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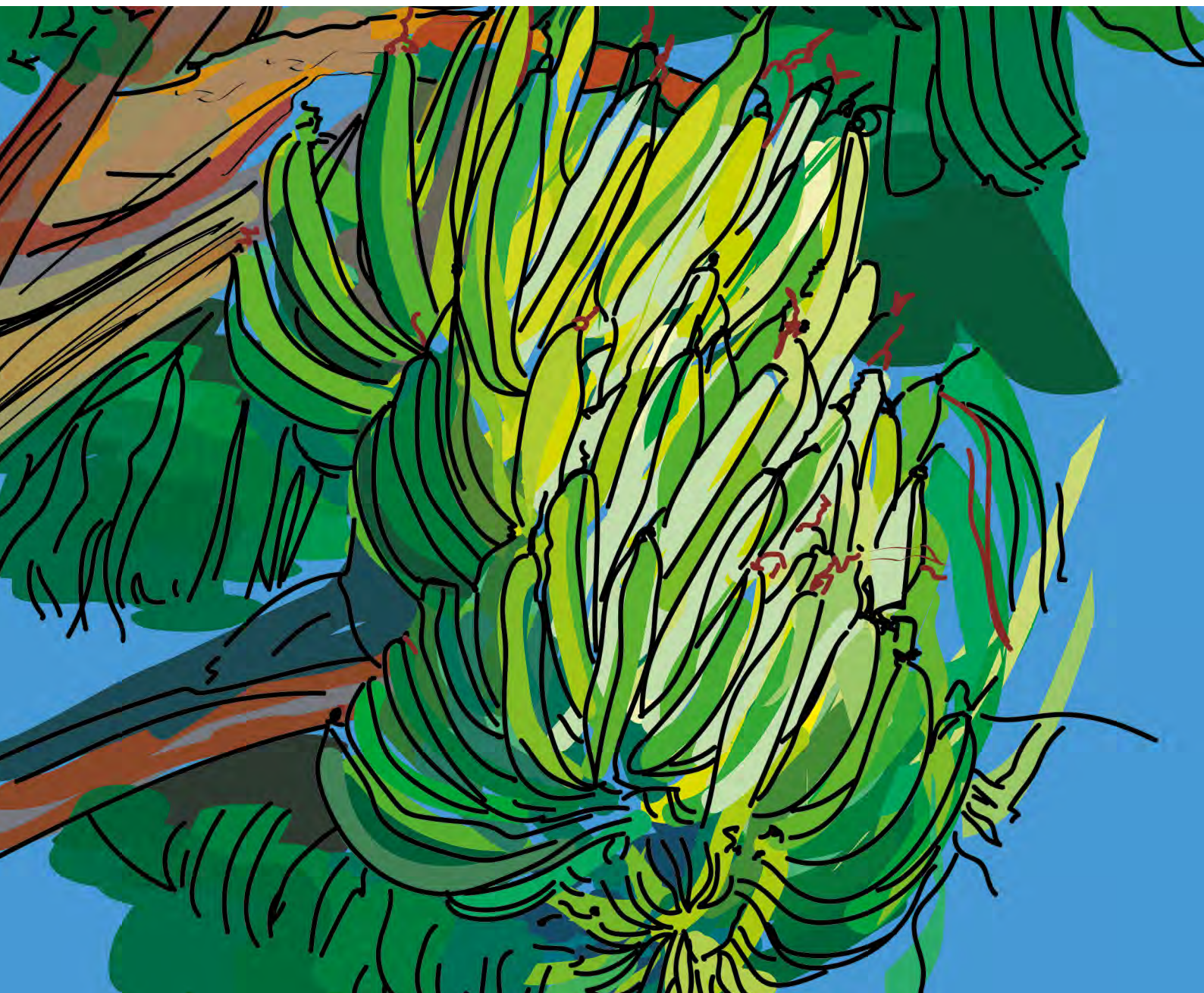
Dessert and plantain banana roadmap summary

The road to sustainable dessert and plantain banana growing [2024-2034]



The road to sustainable dessert and plantain banana growing [2024-2034]

The global banana sector, which is highly diversified (types, zones, practices), is vital for the food security and livelihoods of hundreds of millions of people. Dessert bananas are also widely traded internationally. On local markets, the challenge is to achieve increased supplies, particularly of plantain, while limiting pesticide use. On an international level, production must be made more sustainable and synthetic pesticide-free. ■

Banana production worldwide is estimated at around 150 million tonnes. This puts its second in the world fruit production rankings, behind citrus and ahead of apples. There are more than 1000 varieties. Bananas (genus *Musa*) can be split into two main groups: "cooking" types (including plantain) and "dessert" types (including Cavendish). Bananas are more than just an agricultural commodity found on markets worldwide, they are first and foremost a staple food for a large part of the world's population, for instance in West and central Africa, Asia or South America. The annual global harvest of 10 Mt of plantains comes from more than two million producers, on family farms and alongside other crops. The number of cultivated varieties is estimated at more than 130, most of which are higher-yielding "False Horn" and "French" types. They have many uses, primarily as the basis for many dishes, and also interesting outlets in the agri-food industry (chips, infant cereals and bread flours, and processed products with a long shelf life). Demand is strong and is growing rapidly. According to estimates, there is a 10-Mt shortfall in plantain production in relation to current requirements in West and central Africa. The aim is therefore to support a rapid increase in production while conserving the diversity of production systems and doing the utmost to avoid the sector being reliant on chemical input use, particularly pesticides.

Agroecological transitions are within reach

As regards dessert bananas, it is the Cavendish group that provides most of the global supply, which is estimated at around 93 Mt, including more than 21 Mt sold on export markets. The situation is very different from that of plantain. The banana export chain is very unusual in that it is structured around a single varietal group: Cavendish. That uniformity is compounded by the fact that production systems are all more or less identical: centred on intensive input use (fertiliser, pesticides) and labour-intensive (one or two direct jobs per hectare). The share of so-called "family" systems in global trade has been shrinking for a couple of decades, and is now very marginal due to the difficulty of accessing global markets, which have become highly competitive and standardised. The production sector needs to address many issues, whether social (working conditions, workers' and their families' exposure to pesticides, freedom of association, a living wage, etc) or environmental. Although situations vary depending on soil and climate conditions and national regulations, the sector as a whole consumes huge quantities of synthetic pesticides, as the crop suffers from many pests and diseases: black Sigatoka, nematodes, weevils, fusarium wilt, etc. In non-rational systems, chemical control involves multiple treatments totalling up to 100 kg of active ingredient per hectare, per year. However, there are now several viable alternatives (in vitro plantlet/healthy soil combo, "purifying" fallow, trapping, mechanical stripping, service plants, etc), and innovative cropping systems combining those solutions with genetic advances (a range of resistant varieties) are particularly good at steadily reducing, if not halting, synthetic pesticide use.

Agroecological transitions are now within reach. What remains to be done is to create the conditions for their large-scale rollout, both for the plantain value chain in central and West Africa and for the global export dessert banana value chain. ■

© T. Lescot, CIRAD

| Installing a bag to protect a future Cavendish dessert banana bunch

© J.-M. Deboin, CIRAD

| Wrapping bunches of Cavendish dessert bananas for export

Promoting the dessert and plantain banana production of the future: three ambitions to frame operations

CIRAD has more than 70 full-time post equivalents working across the range of topics relating to bananas: genetics, pests and diseases, quality and postharvest aspects, agronomy and market analyses. For decades, its impact culture, historical presence in the French West Indies alongside producers, and numerous partnerships in other production zones have enabled CIRAD to propose sustainable production systems tailored to individual territories. CIRAD is a major player in worldwide transitions, along with its biotechnology subsidiary Vitropic, helping value chains with their agroecological transitions and supporting public policy. The aim is to avoid or reduce synthetic pesticide use by combining varietal diversity and innovative cropping systems. Three ambitions underpin that vision.

Ambition 1

Dessert banana agroecology 1.0: a major reduction in pesticide use within five to ten years

New knowledge, partnerships and projects will help producers and other value chain stakeholders adopt technical and organisational solutions developed by CIRAD. Based on the principles of agroecology, innovative cropping systems tailored to individual territories will allow a major reduction in pesticide use in the various growing zones devoted to export or regional markets. Innovative practices have long been widely adopted by French producers in Guadeloupe and Martinique and others in central and West Africa, and a wide variety of combinations is possible: fungicide treatments triggered by biological warnings, healthy planting material (in vitro plantlets), purifying fallow, trapping, service plants, etc.

Ambition 2

Dessert banana agroecology 2.0: aiming to go zero-pesticide

The aim is to develop new dessert banana production concepts that make use of varietal diversity (resistant varieties), multi-species systems or systems tending towards agroforestry. This ambition is also intended to ensure a high level of social and territorial sustainability (better distribution of added value, worker wellbeing, contribution to territorial development, etc). This knowledge and know-how will be co-developed and disseminated by CIRAD in association with its Vitropic subsidiary, research partners, producers, various direct players in value chains (including distribution), territorial and national policymakers, NGOs and civil society.

Ambition 3

Ecological intensification of plantain growing in Africa

This ambition is aimed at supporting an economically sustainable increase in plantain production that safeguards natural resources and producer and consumer health. It is based on both the knowledge and innovations built to benefit the agroecological transition in the dessert banana value chain and plantain producers' expertise, such as complex, resilient intercropping systems. The aim is to combine transfer and adaptation of innovations and efficient crop management sequences, particularly through active training for both producers and supervisory staff, production of new knowledge, for instance through an in-depth exploration of the benefits of crop varietal diversity for agroecology, and co-construction of innovative cropping systems with producers. ■

© T. Lescot, CIRAD

| Pheromone trap to capture banana weevils

© E. Wicker, CIRAD

| Variety susceptible to fusarium wilt

Details

Why should we and how can we support the banana value chain through the agroecological transition? What will the banana value chain of the future look like? What are the levers for ecological intensification of plantain? We look at the key points in the dessert and plantain banana roadmap with D. Loeillet*, agroeconomist, J. Carlier*, plant pathologist, and S. Dépigny, agronomist at CIRAD.

Why should we and how can we support the banana value chain through the agroecological transition?

Photos – RR

Denis Loeillet:

The dessert banana value chain has not seen any profound changes since the 1960s, but is now at a crossroads. All the signs point to a need for change, and it is time for agroecological transition. The regulations surrounding pesticide use and residues are ever-stricter, while people working in and living near plantations are increasingly concerned about their health. Distributors are massively resorting to certification systems, which means growing environmental and social demands. The entire range of public and private stakeholders are in favour of transition, albeit with varying degrees of enthusiasm. The banana value chain, which has until now been dominated by the inevitable Cavendish variety and is now under threat from pests and diseases, urgently needs to embark upon agroecological transition. CIRAD is supporting that transition, from two complementary angles: (i) by designing innovative production systems that combine alternative practices such as rational control of black Sigatoka, nematode and weevil control using fallow or trapping, service plants, etc, and (ii) by creating and breeding resistant varieties. This latter approach aims to offer a degree of genetic diversity that would make production systems more resilient and ensure greater added value by segmenting supplies. CIRAD and its Vitropic subsidiary have historically been leaders in the field of conventional varietal improvement by hybridisation (resistant varieties are already being tested), and are now developing gene editing expertise (NGT or New Genomic Techniques). A combination of the two pathways—hybridisation and gene editing—is looking highly promising.

What will the banana value chain of the future look like?

Jean Carlier:

The banana value chain of the future will be one that has managed to overcome emerging diseases while maintaining quality and productivity. French West Indian producers are subject to EU regulations, and cannot multiply chemical treatments against black Sigatoka as other growers worldwide do, and there is no treatment against fusarium wilt. CIRAD suggests creating new resistant varieties by combining the conventional hybridisation approach with biotechnologies based on gene editing. This is the challenge for the Bana+ project (see box below). We know that in time, pathogen populations adapt, and the aim is therefore to create varieties with long-lasting resistance. That means combining different resistance genes within a given variety or mix of varieties (in a given plot), in mosaics (on a landscape scale) or in rotation. More than ever before, for banana and for other value chains, we need to reintroduce crop and species diversity, not just to control pests and diseases but to generate added value.

What are the levers for ecological intensification of the plantain value chain?

Sylvain Dépigny:

There are three levers for producing more plantains in a sustainable way. The first is to convince policymakers, agricultural advisors, trainers and producers that ecological intensification of plantain growing in Africa is the way forward. It would be capable of supplying local and sub-regional markets, which are currently largely under-supplied and have yet to come under pressure from standardisation and quality standards. This is the aim of the IPA (Initiative for the Ecological Intensification of Plantains in Africa)[1]. The second is to train producers and their agricultural advisors in agroecology. Producing plantains as a specialist crop takes skill, particularly without pesticides. The FABA teaching package and the training it provides for trainers are a good solution. The third lever is to generate knowledge and thus develop agroecological practices that benefit plantain. Agricultural research must make use of the crop's main advantages: more than 150 varieties cultivated and consumed, with little-known agronomic characteristics, very diverse cropping systems that probably include biological regulation possibilities of benefit to plantain, and nutrition requirements that are little-known but lower than those of dessert bananas, etc. It must produce knowledge of use for innovation, prove its value, and support training and advocacy for efficient, sustainable plantain production. ■

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

*CIRAD banana and plantain research coordinators

[1] The Initiative for the Ecological Intensification of Plantains in Africa aims to associate players from the continent's plantain banana sector to build an efficient, profitable value chain that respects the health of both humans and territories. Find out more: **https://tinyurl.com/plantain-sans-pesticides**

Bana+, the varieties of the future...

CIRAD is coordinating the multi-partner Bana+ project, under the Ministry of Agriculture's PARSADA[2] plan, over the period 2025-2029. The aim is to develop banana varieties resistant to fungal disease, particularly black Sigatoka, to reduce pesticide use in the West Indies and other overseas regions. Given the limitations of fungicides and the threat from TR4 fusarium wilt, varietal diversification is essential to guarantee the future of the value chain, which currently depends on the highly vulnerable Cavendish variety. The project combines conventional genetic improvement, gene editing and hybridisation. It is based at platforms in Guadeloupe and Montpellier, with advanced tools and a broad scientific partnership, in the hope of proposing concrete solutions between now and 2029.

Find out more:

[2] Strategic action plan to anticipate the potential EU ban on active substances and the development of alternative crop protection techniques

Inventing sustainable dessert and plantain banana growing for the future

CIRAD is addressing the challenges facing the value chain

Dessert and plantain bananas: major disparities

Dessert bananas are predominant

Dessert bananas **71%** Cooking bananas **28%**

Year 2024. Source: Thierry Lescot, CIRAD-GECO, FruiTrop journal

Cavendish heads the production rankings

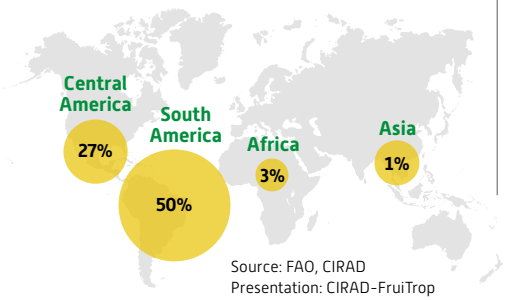
AAB plantains	**24 681**
Highland + ABB + other AAB + AAA + AA bananas	**22 246**
Cavendish AAA sub-group	**92 895**
Gros Michel and other AA, AAA, AAB, ABB dessert bananas	**20 142**
Total	**159 964**

2024 estimates in Mt. Source: Thierry Lescot, CIRAD-GECO, FruiTrop journal, based on bibliography, surveys, professional sources, FAO, ITC, etc

Focus on dessert bananas

Global banana exports

21.2 Mt in 2025



Source: FAO, CIRAD
Presentation: CIRAD-FruiTrop

Main exporting countries

Ecuador – 6 763 732
Guatemala – 2 638 336
Colombia – 2 567 397
Costa Rica – 1 942 363
Philippines – 1 634 518

In tonnes (2025)
Source: Trademap, Eurostat

Major differences between producing countries: Some countries use **more than 80 kg of pesticides/ha** compared to **3 kg/ha in the French West Indies**

- An approach based on the **principles of agroecology** with innovative cropping systems combined with resistant varieties

- A **CIRAD-Vitropic** dessert banana improvement programme that offers **hybrids resistant to banana diseases** (fusarium race 1, fusarium tropical race 4, black Sigatoka, etc)

Focus on plantain banana

> 2 million family farmers in central and West Africa

Yields

current = **8 t/ha**
target = **20-30 t/ha**

Doubling productivity

by
- **zero-pesticide ecological intensification**
- **reducing postharvest losses**
- **adapting to climate change**

boost plantain banana supplies so as to feed a growing population (+ 10 Mt expected in the next 10 years)

Our ambitions...

Agroecology
Dessert banana 1.0
A major reduction in pesticide use
within 5 to 10 years

Agroecology
Dessert banana 2.0:
Target: "zero pesticides"

Ecological intensification of plantain banana growing in **Africa**

... in partnership

Several platforms in partnership for research and training (dP)s work on dessert and plantain banana:

Africa: DIVECOSYS
Asia: ASEA, SALSA
IO: Biocontrôle-OI
Latin America: AGROFORESTA

CIRAD is a member of several international networks, such as the World Banana Forum or Musanet, international research centres such as The Alliance of Bioversity International and CIAT, learned societies, etc.

Our means and resources

70
scientists including 45 researchers, mainly from 2 departments (PERSYST and BIOS)

26
research disciplines involved, from genetics, through agronomy, to the economic and social sciences

35
CIRAD created and has been editor-in-chief of **the journal FruiTrop for 35 years**

50
Vitropic, a CIRAD subsidiary, has produced and distributed **50 M banana in vitro plantlets worldwide**

40
educational resources in the FABA pack for training in agroecological plantain banana growing (videos, producer sheets, etc)

4800
FABA YouTube channel: 4800 subscribers, around 2500 views/month of educational videos

Partnerships, at the heart of CIRAD's research

Partnerships are a major lever for the CIRAD dessert and plantain banana roadmap. CIRAD relies on long-standing collaborations with research organisations, technical institutes, producer organisations, firms and public players to co-construct bespoke knowledge and innovations in line with the needs of value chains. Its partnerships with IT2 in the West Indies, national research centres (IRAD, CNRA, etc) and CIRAD's subsidiary Vitropic, the leading European laboratory for in vitro culture of tropical crop species, embody that ambition. These collaborations are both anchored in territories and open to the world, and boost the impact of research to foster sustainable agroecological transitions. ■

© D. Loeillet, CIRAD

| Cover crop in a dessert banana planting, an alternative to using herbicides

A word from our partners

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Interview with Eric Avom Alara,

Coordinator of the National Fruit Crop Development Project at the Ministry of Agriculture and Rural Development in Cameroon

How did your partnership with CIRAD come about and what does it look like today?

Our partnership with CIRAD began in 2020, with the FABA project. At the time, contact was made by e-mail with the Ministry of Agriculture, which quickly led to exchanges. As Coordinator of the National Fruit Crop Development Project, I then took over and we began our collaboration, centring on several aspects.

The initial aim was to ensure that the authorities were behind the project, and prepared to sit on the steering committee. We were very soon involved in collective work alongside multidisciplinary teams, to co-construct teaching resources, notably in the middle of the Covid crisis, which meant holding many remote meetings. The partnership also resulted in our participation in international meetings, audiovisual productions and promotional events such as the Paris Agricultural Show. We helped to organise workshops in Cameroon and Ivory Coast, and received international interns in Cameroon.

Our collaboration has had very tangible results. With the teaching pack produced as part of FABA, we have free-access, quality teaching resources on zero-pesticide plantain production that have changed how we work. They are now used by producers, trainers and institutions.

How do you see the future of the partnership, and to what extent do CIRAD's priorities tally with agricultural issues in Cameroon?

In future, the partnership will build on the operations under way, with a strong emphasis on the dissemination and appropriation of the resources produced. Since those resources were released, we have been actively working with technical colleges, universities and producer organisations. Several higher education establishments are already involved, and the rollout is due to continue across the country.

Another important lever is incubation centres, where those resources play a central part in the training provided to young people and professionals. The aim is clear: to foster productive, sustainable and market-oriented agriculture. Plantain is a priority crop, but yields in Cameroon are still low. However, the agroecological approaches now being promoted substantially increase yields on small areas, while reducing pesticide use and environmental impact. Concrete practices developed through research, such as early sucker selection, using weevil traps, or certain bespoke cropping techniques, have now been adopted in the field. They are helping to boost productivity and secure production systems.

Our partnership with CIRAD can be seen as a strategic lever for achieving national objectives, particularly in terms of increasing the volumes produced between now and 2030, while taking a sustainable pathway. ■

RR

Interview with Peter Bentata,

Vice-President of Production, Compagnie Fruitière

CIRAD and Compagnie Fruitière have been working together for several years. How did the partnership start, and what are its main achievements?

Our partnership with CIRAD reflects a strong belief that the only way of achieving agroecological transition is by associating research and grassroots players. This is what prompted the launch of the B2A programme on agroecological banana growing in Africa, in 2019, following a shared diagnosis of phytosanitary practices on our plantations in Ivory Coast, Ghana and Cameroon. Since then, we have worked with CIRAD to build a co-innovation approach. Together, we test and roll out solutions tailored to field realities: integrated pest management, optimised fertilisation, service plant development or precision farming. This approach has already given tangible results, with a significant reduction in pesticide, inorganic fertiliser and herbicide use, while maintaining agronomic performance. Our partnership has now reached a new stage. We now want to build on the B2A programme and work with CIRAD to design the banana systems of the future: models that will be resilient to climate change, based on biocontrol, agroforestry, crop diversification and eventually ever more ambitious reductions in synthetic pesticide use.

How does the CIRAD roadmap fit with Compagnie Fruitière's strategy?

CIRAD's ambitions tally perfectly with the path we have been on for several years. Our sustainable development strategy aims to accelerate the agroecological transition of our production systems, by tackling major challenges such as climate change, biodiversity preservation, water management and reduced synthetic input use. CIRAD provides the scientific expertise we need to achieve those objectives. Thanks to the B2A programme, we are building concrete solutions together, ones that are tailored to the realities on our plantations. As well as technical innovations, we share a technical vision: that of more resilient tropical farming systems capable of reconciling economic performance, environmental protection and territorial development. The convergence between our CSR roadmap and CIRAD's scientific priorities make our partnerships a vital lever for transforming banana production sustainably. ■

© S. Dépigny, CIRAD

| New zero-pesticide plantain banana planting, keeping the wild plant cover

© S. Dépigny, CIRAD

| Plantain banana crop in storage before being sent to market

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 three ambitions for sustainable dessert and plantain banana growing.

Contact us to find out more: **banana@cirad.fr**

Working together for tomorrow's agriculture

Find out more about the dessert and plantain banana value chain at CIRAD

cirad.fr