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AGROFORESTERIE DE DÉFORESTATION/REFORESTATION / ARTICLE D'OPINION

Fostering agroforestry? Lessons from The Republic of Côte d'Ivoire

Irié Casimir Zo-Bi[1]
Bruno HÉRAULT[2, 3]

[1] Institut national polytechnique Félix Houphouët-Boigny (DFR-FOREN/INP-HB)
Département de foresterie et environnement
Yamoussoukro
Côte d'Ivoire

[2] Cirad
UPR Forêts et Sociétés
34398 Montpellier
France

[3] Forêts et Sociétés
Univ Montpellier, Cirad
Montpellier
France

Auteur correspondant / Corresponding author:
Bruno HÉRAULT – bruno.herault@cirad.fr

ORCID

Irié Casimir ZO-BI: 0000-0003-0982-8579

Bruno HÉRAULT: 0000-0002-6950-7286

Photo 1.
Cocoa trees under the shade of an Iroko (*Milicia excelsa*), surciming an Avocado (*Persea americana*) well established in the intermediate stratum. Yamoussoukro, Côte d'Ivoire, June 22, 2023.
Photo I. C. Zo-Bi ©.

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RÉSUMÉ

Promouvoir l'agroforesterie ? Les leçons de la Côte d'Ivoire

L'émergence de l'agroforesterie en Côte d'Ivoire est devenue une priorité nationale. Le secteur agricole du pays génère 70 % des recettes d'exportation, emploie les deux tiers de la population active et contribue à un tiers du PIB. Cependant, ces performances économiques remarquables reposent sur une agriculture de rente qui se développe au détriment des forêts naturelles, entraînant l'un des taux de déforestation les plus alarmants au monde. Pour faire face à cette situation, l'État ivoirien promeut l'agroforesterie comme solution, en particulier dans le secteur du cacao. Cependant, une analyse fine de l'origine des arbres présents dans les champs suggère que l'agroforesterie en Côte d'Ivoire peut être divisée en deux catégories : l'agroforesterie de reforestation, qui permet de reconstituer le couvert forestier en associant progressivement des arbres aux cacaoyers, et l'agroforesterie de déforestation, qui dégrade et appauvrit la couverture forestière en convertissant les forêts naturelles en systèmes agroforestiers. Il est crucial de distinguer ces deux formes d'agroforesterie afin de développer des politiques qui encouragent la reforestation plutôt que la déforestation. Il est également nécessaire de mettre en place des indicateurs dynamiques qui permettent d'évaluer les trajectoires agroforestières des champs dans le temps et, ainsi, de favoriser un engagement à long terme des agriculteurs dans l'augmentation de la couverture forestière.

Mots-clés : agroforesterie de déforestation, agroforesterie de reforestation, cacaoculture, indicateur, trajectoire, Agro-Forêt, agroforesterie, Côte d'Ivoire.

ABSTRACT

Fostering agroforestry? Lessons from the Republic of Côte d'Ivoire

Promoting the emergence of agroforestry in the Republic of Côte d'Ivoire has become a national priority. The country's agricultural sector generates 70% of export income, employs two-thirds of the working population and contributes one-third of GDP. However, this remarkable economic performance is based on cash crop farming, which has developed at the expense of natural forests, resulting in one of the most alarming deforestation rates in the world. To address this situation, the Ivorian government is promoting agroforestry as a solution, particularly in the cocoa sector. However, a detailed analysis of the origin of the trees present in cropfields suggests that agroforestry in Côte d'Ivoire can be divided into two categories: *reforestation agroforestry*, which restores forest cover by gradually associating trees with cocoa trees, and *deforestation agroforestry*, which degrades and impoverishes forest cover by converting natural forests into agroforestry systems. It is crucial to distinguish between these two forms of agroforestry in order to develop policies that encourage reforestation rather than deforestation. Also essential is to develop and set up dynamic agroforestry monitoring indicators that can assess the agroforestry trajectories of cropfields over time, and thus encourage farmers' long-term commitment to increasing forest cover.

Keywords: deforestation agroforestry, reforestation agroforestry, cocoa farming, indicator, trajectory, Agro-Forest, agroforestry, Côte d'Ivoire.

RESUMEN

¿Promover la agroforestería? Lecciones de Costa de Marfil

La agroforestería en Costa de Marfil se ha convertido en una prioridad nacional. El sector agrícola del país genera el 70 % de los ingresos de exportación, emplea a dos tercios de la población activa y aporta un tercio del PIB. Sin embargo, este notable rendimiento económico se basa en los cultivos comerciales, que se desarrollan a expensas de los bosques naturales, lo que provoca una de las tasas de deforestación más alarmantes del mundo. Para hacer frente a esta situación, el gobierno marfileño promueve la agroforestería como solución, especialmente en el sector del cacao. Sin embargo, un análisis detallado del origen de los árboles presentes en los campos sugiere que la agroforestería en Costa de Marfil puede dividirse en dos categorías: la agroforestería de reforestación, que permite reconstituir la cubierta forestal asociando progresivamente otros árboles con el árbol del cacao, y la agroforestería de deforestación, que degrada y empobrece la cubierta forestal al convertir los bosques naturales en sistemas agroforestales. Es crucial distinguir entre estas dos formas de agroforestería para desarrollar políticas que fomenten la reforestación en lugar de la deforestación. También es necesario establecer indicadores dinámicos para evaluar las trayectorias agroforestales de los campos a lo largo del tiempo, animando así a los agricultores a comprometerse a largo plazo con el aumento de la cubierta forestal.

Palabras clave: agroforestería de deforestación, agroforestería de regeneración, cultivo del cacao, indicador, trayectoria, bosque agroforestal, agroforestería, Costa de Marfil.

Making agroforestry a national priority

In Côte d'Ivoire, the agricultural sector generates 70% of export revenues. It employs two-thirds of the active population and contributes one-third of the Gross domestic product (GDP). The country's global (1st producer of cocoa and cashewnuts) and African (1st producer of natural rubber) rankings testify to this economic dynamism. The Economic Dashboard (ED) (DSCE, 2023) indicates a growth rate consistently higher than the global average: 6.8% in 2021 compared to a global average of 6.2%; and 3.6% compared to 3.4% in 2022. Additionally, the per capita GDP has been steadily increasing, surpassing the threshold of 2,200 US dollars (USD) in 2018 and reaching 2,400 USD since December 2022 (DSCE, 2023). However, these remarkable performances rely on cash crop agriculture (based on the export of primary products), which is developing at the expense of natural forests, and whose production is still proportional to cultivated areas. As a result, one of the world's most alarming deforestation rates (7.8 million hectares in 1990; 2.8 million hectares in 2020, representing a –64.1% change) is observed in the country (FAO, 2020). This near-total deforestation of the country leads to increasingly strong climate uncertainties (especially rainfall patterns) and food insecurity (associated with climate uncertainties) in the context of a booming population (2.9% between 2018 and 2021 according to the latest population census). To address these issues, one of the solutions promoted by the Ivorian government in its new 2019 forestry code is agroforestry (MINEF, 2019). It is important to clarify what lies behind the term "agroforestry". Historically, the concept of agroforestry evokes the reconciliation or mutual benefit between agricultural and forestry activities. Thus, in the compound word "agroforestry", agriculture (the prefix "agro") precedes forestry, i.e., the introduction of silvicultural practices into agricultural farms to build agroforestry systems (Nair, 1987) where forestry safeguards agriculture against the risk of non-sustainability. These systems are commonly referred to as agroforests (Penot and Feintrenie, 2014). However, the history of Ivorian cocoa farming (Vroh *et al.*, 2019) invites us to specify the concept in order to reposition the agroforestry system in its recent temporal trajectory (acknowledging that, in the distant past, forests constituted the initial ecosystem of the majority of current agricultural territories). Indeed, an agroforestry system is inherently not a static system but a dynamic one, like any ecological system. The observation of recent trajectories of agroforestry systems in Ivorian cocoa farming highlights two very different situations. In this way, most systems are dominated by remnant trees (coming from the pre-existing forest) and reflect a recent deforestation agroforestry (conversion of natural forests into agroforestry systems). In other systems, these remnants are in the minority and reflect a recent reforestation agroforestry (conversion of a full-sun agricultural field into a shaded crop). Intermediate situations exist, but they remain in the minority (figure 1).

Reforestation agroforestry

Reforestation agroforestry could be defined as the result of converting a full-sun agricultural crop into a shaded crop. Thus, a reforestation agroforestry system, in cocoa farming, is achieved by the gradual association, through natural regeneration and/or planting, of trees in a way that allows them to coexist harmoniously with cocoa trees. In this scheme, the previous crop is a nearly pure cocoa crop, with few or no remnant trees (as per N'Guessan *et al.*, 2019). Reforestation agroforestry is therefore an agroforestry approach (Carodenuto, 2019) that contributes to the restoration of forest cover. It helps to locally restore various ecosystem services (Tiemann and Ring, 2022), including plant biodiversity, carbon stocks, and timber resources (table I). Such an agroforestry system must be clearly distinguished from any other agroforestry system with a different history and trajectory. In this regard, the new Ivorian forestry code of 2019 is suitable for promoting agroforestry in Côte d'Ivoire, but it currently does not allow for this distinction. It defines Agro-Forest (Article 1 – Title 1) as a regulated area located within the private forest domain of the state, where agricultural plantations and forest trees coexist. Since the private forest domain of the state consists exclusively of classified forests and protected areas, the forest trees mainly refer to remnant trees (figure 1). Thus, this official definition of Agro-Forest could inadvertently accelerate, in the absence of monitoring and control, the conversion of the few remaining forest patches into Ivorian-style agroforestry systems. Hence, it is important to differentiate reforestation agroforestry from deforestation agroforestry.

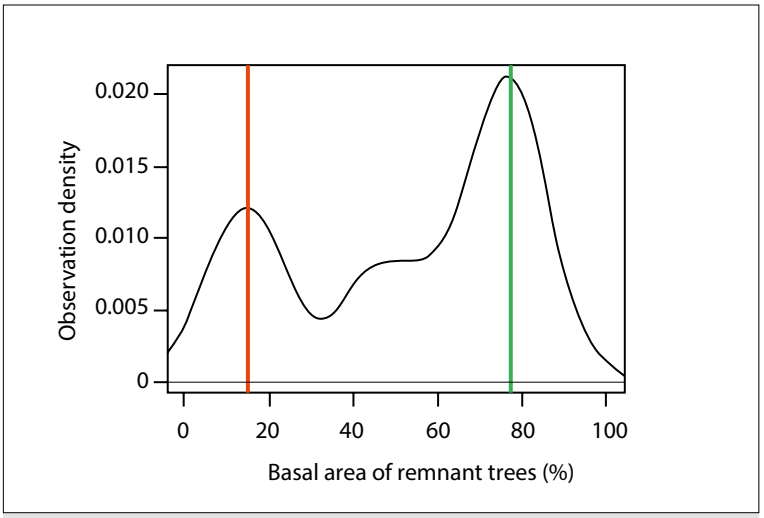

Figure 1.
Density of observations of agroforestry plots as a function of the percentage of basal area occupied by remnant trees. The data come from the Cocoa4Future project (details in Kouassi *et al.*, 2023), for which 150 permanent plots were set up throughout Côte d'Ivoire's cocoa production zone. To retain only agroforestry plots in the strict definition, the plots were filtered to keep only those with a basal area of trees greater than 10 m^2/ha. The observation density is shown in black, the local maximum corresponding to a dominance of non-remnant trees (reforestation agroforestry) is shown in red, and the local maximum corresponding to a dominance of remnant trees (deforestation agroforestry) is shown in green.

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Table I.
Differences in characteristics between reforestation (column 2) and deforestation (column 3) agroforestry systems. The differences are reported for two typical situations of agroforestry systems that have been built from a full-sun cocoa field (column 2) or from a natural forest (column 3). More complex situations do exist, but they are still in the minority in Côte d'Ivoire's cocoa plantations (figure 1).

Characteristics	Reforestation Agroforestry	Deforestation Agroforestry
Previous land use	Full sun cocoa farming	Natural forest
Origin of associated trees	Natural regeneration & (trans)planting*	Remnant trees
Impact on biodiversity	Gain in local biodiversity	Loss in local biodiversity
Impact on carbon	Increase in national carbon stock	Decrease in national carbon stock
Impact on timber resources	Reconstitution of timber volumes	Timber resources expected to come to an end
Impact on landscape	Restoration of forest cover	Degradation of forest cover
Development approach	Sustainable	Unsustainable

* The term (trans)planting refers to the action of planting a tree that has been raised in a nursery (planting) or uprooted and moved by the planter at the seedling stage (transplanting).

Deforestation agroforestry

Unlike reforestation agroforestry, which contributes to the restoration of forest cover, deforestation agroforestry degrades and impoverishes it. Deforestation agroforestry is defined as the conversion of natural forests (more or less degraded) into agroforestry systems (table I). This peculiar land-use change (Ouattara *et al.*, 2021) follows a process that is well described by Barima *et al.* (2016, 2020). In the state's private domain, cocoa farmers, aware of the illegality of their presence, settle in a way that is difficult to detect by forest services. In the early years, they only fell small understory trees and directly sow cocoa beans in the open ground. As the young cocoa trees grow under the forest canopy, the intermediate-level trees are gradually weakened by girdling, ring-barking, or girdling (removing the bark from a tree around its entire circumference, at the base of the tree or at breast height, this results in death on the standing tree, as the flow of sap from the leaves to the roots is interrupted, preventing the formation of stump sprouts) until the larger dominant trees are affected. This is done gradually to adapt to the light requirements of the cocoa trees. The result is agroforestry systems that, based on indicators commonly used by agronomists (relative basal area, number of trees per hectare), appear similar to reforestation agroforestry systems. Therefore, it is absolutely necessary to consider their respective histories or trajectories (*sensu* Amani *et al.*, 2022) in order to distinguish them. There is a diversity of agroforestry systems in

Photo 2.
A view of the understorey of an agroforest based on cocoa trees in association with Akpi (*Ricinodendron Heudelotii*), oil palm (*Elaeis guineensis*), plantain (*Musa × paradisiaca*) and pineapple (*Ananas comosus*). Yamoussoukro, Côte d'Ivoire, June 22, 2023.
Photo I. C. Zo-Bi ©.

the Ivorian cocoa orchard where cocoa trees coexist with cohorts of trees (Sanial *et al.*, 2023) with very different histories: (i) remnant trees from the pre-existing forest that were not cut/burnt during forest clearing, (ii) spontaneous trees from natural regeneration (Doua-Bi *et al.*, 2021) that the farmer intentionally spared during maintenance and allowed to grow naturally, and (iii) planted trees for producing goods and services that the other two cohorts would not provide. Considering the relative weight of these three cohorts of trees allows for reconstructing the history of the cocoa plantation and its agroforestry trajectory (figure 1). An agroforestry plot dominated by remnant trees thus indicates an agroforestry system resulting from deforestation. Conversely, an agroforestry plot dominated by spontaneous or planted trees reflects the slow construction, by the cocoa farmer, of an agroforestry system where trees have been actively chosen, maintained, and supported in their growth. This reading grid sheds light on the current situation of the Ivorian cocoa orchard (Kouassi *et al.*, 2023).

The importance of agroforestry trajectories

A snapshot photo, a punctual assessment, or a measurement without monitoring in time the importance of trees in a cocoa field (photos 1 and 2) generally does not allow for the inference of its past trajectory and therefore does not reward virtuous agroforestry trajectories. As previously shown, a tree-rich agroforestry system can have two diametrically opposed origins or trajectories: (i) it can stem from deforestation and thus be created, in a way, on forest rent (Léonard and Ibo, 1994) or (ii) it can result from reforestation and therefore be the fruit of the long and patient work of the farmer to select and/or plant trees in their plot (Sanial *et al.*, 2021). Consequently, all indicators of agroforestry performance or other certification criteria that are solely based on the value, at a given time, of the relative basal area of trees and/or forest cover are at best ineffective in assessing the agroforestry trajectory and at worst risk encouraging unvirtuous behaviors. Indeed, the fastest and easiest way to meet the indicator thresholds in a cocoa field is (i) to establish a new field on old forest land or (ii) to expand one's field into the adjacent forest to include a few large trees in the cocoa plantation. These different strategies have been frequently observed in the field by the authors. Thus, promoting agroforestry without considering agroforestry trajectories carries significant risks of increasing deforestation (Angelsen and Kaimowitz, 2004). It is therefore essential for agroforestry promotion policies to completely change their paradigm to reward virtuous trajectories. In concrete terms, this involves abandoning static indicators and developing dynamic indicators (based on a comparison of the indicator value with the previous value obtained in the same field, rather than an arbitrarily defined threshold value) that reward positive evolutions in the agroforestry character. This likely also involves a form of agreement made between the farmer and the public authority, a co-constructed pact that materializes the farmer's commitment, over several years, to increase the presence of trees in their field. In this perspective, regardless of the initial situation, only the evolution of forest cover over time would be rewarded with a purchase premium. Changing the paradigm thus becomes a necessary condition for agroforestry promotion to develop through the promotion of genuine reforestation-based agroforestry.

Data access

The data are accessible on the Zenodo data warehouse with the following Internet link: https://doi.org/10.5281/zenodo.8138694

In case of using this data, we recommend to inform the authors and cite the origin of the dataset as following:

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Photo 3.
Snapshot of the undergrowth of an agroforestry system based on cocoa trees combined with forest trees on the right (Iroko - *Milicia excelsa*) and fruit trees on the left (Avocado - *Persea americana*). Photo I. C. Zo-Bi ©.

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Zo-Bi *et al.* – Author's contributions

Contributor role	Contributor names
Conceptualization	I. C. Zo-Bi, B. Hérault
Data Curation	I. C. Zo-Bi, B. Hérault
Funding Acquisition	I. C. Zo-Bi, B. Hérault
Investigation	I. C. Zo-Bi, B. Hérault
Methodology	I. C. Zo-Bi, B. Hérault
Project Administration	I. C. Zo-Bi, B. Hérault
Resources	I. C. Zo-Bi, B. Hérault
Supervision	I. C. Zo-Bi, B. Hérault
Validation	I. C. Zo-Bi, B. Hérault
Visualization	I. C. Zo-Bi, B. Hérault
Writing – Original Draft Preparation	I. C. Zo-Bi, B. Hérault
Writing – Review & Editing	I. C. Zo-Bi, B. Hérault

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