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AGRICULTURAL RESEARCH FOR DEVELOPMENT

Rubber roadmap summary

The road towards sustainable rubber growing [2024-2034]

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Hevea brasiliensis (also known as rubber tree) is the leading source of natural rubber, which is vital for many industrial sectors, including tyre production. More than 80% of the world's natural rubber (14.6 Mt in 2024) is produced on family farms. While production in Africa has grown substantially in recent years, some 80% of natural rubber is both produced and consumed in Asia. CIRAD has pinpointed four ambitions that will frame its research over the next decade, to achieve sustainable growth in a sector facing a range of challenges. ■

Hevea brasiliensis produces two agromaterials: natural rubber and rubber wood. It is a tree crop, with a very long lifespan – between 25 and 40 years – that begins with an unproductive period lasting five to seven years under optimum conditions. Towards the end of its life cycle, rubber wood can be used in various ways (fuelwood, furniture making, etc). Natural rubber production is entirely dependent on human intervention: rubber trees do not produce latex unless they are tapped by hand. Tapping is done almost year-round, enabling regular production. In 2024, the world's top three natural rubber producing countries were Thailand (34%), Indonesia (14%) and Ivory Coast (12%), while the three leading consumers were China (45.8%), India (9.2%) and Thailand (6.7%). Some 80% of the world's natural rubber comes from family farms, with the remaining 20% produced on agroindustrial plantations (source: *IRSG Rubber Statistical Bulletin*, Vol. 79, 2025). These two complementary production models are facing growing challenges, which have prompted both common and specific research operations.

Climate change, a major challenge for rubber growing

Rubber growing is concentrated (85%) in zones with a mean annual temperature of between 26°C and 28°C, and rubber has never been grown in zones with a mean annual temperature of more than 28°C. What would become of rubber growing if temperatures were to rise by between 2 and 3°C, as the IPCC predicts? Air moisture contents are highly sensitive to temperature, and any change will affect not only rubber tree evapotranspiration, but also the conditions in which smallholders dry their sheet rubber. Lastly, faster, more frequent strong winds are likely to result in more wind breakage. The effects of such variations on tree survival, growth and yields are as yet undetermined. What cropping techniques will enable rubber plantations to adapt to such changes? What will the effects be on postharvest operations and natural rubber quality? The emergence of new diseases as a result of climate change should also be taken into account.

Social, economic and environmental challenges

Guaranteeing a living income for family producers while satisfying growing market demand in terms of quality and standards is a major challenge. Harsh working conditions, low salaries and a lack of social recognition make it difficult for the sector to recruit workers in many countries, such as Thailand, Vietnam and Ivory Coast. The large number of natural rubber smallholders (several million), combined with the wide range of different situations, means that it is not easy to transfer knowledge or market what they produce. This is compounded by the low prices seen since 2014, and substantial natural rubber price volatility on commodity markets. These fluctuations have a direct impact on producers' incomes and prevent any return on investment in planting. There is now little risk of further deforestation due to the expansion of rubber plantations in Southeast Asia, albeit primarily because the forest zones that were suitable for it have largely disappeared. However, there is still some danger elsewhere, particularly in Central Africa and Latin America, depending on whether governance is effective and laws are respected. Small-scale plantations can also result in more homogenous landscapes and in biodiversity loss. Nevertheless, rubber growing can also play a positive role in restoring degraded landscapes and in reforestation, particularly in the case of agroforestry systems. ■

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| Large-scale variety trial (Ivory Coast)

© L. Vaysse, CIRAD

| Rubber plantation (Thailand)

Promoting the rubber sector of the future: four ambitions to frame operations

When it was founded in 1984, CIRAD took over the research activities of the Institut de recherches sur le caoutchouc (rubber research institute). Since then, it has been working to build a sustainable rubber value chain, to benefit family farming systems in particular. Its research encompasses genetics and genomics, agronomy and ecophysiology, plant health, socioeconomics, processing technology and product quality. That research is backed by a range of resources including collections, experimental networks and shared laboratories in some 20 countries. CIRAD is a member of the HRPP platform in partnership for research and training (dP) set up in Thailand in 2008. Eleven of its research units across its three scientific departments – Biological Systems (BIOS), Tropical Production and Processing Systems (PERSYST), and Environment and Societies (ES) – are involved in rubber research, and the departments are providing resources with a view to achieving four main ambitions.

Ambition 1

Optimize land and labour productivity and produce quality rubber

Improving rubber plantation productivity and rubber quality is central to CIRAD's research. One of the main challenges is how to intensify production on the areas already planted, which cannot be extended due to deforestation-free product regulation and competition with food crops. It is also vitally important to improve labour productivity, notably during tapping, to overcome the chronic labour shortage in the sector. CIRAD is working to address these challenges by producing knowledge and innovations to optimize tapping and post-tapping systems, as part of the agroecological transition. Its research covers tree physiology and soil health, crop diversification on various scales, and rubber quality, among other aspects.

Ambition 2

Give family farmers a living income

Family plantations currently account for 80% of the area planted with rubber worldwide. They have prospered thanks to their low structural costs, albeit at the expense of producer incomes. Improving producers' living conditions is one of CIRAD's ambitions, and to this end, it is testing innovative techniques and organizational methods. This requires an interdisciplinary approach. CIRAD is focusing on farm characterization and household income levels and composition, and is building participatory processes to involve stakeholders in designing innovations and ensure that they are adopted. Particular attention is being paid to optimizing rubber-based agroforestry systems.

Ambition 3

Adapt rubber growing to climate change and other types of environmental change

The capacity of rubber and rubber growing to adapt to largely unpredictable climate changes is vitally important for the sector. The possible emergence of new diseases, including leaf fungi, is a real threat. CIRAD is conducting foresight research, preparing responses to the impact of climate change, and looking into the possibilities for adaptation. Ecophysiology, genetic improvement, plant pathology and new cropping systems are among the fields being explored. This includes phenotypical assessments and the creation of varieties tailored to climate change, tolerant of leaf fungi and suited to a range of soil and water stress conditions.

Ambition 4

Integrate rubber growing into territorial frameworks

Rubber is a tree crop with a 35-year cycle that requires nearby initial processing and marketing infrastructures, therefore it influences the landscapes in which it is planted. It can help preserve biodiversity, limit deforestation and restore territorial connections. Since rubber plantations generate jobs and revenue, they also trigger flows of people requiring technical training and social support. CIRAD is therefore looking at the interactions between rubber growing, the environment, health and territories, to come up with agroecological solutions to make the sector sustainable. Implementing the One Health approach to help manage rubber-growing territories could foster harmonious integration. ■

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| Agroforestry systems combining rubber and cocoa trees (Brazil)

Details

How can we make rubber growing more productive and boost natural rubber quality? What do we mean by a "living income"? How can the sector adapt to climate change? These are just three of the questions facing the sector. We look at the key points in the rubber roadmap with CIRAD rubber value chain research coordinators Dominique Garcia, a researcher specializing in plant breeding and plant health, and Laurent Vaysse, an agronomist specializing in natural rubber biochemistry and quality.

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How does CIRAD intend to go about optimizing land and labour productivity?

Laurent Vaysse: Optimizing land and labour productivity is central to CIRAD's remit in terms of the agroecological transition. With markets and societies demanding ever more rubber but zero deforestation, we need to continue to produce knowledge in order to optimize yields per hectare. Tapping is labour-intensive, complex in terms of organization, and difficult to mechanize. Unlike other plants, rubber trees can be "harvested" more than 100 times a year, producing around 15 kg/ha each time. Among other things, CIRAD is working on tapping systems that will optimize land and labour productivity.

Dominique Garcia: Increasing productivity will also partly rely on genetics. We are working on genetic drivers of the latex production, tree growth and disease resistance. CIRAD is developing new approaches to genomic selection, enabling an increase in selection intensity on a reduced experimental area. This is a long-term undertaking, given that it takes some 24 years to produce a rubber variety.

What exactly do you mean by a "living income", and how can it be achieved?

L. V.: We have chosen the ILO definition: a living income is one that gives workers and their families a decent standard of living and allows them to afford essentials such as food, water, housing, education, healthcare, transport and provident savings. It is well above the poverty line, and this is therefore an ambitious objective. To begin with, this means understanding what determines income levels, to pinpoint organizational methods likely to boost both labour productivity and incomes.

D. G.: Improving growers' incomes means analysing farming systems, setting up information platforms to disseminate innovations, and ensuring that those innovations are adopted. To this end, CIRAD is working with groups of professionals, who provide their knowledge, as well as local extension services and research organizations. Innovative reduced-frequency latex tapping systems are increasing both labour productivity and incomes.

What are the main levers for adapting the rubber value chain to climate change?

L. V.: The main levers are varietal improvement and plantation management. However, before we start working on adaptation, we need to identify the effects of climate change. CIRAD is working in the Abiophen high-tech ecophysiology greenhouse in Montpellier to simulate how rubber trees perform in high temperatures. We have worked with Forest AI and Michelin, using IPCC climate scenarios, to produce maps of the zones suitable for rubber in 20, 30 or 40 years' time. However, in many cases, they correspond to forest zones, and there is no question of increasing deforestation.

D. G.: We are working on improvement programmes with Michelin in Brazil, and with the Institut français du caoutchouc and plantation companies in Ivory Coast. Elite varieties are being assessed in several countries, in different environments and conditions. CIRAD also manages a rubber collection at the Tree Crop Biological Resource Centre in French Guiana.

What are the merits of a territory-based approach for developing the rubber sector, and how could it be used, in concrete terms?

L. V.: It would be worth studying the interactions between rubber plantings and their production basins, notably because of the size of the areas planted and the long growing cycles and productive lifespan. In Thailand, for instance, there are entire provinces covered with rubber trees. One positive consequence is that planting rubber trees may help mitigate climate change. In northeastern Thailand, a local researcher colleague recently told me that people were now able to grow food crops in zones that were previously too dry. We have had similar reports from northern Ivory Coast, where rainfall levels have apparently increased since cocoa was replaced with rubber. However, these claims are not yet scientifically documented.

D. G.: The negative impacts include the fact that there are more mosquitoes, which carry dengue and malaria, around rubber plantings, because of the water that collects in tapping cups. On a territory level, these impacts are vitally important for environmental, animal and human health. In Southeast Asia, CIRAD is promoting a One Health approach in rubber growing zones, linking two platforms in partnership for research and training: **HRPP** and **GREASE**. ■

Find out more: **hevea@cirad.fr**

FORSEA* – Forecasting impacts of climate change and workforce availability

The FORSEA regional project set out to anticipate the major challenges for the rubber sector in Southeast Asia, primarily climate change and agricultural labour shortages. It focuses on Cambodia, Thailand and Vietnam, and is documenting the technical, social and economic consequences of the changes underway, pinpointing adaptation options, and sharing those data with players in the sector on different decision-making levels. The project combines research, expertise, knowledge transfer and training in adapting farming practices to IPCC climate scenarios. It aims to identify the risks linked to climate change and labour shortages, build technical and organizational innovations, and train local students. Lastly, by means of a prospective study involving building contrasting scenarios, the project aims to provide information to support public and private decision-making in terms of investment in rubber production and the development of rubber growing areas. One of the secondary objectives is to enable the partner countries to build their own policies based on validated scientific knowledge.

The FORSEA project is funded by the Agence française de développement.

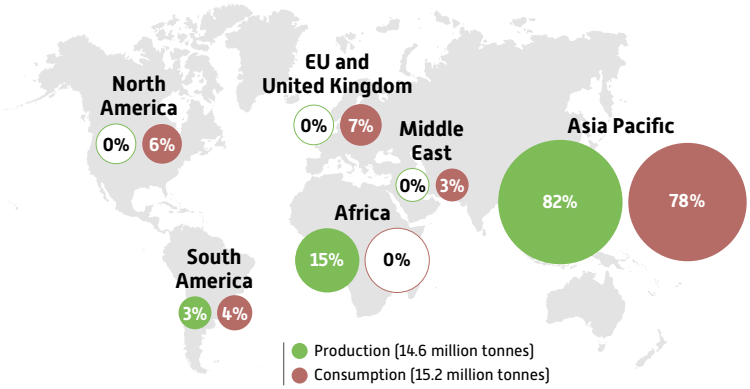
* Forecasting impacts of climate change and workforce availability on natural rubber commodity chain in South-East Asia

Find out more:

Inventing the sustainable rubber sector of the future
CIRAD is addressing the challenges facing the value chain

A sector that combines family farming and industrial production

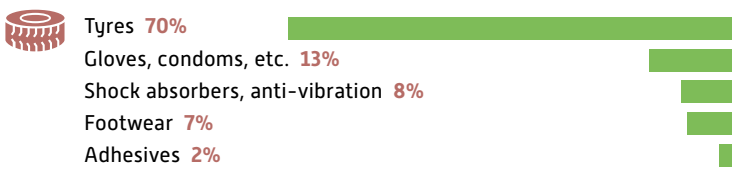
Production and consumption of natural rubber (2024)



Production mainly carried out by smallholders

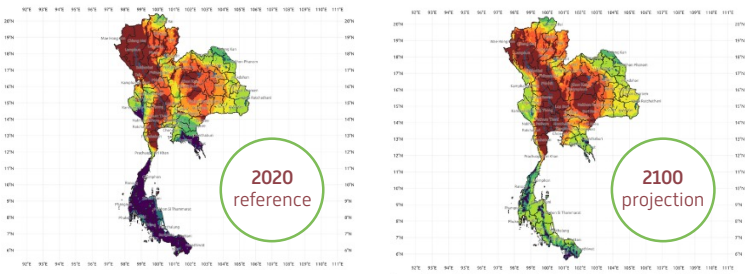
Year 2024. Source: *IRSG Rubber Statistical Bulletin*, Volume 79, Jan-Mar 2025

Production primarily intended for tyre manufacturing



A sector in transition

Using modelling to adapt to climate change



Rubber has never been grown at an average annual temperature of more than 28°C. Research into its behaviour under high temperatures has been carried out as part of the FORSEA project, with a consortium of public and private partners in Thailand, Cambodia and Vietnam.

A crop that must adapt to the regulatory context

Towards zero deforestation: From **1 January 2026**, no rubber or rubber-derived products will be allowed* into the European market without proof that they do not contribute to deforestation.

*EU Regulation on Deforestation-Free Products (EUDR)

Our ambitions...

Optimising **land and labour productivity**, and producing **quality rubber**

Enabling **family farms** to earn a **living income**

Adapting rubber growing to **climate change** and other types of environmental change

Integrating rubber growing into a **territorial framework**

...in partnership

Three platforms in partnership for research and training (dPs):

CIRAD is working with all research centres in rubber-producing countries and with numerous universities. It is a founding member of the **French Rubber Institute (IFC)** and a member of the **International Rubber Research and Development Board** (IRRDB). It collaborates with the world's leading tyre manufacturers.

Our means and resources

45 scientists from **11 research units**

130 publications, including **90 with partners from the Global South** over the past 10 years (2015-2025)

30 **doctoral** students trained by CIRAD over the past 10 years (2015-2025)

790 **hevea accessions** in the Biological Resource Centre – Perennial Plants

2 research products recognised worldwide: Latex diagnosis and clonal conformity analysis

Partnerships, at the heart of CIRAD's research

CIRAD's rubber research operations rest on long-term partnerships with public and private players in various regions with contrasting climates (Cambodia, Thailand, Ivory Coast, etc). Its collaborations involve national research organizations and universities in the global South and North, NGOs, government bodies, international networks and the private sector. At the heart of these partnerships, the Hevea Research Platform in Partnership (dP HRPP), centring on the Association of Southeast Asian Nations (ASEAN), is a major asset for tackling the challenges facing a region that produces the vast majority of the world's natural rubber. The platform was set up in 2008 and associates more than ten academic and private-sector partners, enabling a unique integrated multidisciplinary approach to a wide range of research topics, from rubber plantlet to raw rubber bales. ■

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| Latex sampling in an experimental plantation (Thailand)

A word from our partners

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Interview with Thierry Stéphane Serres,

Managing Director of Société africaine de plantations d'hévéas (SAPH), a SIPH subsidiary and member of the Ivorian agroindustrial group SIFCA

What is the history of the links between SIPH and CIRAD?

Our partnership dates back to before the founding of CIRAD, to the institutes that preceded it, and CIRAD has always been a major partner, working alongside players in the sector. We have a direct bilateral relationship, but also a transverse one via the Institut français du caoutchouc (IFC), a network in which we also work with other partners such as Michelin, which has a history of R&D activities focusing on this vital material. Our partnership is still active and dynamic. It focuses on Africa, notably Ivory Coast, but also benefits from projects in Brazil and Asia (Thailand, Indonesia and Cambodia), with expertise and research work being shared with a range of players, operators, academics, scientists, etc. Our collaboration with CIRAD encompasses a wide range of topics and skills, from varietal breeding to natural rubber processing and delivery to end customers. Our partnership with CIRAD is both fruitful and indispensable, and rests on the quality of the relationships forged between CIRAD's researchers and our professionals, in every area of the value chain. CIRAD's range of operations and skills is a key asset, as is its "value chain" approach, which ensures the sort of coherent vision our partnership needs.

How do you feel about the ambitions set out in the roadmap?

Rubber productivity and quality, ambition 1 of the CIRAD roadmap, are vitally important. Our work with CIRAD, notably the development of new varieties and efficient tapping systems that optimize yields per unit area and labour productivity, is a reference in the sector. Ambition 2, to ensure a living income, is also crucial. In Ivory Coast, a million people rely on growing rubber for their living. Rubber offers growers a steady income throughout the year, produces not just rubber but also a valuable wood, and captures large quantities of carbon throughout its long life cycle. To cushion rubber price variations and guarantee a living income for producers, we are also working with CIRAD on crops that could be grown with rubber, to spread the risks on a plot or territory scale. As for ambition 3, focusing on climate change, we have worked with CIRAD on a foresight exercise up to 2100, combining a production model with IPCC data to pinpoint the possible changes in the potential of the different rubber growing zones. The results, which are alarming in some cases, will serve to light the road ahead and will be decisive for a sector in which any investments are necessarily long term, and which will thus be better equipped to build adaptation and mitigation strategies. ■

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Interview with Dr Sunantiga Pangchuti,

Foreign Relations Officer, Foreign Affairs Sub-Division, Rubber Authority of Thailand (RAOT)

What is the history of your partnership with CIRAD?

I have been working with the Rubber Authority of Thailand (RAOT), the central state organization responsible for the rubber sector in Thailand, for the past 15 years. Since becoming the Chief of the Foreign Affairs Sub-division in 2018, I have collaborated with CIRAD on several projects – from facilitating local farmer and rubber farmer groups visits and fieldwork to co-organizing international workshops in partnership with other respected institutes and organizations in Thailand.

One of the key achievements during my tenure has been expanding the network to include associated partners from the private sector of the rubber industry, such as Michelin and Sumitomo Rubber Industries. By ensuring that the academic and downstream sectors have a proper platform for communication and the exchange of research knowledge and academic expertise – and by disseminating this information internationally – we have been able to generate practical benefits for end-users, improve the livelihoods of rubber farmers and their local communities, and enhance engagement among various stakeholders in the rubber sector.

Another accomplishment I am proud of is the honor of being appointed the Thai coordinator of the dP HRPP for 2024, as well as my participation in the dP Days and CIRAD's 40th anniversary event in Montpellier last September. It marked the first time that a representative from RAOT attended the event. The experience broadened my perspective and allowed me to build valuable connections with other dP members from other countries.

What do you think of the main objectives of the CIRAD natural rubber roadmap? Do they fit in with those of your organizations?

The main objective of the Rubber Authority of Thailand (RAOT) is to improve the wellbeing of rubber stakeholders – especially smallholders – in a sustainable manner across social, economic, and environmental dimensions, as outlined in RAOT's 20-Year National Strategy (2018–2037). In this regard, our National Strategy closely aligns with the CIRAD roadmap. Both initiatives emphasize the adoption of new technologies and innovations to add value to natural rubber.

Furthermore, we prioritize the development of strong communities among rubber smallholders and farmers' institutions to facilitate knowledge sharing and technology transfer. This includes promoting efficient tapping techniques, good agricultural practices, and addressing key challenges such as labor shortages and low productivity.

We also aim to foster the next generation of researchers and build an international network of rubber academics with a clear intention of producing tangible results – especially in commercializing research and generating new opportunities for rubber-based products.

Given the economic challenges, and considering that Thailand is one of the world's leading rubber producers, we place great emphasis on developing innovative rubber products and identifying Blue Ocean Markets. It is crucial that we discover new and sustainable pathways for the rubber market to enhance its long-term value.

Finally, I would like to thank CIRAD for its dedication and efforts in developing the natural rubber supply chain roadmap. This initiative is highly beneficial for both rubber-producing and rubber-consuming countries, as it provides strategic direction toward a sustainable rubber supply chain through our joint research. ■

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| Inspection of a fresh rubber sheet on a family farm (Thailand)

© L. Vaysse, CIRAD

| Dry rubber samples obtained after creping/drying of cup coagula (Thailand)

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

It works with its partners to build knowledge and solutions for resilient farming systems in 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, health (of plants, animals and ecosystems), sustainable development of rural territories, and their resilience to climate change. CIRAD works in some fifty countries on every continent, thanks to the expertise of its 1750 staff members, including 1200 scientists, backed by a global network of some 200 partners. It also supports French science diplomacy operations.

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

CIRAD hopes that multi-stakeholder partnerships and alliances will discuss, share and support its four ambitions for a sustainable rubber sector.

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

Working together for tomorrow's agriculture

Find out more about the rubber value chain at CIRAD

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