BEYOND THE HEADLINE

THE CACAO TREE OF THE FUTURE

One of the world's most popular guilty pleasures is being increasingly framed as a product under threat.

Climate change, disease outbreaks and soaring cocoa prices have fuelled headlines warning of cocoa shortages and an uncertain future for chocolate production. Into that anxiety has stepped a familiar promise: that gene editing can make the cacao tree (*Theobroma cacao*) – from which we get the raw commodity, cocoa, used to make chocolate – resilient enough to withstand whatever comes next.

What are they trying to do?

Mars, one of the world's largest confectionery companies, wants to be seen leading that rescue. It has partnered with researchers linked to the Innovative Genomics Institute (IGI) at UC Berkeley and, more recently, biotechnology company Pairwise to develop gene-edited cacao.

In August 2025, Pairwise announced that Mars had licensed its Fulcrum CRISPR platform, including the SHARC enzyme, for cacao R&D.

Mars's own gene-editing policy describes their efforts as "*preliminary research*", also underway on peanut, maize and mint, aimed at crops that are "*high-yield, climate- and disease-resistant, as well as water- and nutrient-efficient*."

The language used to describe this ambition is worth pausing on. Mars's own communications have long framed cacao as fragile and biotechnology as the rescue: a 2023 corporate article promised to help "*future-proof chocolate,*" invoking "*groundbreaking science*" and "*the cocoa plant of the future*."

When Mars and Pairwise announced its partnership two years later, Pairwise's press release described CRISPR as a way to "*unlock the plant's inherent potential*" and to "*significantly accelerate the development of impactful crop traits compared to traditional breeding methods*" – positioning gene editing not merely as one tool among many, but as a faster, better route to resilience.

That framing has been picked up, largely uncritically, across the trade press. *FoodNavigator* described Mars as "*confident that gene editing could be the solution*," promising to "*futureproof cocoa crops.*" *The Chemical Engineer* wrote of a strategy to "*future-proof cacao production*" that would "*boost climate resilience*" and "*strengthen global supply chains*."

Together, these accounts tell a story: cacao is under threat, gene editing is the answer and Mars is already delivering it. What that story leaves out – how far the science has actually got and what "resilience" is being asked to paper over – is the subject of the rest of this briefing.

How far have they got?

In 2018, researchers made the first successful CRISPR edits to this gene in cacao leaf and embryo tissue, successfully altering around a quarter of their targets. The edited tissue showed greater resistance to *Phytophthora tropicalis*, a pathogen linked to black pod disease. But this was lab-tissue work, not a plant and a proof-of-concept rather a commercial variety.

A 2025 follow-up study moved that work a step further, producing whole cacao plants carrying the same TcNPR3 edits and growing them to maturity.

These plants showed stronger immune responses and disease lesions around 42% smaller than unedited plants and researchers were able to breed the CRISPR-related foreign DNA back out while keeping the beneficial edit. It's a meaningful technical advance but the researchers themselves describe the work as still experimental, with long-term field trials now underway to see whether the resistance holds up under real farming conditions over time.

Alongside this, IGI has been developing the broader genetic toolkit needed to edit the cacao. A 2026 study demonstrated that foreign DNA could be reliably inserted into two elite commercial cacao varieties and passed on to future generations without disrupting growth or fertility.

Much of what's being reported as "gene-edited resilient cacao" is just groundwork that might eventually make such a plant possible.There is no gene-edited cacao tree in commercial use, no field-proven variety and no public evidence yet that any edited trait performs reliably outside controlled trial conditions.

The real crisis beyond the headline

Every version of this story examined so far is built around the same implicit argument: cacao is in crisis, the crisis is happening now and there is no time to do anything except intervene at the level of the plant's genome.

Essentially, a complex crisis affecting cacao farmers, landscapes and commodity markets is being translated into something much simpler and more emotionally manipulative: a threat to chocolate. The endangered subject is no longer primarily the farmer or the farming system, but a product consumers fear losing.

Once framed this way, the question also changes. Instead of asking what would make cacao farming more resilient, the story becomes how to secure the future supply of cocoa. Gene editing then appears not as one possible intervention among many, but as an urgent rescue. Questions about low farmgate prices, underinvestment, ageing plantations, monoculture and who bears the risks of production are pushed into the background.

This farming system has left millions of smallholders in poverty and left soils to degrade because there has not been capital or incentive to replant, rotate, or invest in the land any other way.

Disease outbreaks and climate stress are real but they are also intensified by exactly this system with its monoculture plantings and heavy chemical dependence. A gene edit can plausibly make one tree more resistant to one pathogen. It cannot make farmgate prices fairer, plantations younger, or soils healthier.

Gene-edited cacao, therefore, is being framed less as a way to make cacao farming resilient than as a way to secure the future supply of chocolate. Those are not necessarily the same thing.

Disease is not a single problem

Coverage of gene-edited cacao often talks about 'disease resistance' as if it were a single target. It isn't. IGI itself is pursuing different strategies against black pod disease and cacao swollen shoot virus (CSSV) – two distinct problems requiring different responses.

Black pod is caused by Phytophthora species; CSSV is a virus spread by mealybugs and has no cure once a tree is infected. Climate stress is a third, separate challenge.

The published CRISPR work targets black pod specifically, through the plant's fungal immune-response pathway. It says nothing about resistance to CSSV and doesn't directly address climate stress.

So when headlines describe gene-edited cacao as simply 'disease-resistant' or 'climate-resilient', they blur three distinct problems into the potential of a single gene edit aimed at only one of them.

Who owns the 'future proof' tree?

None of the coverage of the Mars–Pairwise deal answers a basic question: who would own a gene-edited cacao tree and on what terms would farmers be able to grow it?

The partnership gives Mars access to Pairwise's gene-editing platform, enzymes and trait libraries, but the public announcements do not disclose

whether the licence is exclusive, its geographic scope, or who would own cacao traits developed using it.

This is a significant omission because gene-edited crops can involve several layers of intellectual property, covering the editing technology, its applications and individual traits or genetic sequences. Research suggests that increasing privatisation of crop genetic resources can restrict their use in farmer breeding and increase smallholder dependence on the private seed sector.

For a crop produced overwhelmingly by smallholders, the unanswered question is therefore not simply whether gene-edited cacao will work, but who will control it – and on what terms farmers will be allowed to use it.

What true resilience requires

Gene editing is often presented as the most innovative or promising response to cocoa vulnerability. But resilience is not only an agronomic problem and a range of non-gene-edited approaches – agronomic, economic and political – are already being developed and tested across cocoa-growing regions, generally with far less coverage than CRISPR receives.

Agronomic approaches

Conventional breeding programmes continue to produce new cacao hybrids adapted to drought conditions, disease pressure and changing climates. A recent multi-location study in Ghana evaluated 25 cocoa hybrids under farmers' production conditions, finding several with strong survival and early pod production under difficult environmental conditions.

Other approaches focus on broader farming systems rather than individual plant traits: agroforestry, shade trees, soil management and enhancing pollination to improve long-term resilience.

In Ghana, the Cocoa Research Institute of Ghana (CRIG) is running long-term trials comparing "Dynamic Agroforestry" systems with conventional cocoa monocultures, with early findings suggesting that more diverse systems may improve soil

Key questions

Journalists, policymakers and consumers evaluating claims about gene-edited cacao should be asking the following questions to assess how much weight the "future-proofing" narrative can actually bear.

Evidence and real-world applicability

- Has the research been published in peer-reviewed journals, or does it rely on company and press-release framing?
- Has resistance been tested against real-world disease pressure over multiple seasons, not just controlled trial conditions?
- What is the realistic timeline from current field trials to a commercially available variety, and how does that compare with the urgency implied by the coverage?

Ownership and access

- Who would own a gene-edited cacao variety, and on what terms would smallholder farmers be able to grow it?
- Would access require licensing fees, and if so, who would set them?

Risks and unintended consequences

- Cacao trees are long-lived perennials – what happens if edited traits interact unpredictably with pests, pathogens or local ecosystems over a tree's decades-long lifespan?
- Is there any risk of gene flow between edited and wild or unmanaged cacao populations?
- If large-scale planting of a single edited variety were to occur, would that reduce genetic diversity/create new vulnerabilities?

The bigger picture

- Is the "future-proofing" framing being used to suggest urgent action is needed on gene editing specifically, while similarly urgent economic and political reforms (price mechanisms, deforestation regulation) receive comparatively little attention?

moisture, biodiversity and resilience to climate stress while reducing reliance on external inputs such as fertilisers and irrigation.

Economic approaches

Farmgate price reform is another main lever. Ghana and Côte d'Ivoire, which together produce most of the world's cocoa, have coordinated a joint Living Income Differential (LID) – a premium on the world price intended to lift farmer incomes. Research suggests it could raise incomes by up to 28% in the best case, still far short of the 93–113% increase needed for a living income.

The mechanism's fragility was clear in March 2026, when Côte d'Ivoire cut its guaranteed farmgate price by 57% after a bumper harvest and falling global demand, a reminder that price interventions can be reversed as quickly as they're introduced.

Political approaches

The EU's deforestation regulation (EUDR), due to affect cocoa imports, is pushing traceability and due-diligence requirements back onto producing countries – a significant compliance burden for smallholders, but also potential leverage against the land degradation described above.

Ghana and Côte d'Ivoire have also begun coordinating directly with each other on pricing and marketing through joint declarations, rather than negotiating separately with buyers.

How this connects to the gene-editing narrative

These approaches are generally slower and less headline-grabbing than biotechnology-based solutions and none of them are silver bullets. The LID research above shows even a coordinated, well-intentioned price mechanism can fall well short of its goal and the March 2026 price cut shows how quickly such mechanisms can be reversed under market pressure.

But agronomic, economic and political measures are attempting to address the actual sources of cacao's vulnerability identified above – low farmgate prices, ageing plantations, ecologically fragile monocultures — in ways that a disease-resistance gene edit, however successful, cannot.

Conclusion

The gap running through this briefing is consistent. Mars and Pairwise's own language promises an imminent, near-total fix – future-proofing the cocoa plant of the future – and the trade press has uncritically repeated that promise. What actually exists is a single, promising gene edit for one fungal disease, still in field trials, sitting inside a much larger and murkier picture: a research toolkit still being built, an ownership structure nobody has disclosed and a crisis that was never purely genetic to begin with.

Presenting that as an answer to "*the cocoa crisis*" overstates the science and forecloses the conversation about why cacao farming produces poverty and ecological strain in the first place.

It's also not the only technological bet on the table. A separate, faster-moving effort is underway to sidestep the cacao tree altogether. Some companies are growing cocoa cells directly in bioreactors, skipping plantations, pests and West African weather entirely and Mondelēz has already produced cell-cultivated chocolate bars in partnership with Celleste Bio.

It remains an early-stage and currently more expensive process and one that would sideline rather than support the smallholder farmers this briefing has focused on throughout.

Taken together, gene editing and cell cultivation reveal something important about what "future-proofing chocolate" can mean. One seeks to make the cacao tree better able to supply the existing system; the other seeks to make cocoa production less dependent on cacao trees, cacao-growing regions and cacao farmers altogether. Neither, by itself, answers the more fundamental question of how to make cacao farming economically and ecologically resilient.

In both cases, the same questions remain: who owns the technology, who benefits from it and whose future is actually being protected?

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