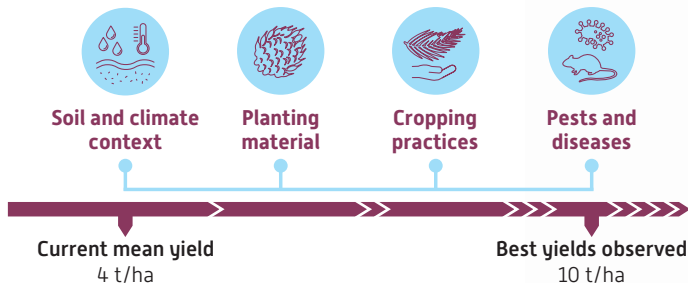
Source: Oil World 2023

Area planted with oil palm / distribution per player / import-export balance per continent



Sources: Oil World 2023, CIRAD

Boosting yields, to satisfy ever-growing demand



Sub-Saharan Africa: painting dishes red



80% of people's diets are deficient in fat-soluble vitamins



0.5 l of red palm oil per person per month covers recommended daily allowances of fat-soluble vitamins

Our ambitions...



Achieving the agroecological transition to more sustainable oil palm plantations that help restore landscapes



Promoting moves within the sector towards greater sustainability, inclusiveness and attractiveness, via new development models



Generating and sharing knowledge, to develop the oil palms of the future



Fostering increased consumption of red palm oil, for sustainable food systems in Africa

... in partnership

Several platforms in partnership for research and training (dPs) work on oil palm:

dP Agroforesterie Cameroun
 dP Amazonie



dP HRPP
 dP SALSA
 dP AGROFORESTA

CIRAD is coordinator of the Oil Palm Genome Projects (OPGP) International Consortium.



PalmElit, a CIRAD subsidiary, conducts genetic improvement programmes and supplies around 1/4 of the oil palm seed traded worldwide.

Our means and resources

89

scientists from 3 departments

10

research disciplines involved, from genetics to sociology

2004

CIRAD has been an affiliate member of the Roundtable on Sustainable Palm Oil (RSPO) since its founding in 2004

39

theses published on oil palm since CIRAD's founding

3

CIRAD has developed varieties resistant to the main 3 oil palm diseases

60

or so articles per year co-published with partners in peer-reviewed journals

Partnerships, the core of CIRAD's research

CIRAD's oil palm operations generate knowledge through research in partnership, to benefit both smallholders and industrial plantation firms. The aim is to facilitate international cooperation by establishing and leading research consortiums and research and development projects. That cooperation relies on partners sharing data and methods, on participatory construction of technical and organizational innovations with local players, and on joint promotion of results by means of multi-institution publications. For CIRAD, understanding, sharing and learning also mean influencing and participating in initiatives aimed at providing professional and academic training, preferably diploma-based, in the value chain. Lastly, as regards commercial aspects, CIRAD and its partners provide field players with consultancy services, while its improved oil palm varieties are distributed and marketed by its subsidiary PalmElit and the partners that produce the selected seeds. ■



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A word from our partners



**Interview with
Daniel Torres,**
Director General,
Mexican Oil Palm
Federation
(FEMEXPALMA)

Could you tell us about the collaboration between the Mexican Oil Palm Federation (FEMEXPALMA) and CIRAD?

FEMEXPALMA is a professional organization founded in 2016. It associates producers and business people keen to unite, represent and defend the interests of stakeholders in the sector, to further the development of oil palm growing in Mexico as part of a new sustainable development scheme. Our country produces around 40% of the oil it consumes. Mexico began growing oil palm some 25 years ago, and FEMEXPALMA and CIRAD started to work together in 2018. We first met CIRAD researchers during an initial trip to sound out the opportunities in Peru and Mexico. Then in 2019-2020, another group of researchers began to forge links with various higher education centres and institutions. "Optipalmex", the first joint project between CIRAD and FEMEXPALMA, was launched in late 2022. Optipalmex works in two

states (Tabasco and Campeche). One of its aims is to plant 200 hectares of oil palm combined with other crops, in an agroforestry system and using agroecological methods. We will be collaborating on the soil analyses required ahead of planting the plots belonging to the producers chosen to take part.

What do you think of the ambitions set in the CIRAD oil palm roadmap, particularly ambitions 1 (agroecology) and 2 (new oil palm development models)?

FEMEXPALMA is on the same page as CIRAD as regards the priority known as the "agroecological transition". We are promoting agroecology to oil palm smallholders and encouraging them to diversify the crops they grow, as part of ecosystem mosaics and forest landscapes (in Chiapas, various producers are alternating cocoa or banana, intercropped with oil palm, and in Campeche, other crops such as maize are grown). The Mexican oil palm sector is currently working to roll out integrated strategies and projects aimed at building sustainable landscapes, in line with the public policies set by the federal government; those policies are intended to ensure that the region's protected natural areas are respected, along with high conservation value zones, in other words those that are exceptionally biologically, ecologically, socially or culturally valuable or critically important. Generally speaking, we work with smallholders to train them and help them to adopt good farming and environmental practices such as planting nectar-producing plants, using cover plants to beat soil erosion, and increasing the use of organic fertilizers (vermicompost, effluent, etc). ■



Interview with Rina Turi,

PhD student at Institut Agro Montpellier and University of Jambi (Indonesia)

What is the history of your partnership with CIRAD?

I am a PhD student at Institut Agro Montpellier; my thesis topic is "Co-constructing agroecological replanting models with oil palm smallholders in Jambi, Indonesia". From 2018, as a student at the University of Jambi, I worked with CIRAD on understanding the link between the agroecological performance of oil palm cultivation and socioeconomic aspects. Then in 2020, with the help of a CIRAD researcher, I won a scholarship from L'Oréal for my PhD. Smallholders (who account for 40% of oil palm plantings in Indonesia, compared to 60% for agroindustry),

are at a crossroads: most palms were planted 25 years ago, so the plantations are ageing and need to be renewed. Today's choices will determine the sustainability of those new plantations.

What is your current project and how does it tie in with CIRAD's sustainability ambitions?

The project we are working on with a CIRAD researcher assigned to Sumatra aims to help smallholders build the best possible oil palm replanting model, combining increased yields and agroecology. The idea is to convince smallholders that they can grow oil palm in a sustainable way, and leave arable land to their grandchildren, provided that they work it sustainably. We want to teach farmers and smallholders how to achieve good yields without using too much fertilizer or herbicides. To do this, we are working with the University of Jambi, the Indonesian Ministry of Agriculture and local cooperatives, across an area of 5200 hectares. The project is funded by the cosmetics company L'Oréal, which uses large volumes of palm oil as a raw material, and wants to guarantee a sustainable supply without deforestation. ■



Interview with Hervé Aholoukpè,

Doctor in Agronomy, agricultural soil specialist, Director of the Centre de recherches agricoles plantes pérennes (CRA-PP) at the Institut national des recherches agricoles du Bénin (INRAB) (Benin)

How did you come into contact with CIRAD and what is the history of the partnership between CRA-PP and CIRAD?

After a Masters in 2009 at the University of Montpellier 2, I defended my thesis on organic matter management in smallholder oil palm plantations in Benin, supervised by a CIRAD researcher from the Eco&Sols joint research unit. However, the partnership between CIRAD and the CRA-PP goes back further than that: as Director of the CRA-PP, I had the privilege of organizing the celebration of its centenary in 2022. The CRA-PP had one of the most important oil palm research stations in the 1940s, managed by the Institut de recherche pour les huiles et oléagineux (IRHO), one of the institutes that subsequently merged to form CIRAD. After CIRAD was founded in 1984, our partnership continued, and still exists today. Since the creation of PalmElit, we have continued our research in partnership. The CRA-PP, PalmElit and CIRAD are now working on joint projects co-constructed with researchers from our organizations and conducted at stations in Benin. Our activities encompass oil palm breeding, agronomy, physiology and plant pathology, among others.

In what way do the ambitions set out in the CIRAD oil palm roadmap inspire you?

We are working together on shared issues. We have already had significant results, for instance as regards planting material quality [oil yields have trebled in 60 years]. That improved material can now be found worldwide, from Ecuador to Indonesia, and obviously across African countries such as Benin, Togo, Nigeria, Congo, and others. Our aim is to create improved varieties that satisfy growers' requirements [high oil yields, disease resistance, water stress tolerance, high extraction rates, etc]. As regards red oil, for example, we are planning to work on oil colour, in response to smallholders' concerns about insufficiently red oils, which look like refined industrial oils. The technologies we are developing are of interest to both large plantation firms and smallholders. We have been working for more than a decade on a project to understand genotype-environment interactions (CIGE), with research on various planting materials in different contexts (Benin, Indonesia and Nigeria). It is a pleasure for me to look back over this longstanding partnership, a valuable heritage that we are committed to preserving and continuing to build upon. ■





CIRAD is the French agricultural research and international cooperation organization 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 mobilizes 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 four ambitions for sustainable oil palm growing.

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

Working together for tomorrow's agriculture

Find out more about
the oil palm value
chain at CIRAD



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