Local farmers shape ecosystemic services provisioning in West african cocoa agroforests

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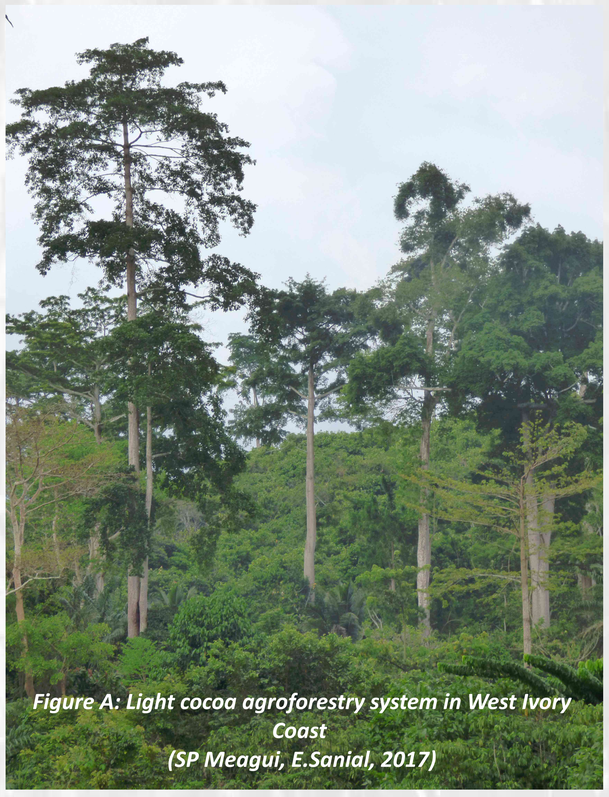

Figure A: Light cocoa agroforestry system in West Ivory Coast (SP Meagui, E.Sanial, 2017)

Public attention is often drawn on threats that tropical forests encounter. Although, where forests have almost undergone complete decline, stakes are, beyond limiting deforestation, maintaining or restoring ecosystems' capacity to provide forests' services.

In south Ivory Coast, first world cocoa producer and a typical post-forest region, we question the ecosystemic services given by rather light cocoa agroforestry systems (biodiversity, carbon storage, food, agronomic services to cocoa trees, medicine, timber). Trees in theses systems come from three origins (called **cohorts**): **remnants** from previous forests, **recruited** or **planted** by farmers.

What is the effect of environmental factors on ecosystemic services provisioning? Do trees origins play different roles in this provisioning? Are these roles complementary?

METHOD

Data collection

Data were collected on four sites (map) in 137 sampled cocoa fields covering 210 hectares.

Services estimation

Aboveground biomass of trees, α and β diversity and uses value for people were estimated.

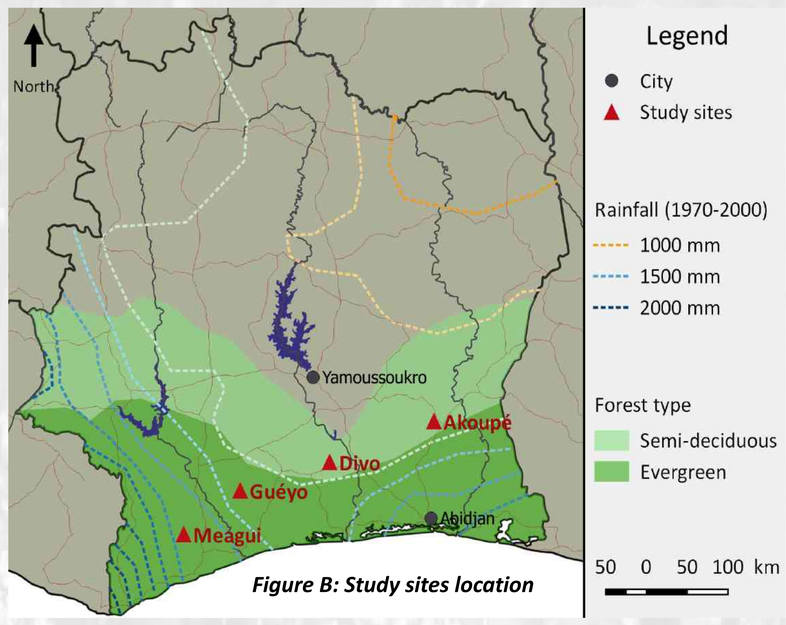

Figure B: Study sites location

RESULTS

Weight of environmental factors

Environmental factors explain between 0.03% (timber) and 28% (diversity) of the services provisioning.

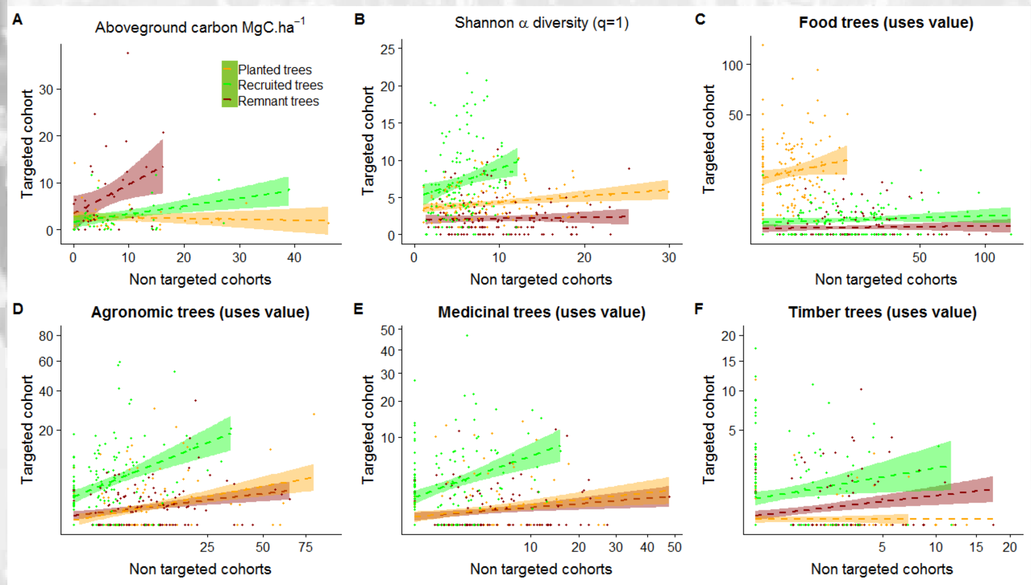

Figure C: Role of trees origins in ecosystemic services provisioning (each cohort ontribution is plotted against the sum of the contributions of the others)

Trees origins' role *(fig. C)*

For each service, one cohort stands out for its contribution.

Remnant trees (n=500) stock 54% of total carbon *(fig.C plot A)* .

Recruited trees (n=2472) is the most diverse cohort with 177 different species which are expected to deliver agronomic services to cocoa trees and are the main providers of medicinal trees *(fig.C plot D and E)*.

Planted trees (n=3371) are mainly fruit trees *(fig.C plot C)*.

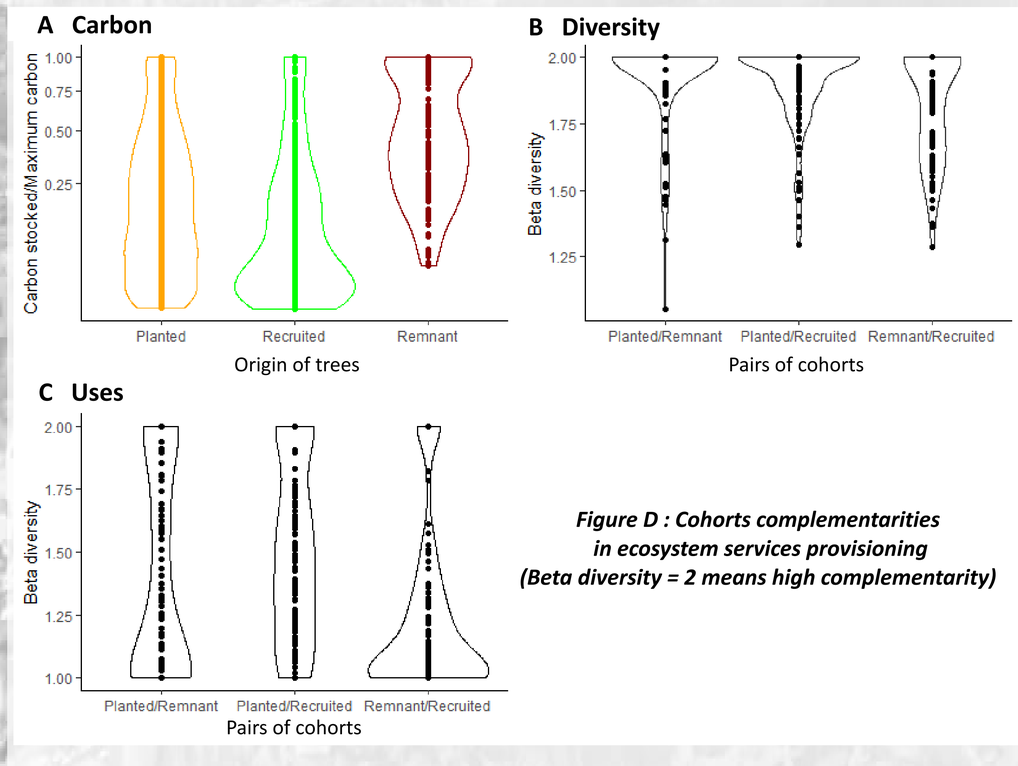

Figure D : Cohorts complementarities in ecosystem services provisioning (Beta diversity = 2 means high complementarity)

Complementarities between cohorts *(fig. D)*

In **carbon** provisioning, each cohort brings trees with different stages of maturity *(fig.D plot A)*.

In **diversity**, each cohort is complementary to others *(fig.D plot B)*. Planted trees (26 original species) and recruited trees (86) are the most complementary.

Uses brought by remnant and recruited trees are rather similar *(fig.D plot C)*. When there is complementarity it comes from planted trees.

DISCUSSION

Environment is a limited factor to explain agroforests' capacities to provide ecosystemic services

- Socio-economic variables influencing farmers decisions might be more determinant to understand associated trees composition.

Trees, with regard to their origins, provide different ecosystemic services

- By maintaining 17 remnant trees.ha^{-1}, carbon loss during forest conversion could be reduced by 25% in evergreen forests or 41% semi-deciduous forests.
- Agronomic services are not expected by farmers from dense and complex agroforests but from finely selected and known recruited trees.
- Planted trees play an important role in providing food. In sites close to urban markets, local informal specialized fruit value chains are observed.

Service	Unit	Min	1st quartile	Median	3rd quartile	Max
Carbon	MgC.ha⁻1	0.04	5.6	8.3	15.8	47.4
Shannon α diversity		0.27	1.86	2.23	2.64	3.32
Food use	trees.ha⁻1	0	6.6	14.4	26.7	124
Agronomic use	trees.ha⁻1	0	1.8	5.5	12.7	109
Medicinal use	trees.ha⁻1	0	0.6	2.5	7.8	49
Timber use	trees.ha⁻1	0	0	0.7	3.1	105

Table 1: Ecosystemic services estimation

Diversifying origins of trees: a way of bringing complementarities in ecosystemic services provisioning

- Even if cohorts are complementary in terms of maturity, the role of remnant trees might difficultly be replaced by recruited or planted trees in one field lifespan (30-50 years).
- Species diversity of the system is enhanced by the coexistence of the three cohorts : almost 60% of all species are present in only one cohort.
- The predominance of food trees in planted cohort does not imply low overall diversity of the cohort and the species it brings in the system are original.

Synthesis and applications for an eco-centered management of agroforests

- To incite farmers to invest in timber and favor contractualisation between timber industry and cocoa farmers : **secure trees outside forests' tenure** through national policy (land and trees rights) and local arrangements framing (added-value sharing).
- **Consider complementarities** between human-brought trees and human-selected trees as forms of diversity present in very anthropized systems *(fig.E)*.
- Provide farmers with nurseries of trees they value different from the ones they already plant or easily find in recruit to keep **diversifying the pool of species present in cocoa fields**.
- **Preserving remnant trees while clearing forest is irreplaceable** for carbon storage. As old cocoa fields are often replaced by monocultures, **set policy for carbon sequestration at a larger scale** (landscape) than cocoa fields.

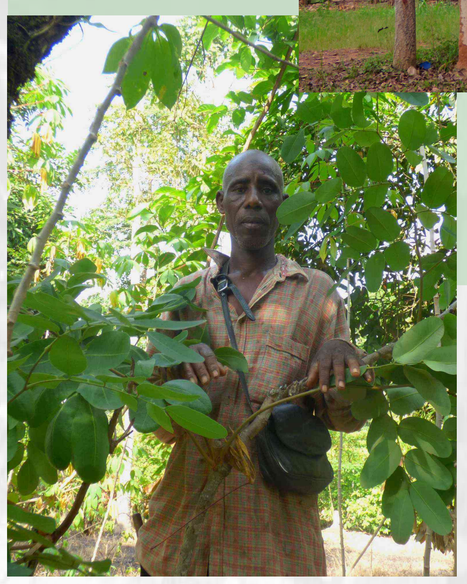

Figure E: Savanna species brought and planted in cocoa fields by migrant farmers

Karité (Vitellaria paradoxa) (top) and Detarium (left) planted in cocoa fields (Kragui, 2017 E.Sanial)

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