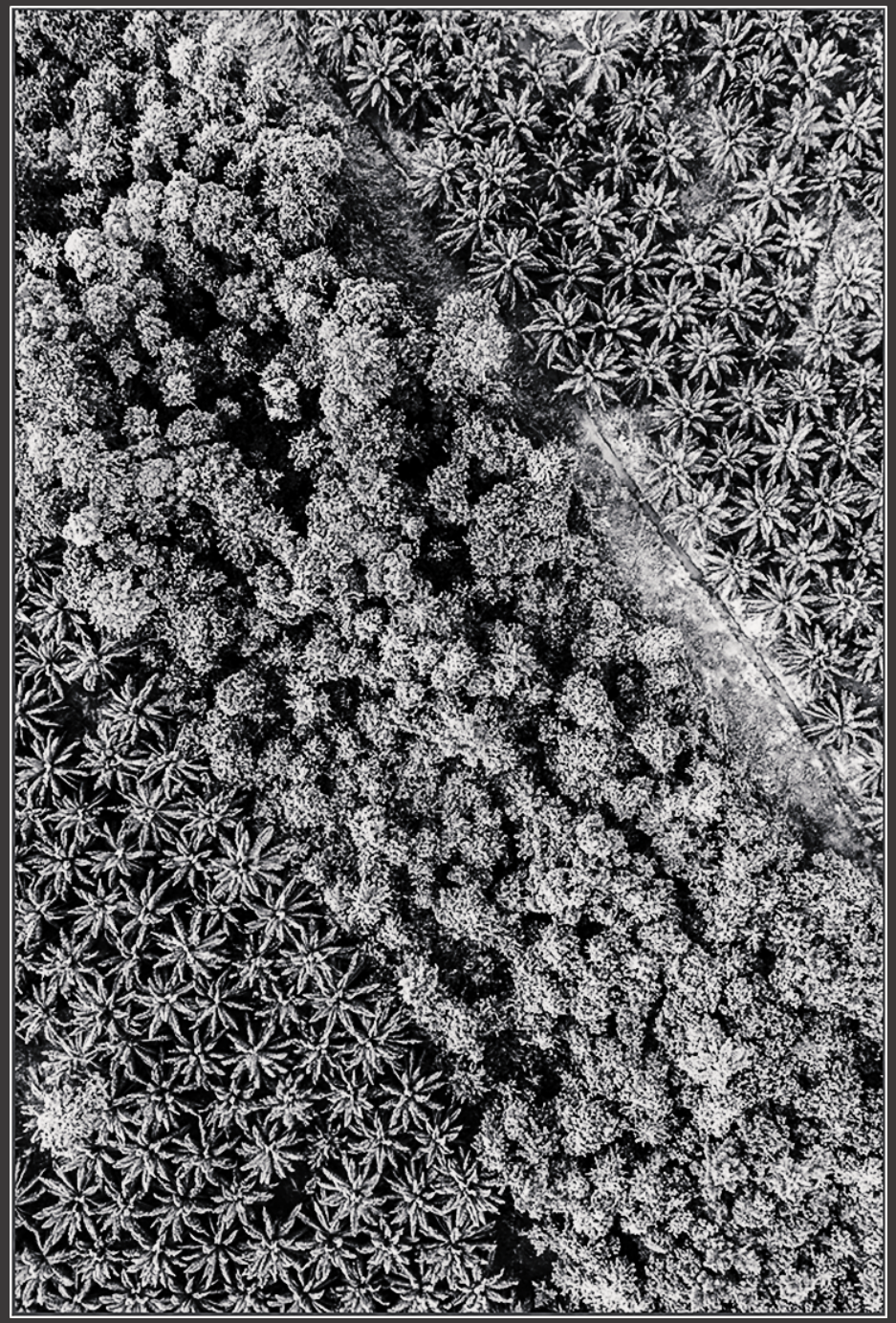


The TRAILS Workshop
June 13, 2023. Kota Kinabalu, Sabah.

Innovative planting and agroforestry design for climate resiliency and yield performance, in large scale oil palm plantation.

The TRAILS pilot.

Alain Rival, Marc Ancrenaz , Isabelle Lackman,
Mustafah Shafiq, & Marcel Djama

alain.rival@cirad.fr

A rising CO_2 context

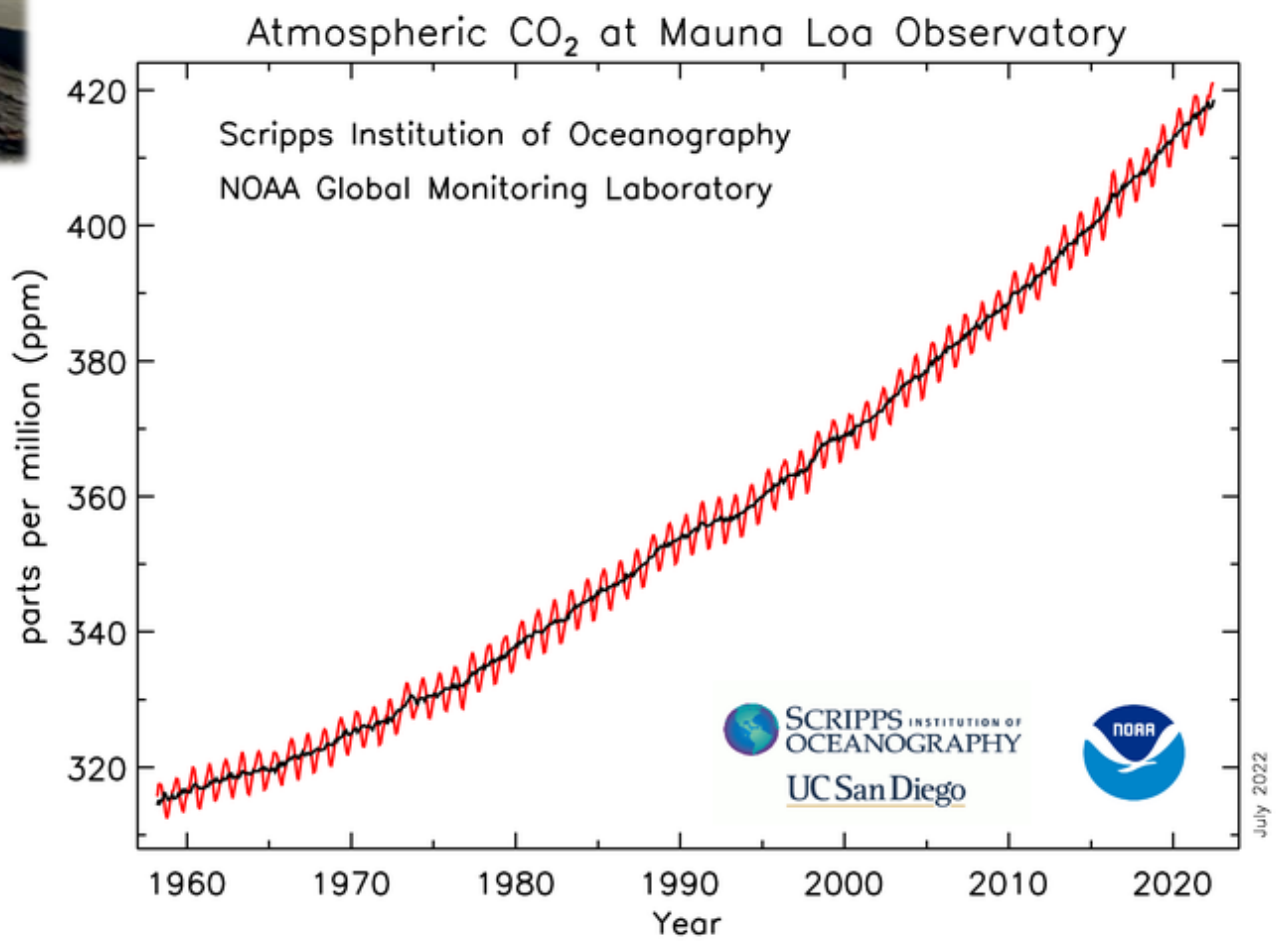
Atmospheric CO_2

April 2023

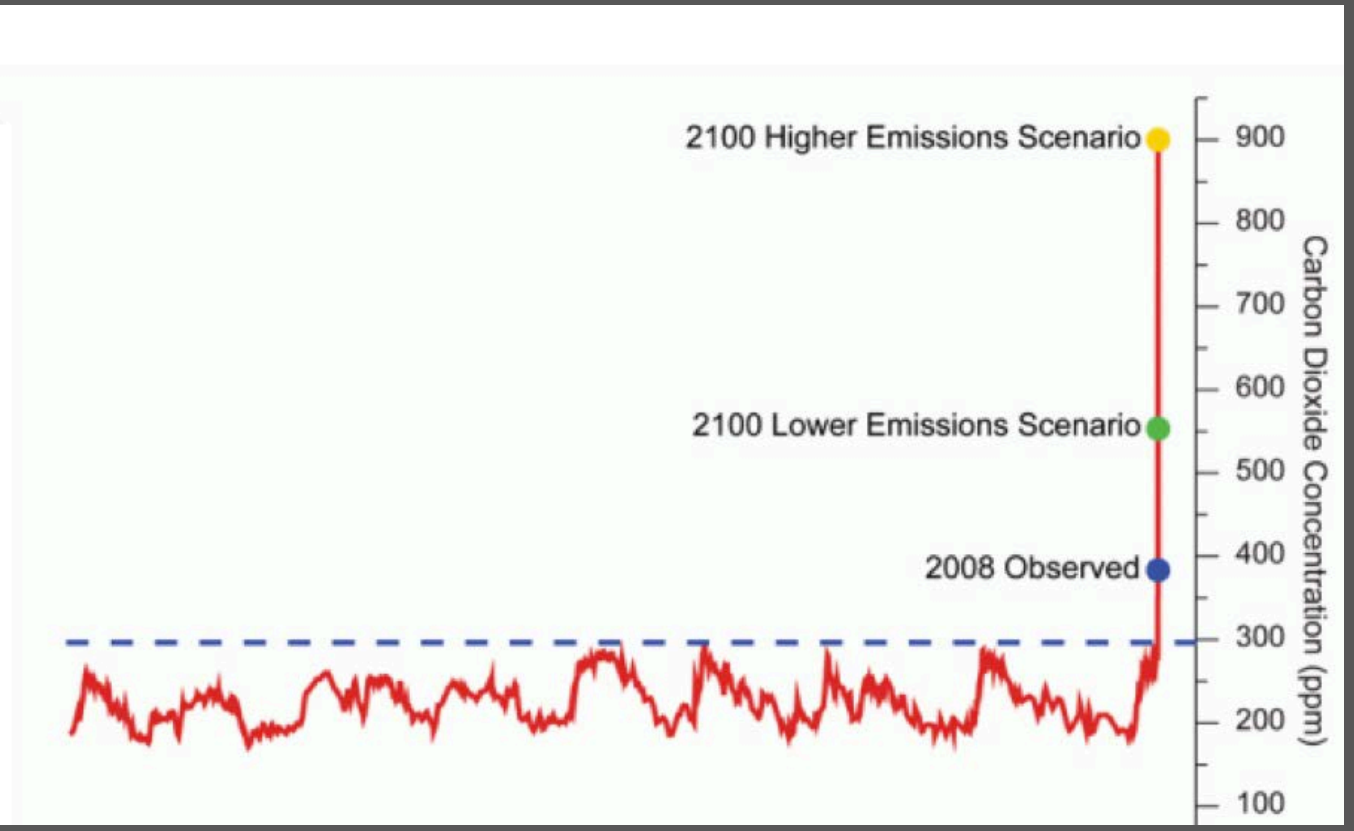
422.73

parts per million (ppm)

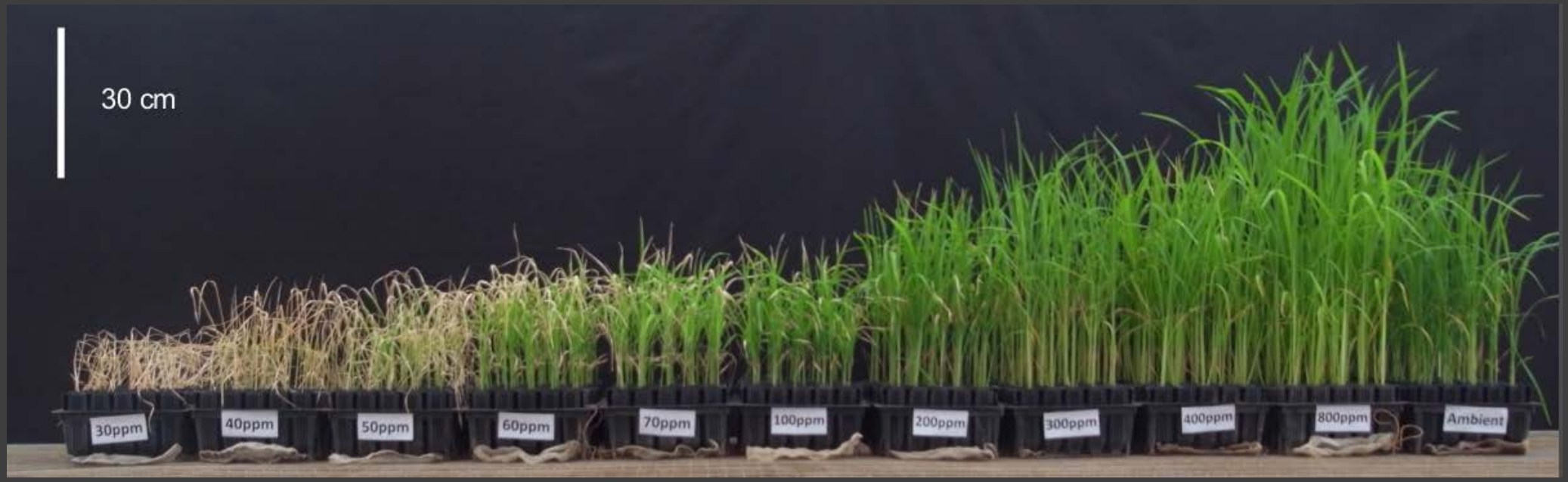
Mauna Loa Observatory, Hawaii (NOAA)



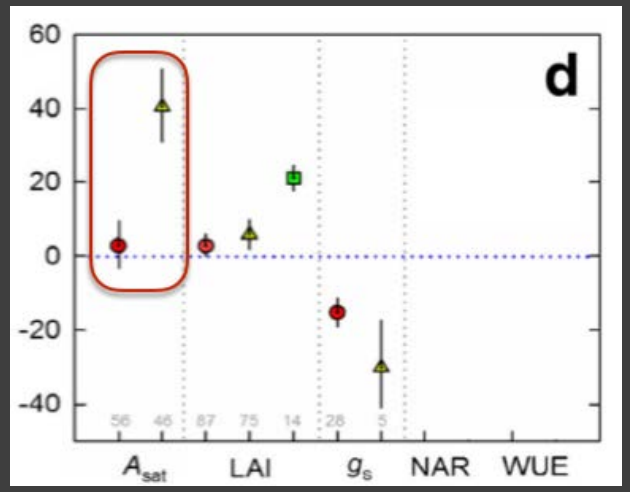
Projections



What happens to plants when CO_2 increase ?



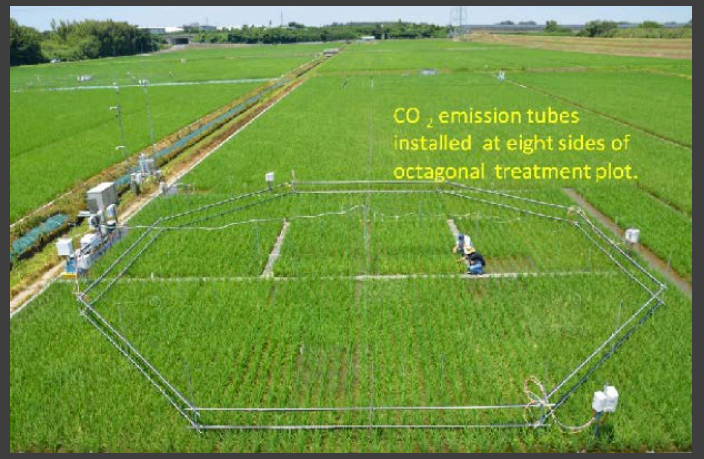
Large photosynthesis variation and Yield (+3 to 36 % !!) (Wang et al.2016)

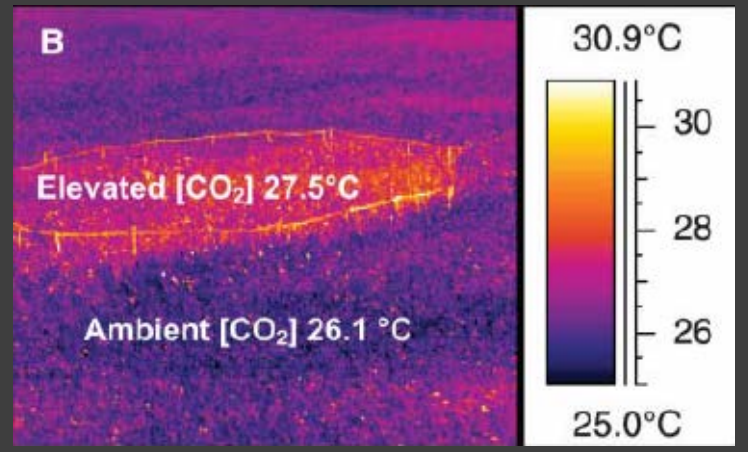


The positive CO_2 effect will not be for everyone !

Indirect effects of CO_2 elevation

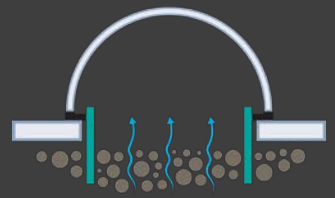
Leaf Temperature ↗



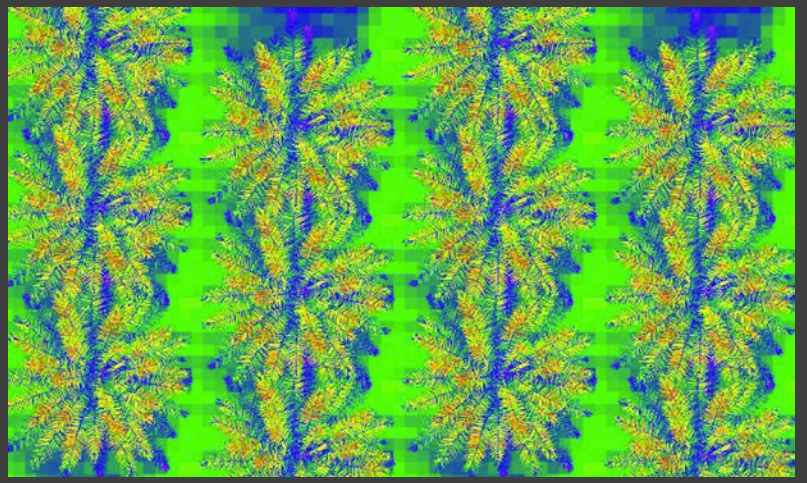


- Reduction on leaf cooling, leaf stomatal closure
- Climate will be drier and hot (with greenhouse gases)

Light canopy interception impacted ?



- Will the optimal density change ?
- Light/T° at ground level : Impact on soil respiration ?
- Impact for understory microclimate ? On wildlife ?



Why agroforestry?

- High productivity comes at a cost: soil that is depleted or eroded, watercourses that are polluted or drying up, and a food system that produces 20–40% of greenhouse gas emissions
- We urgently need to transform the food system, including agriculture.
- Agroforestry, as a nature-based approach to production and land use, will play an important role in this transformation.
- Agroforestry is land use that combines trees with crops, trees with livestock, or trees with both crops and livestock.
- This mix of components creates an agroforestry system in which the components interact in a beneficial manner, improving agriculture in many ways.

Gassner A and Dobie P. eds. 2022. Agroforestry: A primer. Design and management principles for people and the environment. Bogor, Indonesia: Center for International Forestry Research (CIFOR) and Nairobi: World Agroforestry (ICRAF).

Why oil palm-based agroforestry?

- Intensive monoculture has been the norm for most of plantation crops
- This system relies on abundant arable land and docile work force.
- The 2015 El Nino episode demonstrated the poor climatic resilience of intensive monocrop systems.
- The CoVid pandemics has revealed several weaknesses (need for mechanization, labor shortages).
- Diversified systems are more able to resist to price volatility (more stable income from multiple activities).

The TRAILS Project, Malaysia (Sabah)

- TRAILS project builds on a complementary partnership.
- TRAILS links academics, NGO, private and public stakeholders.
- TRAILS relies on long term expertise and multidisciplinary approaches from various science fields.
- TRAILS deals with agronomy, forestry and conservation sciences.

Objectives

- To install oil-palm-based agroforestry inside the oil palm plantation
- To undertake mixed planting in real-life conditions, using selected oil palm seedlings and 15 different native forest species
- To monitor the dynamics of wildlife recolonization (abundance, diversity, and mobility) in selected areas : mixed-planting, riparian corridors, and pure oil palm plantations.
- To comparatively study oil palm performance in these different systems: growth and development, fruit yields and bunch characteristics will be measured.

Objectives

- To understand key characters of climatic resilience and the bioclimatic condition of the agroforestry parcels
- To assess the ability of mixed planting at providing environmental services
    - photosynthetic capacity,
    - soil health,
    - water quality
    - abundance of pollinators
- To analyse the socioeconomic impact of the transition from oil palm monospecific plantation to complex agroforestry systems.

TRAILS in numbers

Allocated area : 100 ha

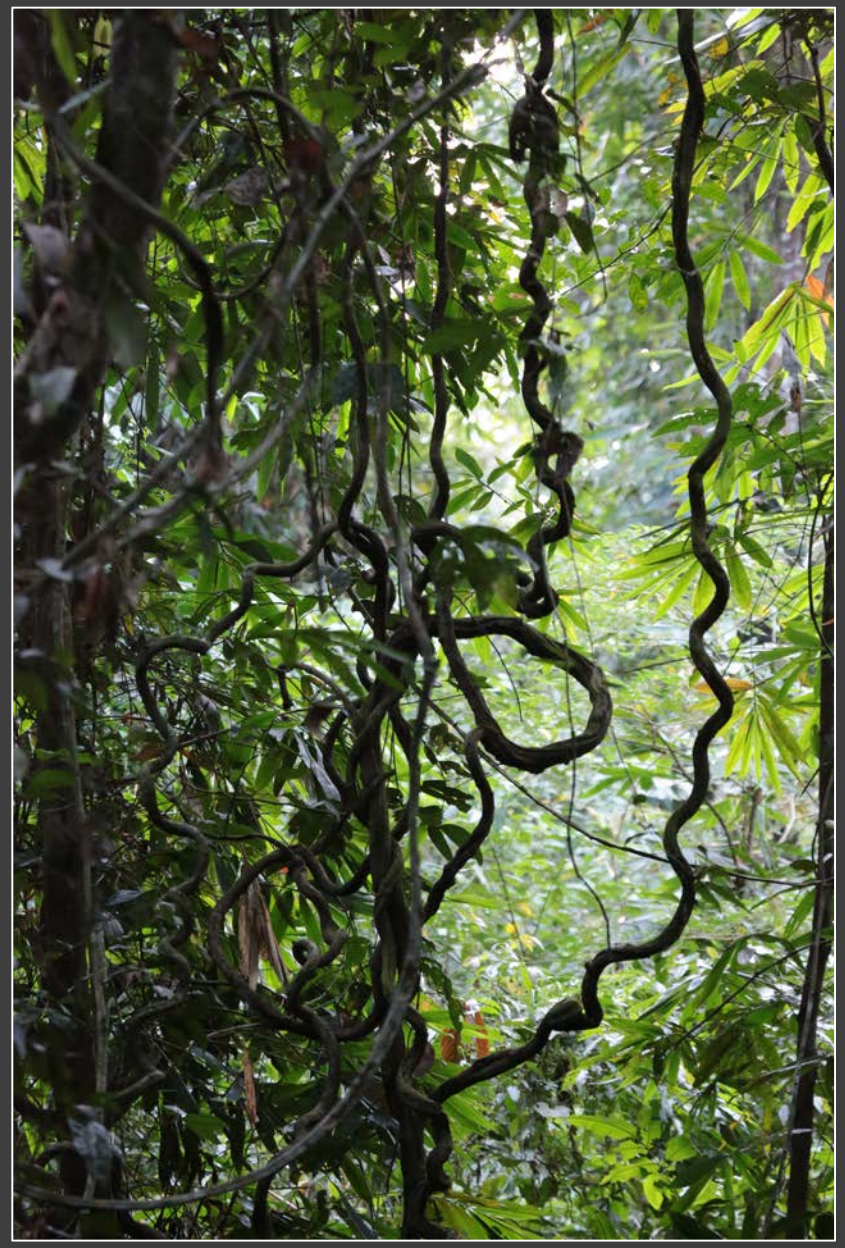
Present planted area : 22 ha

Planted forest species : 15

Planted trees : 3,000

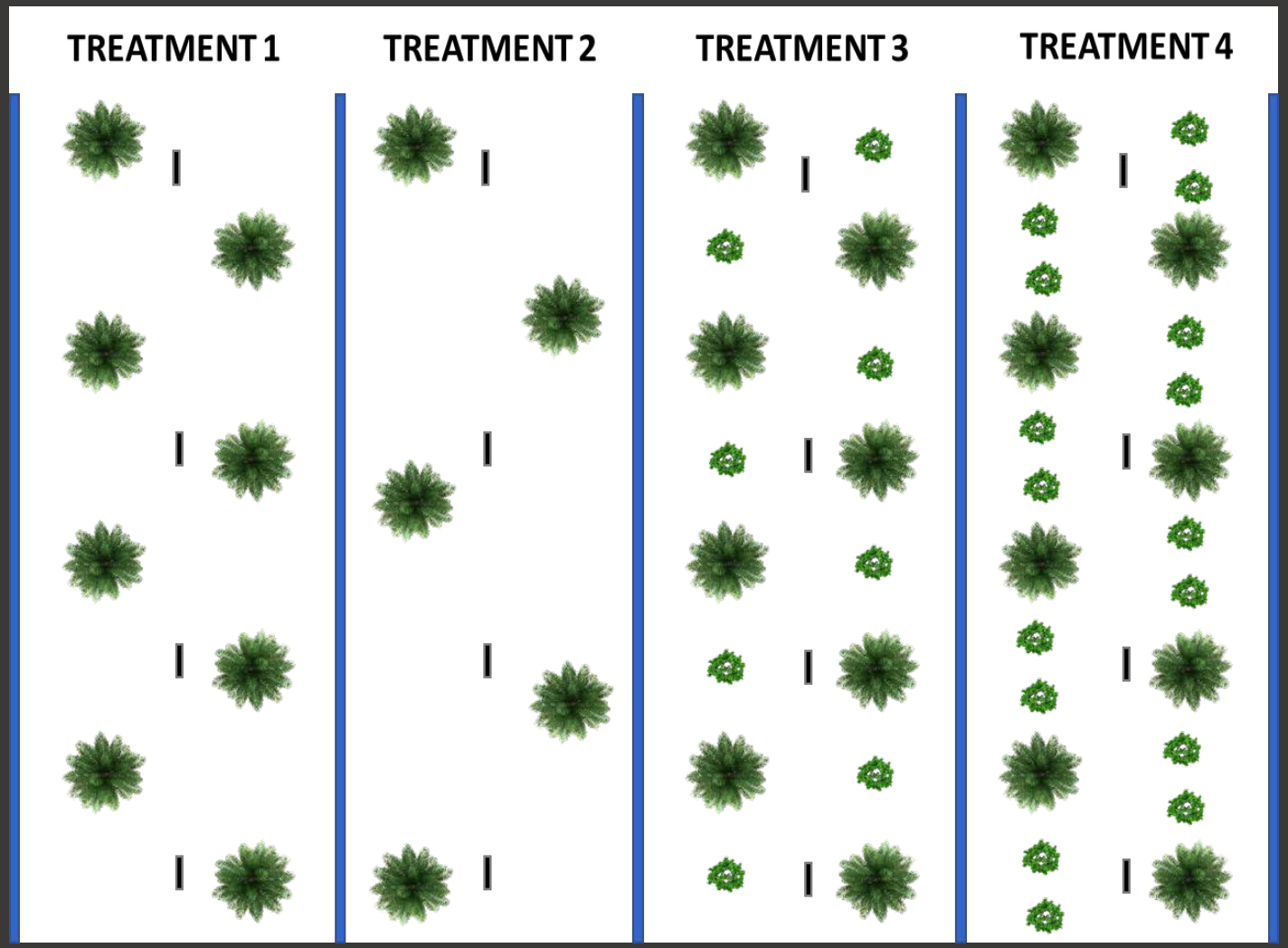
Specific planting designs : 3

TRAILS in numbers -27 native species



Family	Species	Vernacular name
Anacardiaceae	Koordersiodendron pinnatum	Ranggu
Anacardiaceae	Pentaspadon motleyi	Pelajau
Anacardiaceae	Dracontomelon sp.	Sengkuang
Annonaceae	Meiogyne sp.	Karai
Combretaceae	Terminalia catappa	Ketapang Paya
Dilleniaceae	Dillenia borneensis	Simpoh Gajah
Dilleniaceae	Dillenia excelsa	Simpoh laki
Ebenaceae	Diospyros sp.	Kayu Malam
Euphorbiaceae	Croton oblongus	Lokon
Euphorbiaceae	Mallotus muticus	Mallatus Paya
Euphorbiaceae	Glochidion borneensis	Obah Nasi
Euphorbiaceae	Excoecaria indica	Apid Apid
Lauraceae	Cinnamommum spp	Tiga urat
Malvaceae	Pterospermum javanicum	Bayor
Meliaceae	Toona sureni	Limpaga
Moraceae	Ficus septica	Lintotobu
Moraceae	Ficus benjamina	Lamba - banyan
Myrtaceae	Eugenia cerassiformis	Obah Jangkang
Myrtaceae	Eugenia sp.	Obah Putih
Myrtaceae	Syzygium malaccense	Makopa
Myrtaceae	Eugenia cerasiformis	Obah merah
Rubiaceae	Nauclea subdita	Bangkal aiskrim / kuning
Rubiaceae	Nauclea orientalis	Bangkal Daun Besar
Rutaceae	Murraya paniculata	Kemuning
Tiliaceae	Microcos crassifolia	Kerodong Damak-damak
Verbenaceae	Vitex pinnata	Kulimpapa

1 - Oil palm-based interplanting

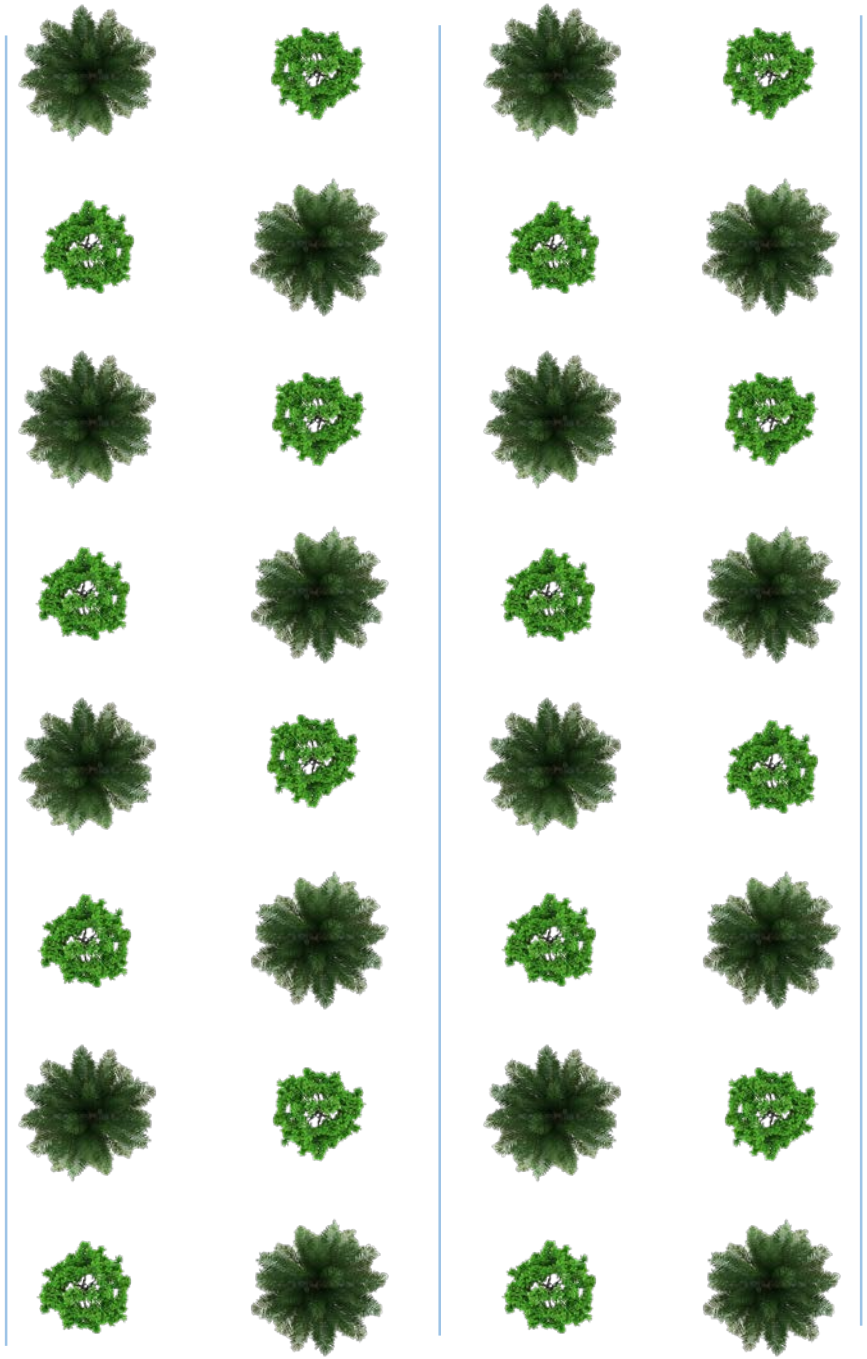


Expected results

- Impact of the reduction of oil palm density (143 to 93 palms/ha)
- Effect of forest trees co-planting on oil palm productivity
- Changes in biodiversity parameters
- Changes in biophysics parameters (soil, water, plant)

Design

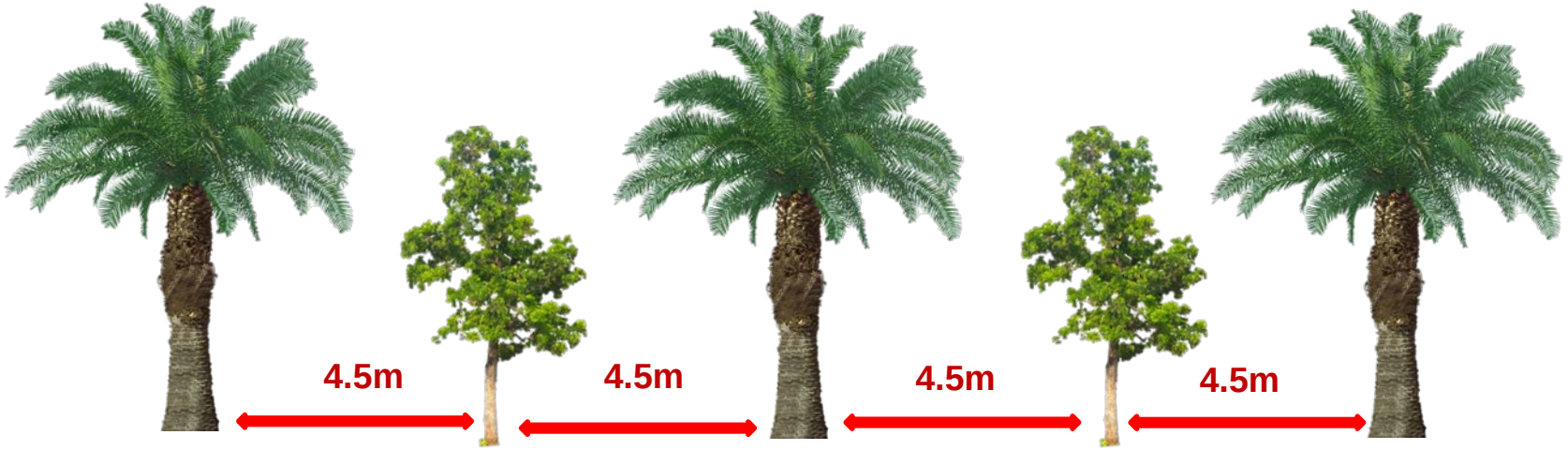
- One single trial made of 5 blocks
- Forest species: *Nauclea subdita*
- a fast growing native species generating light shading.

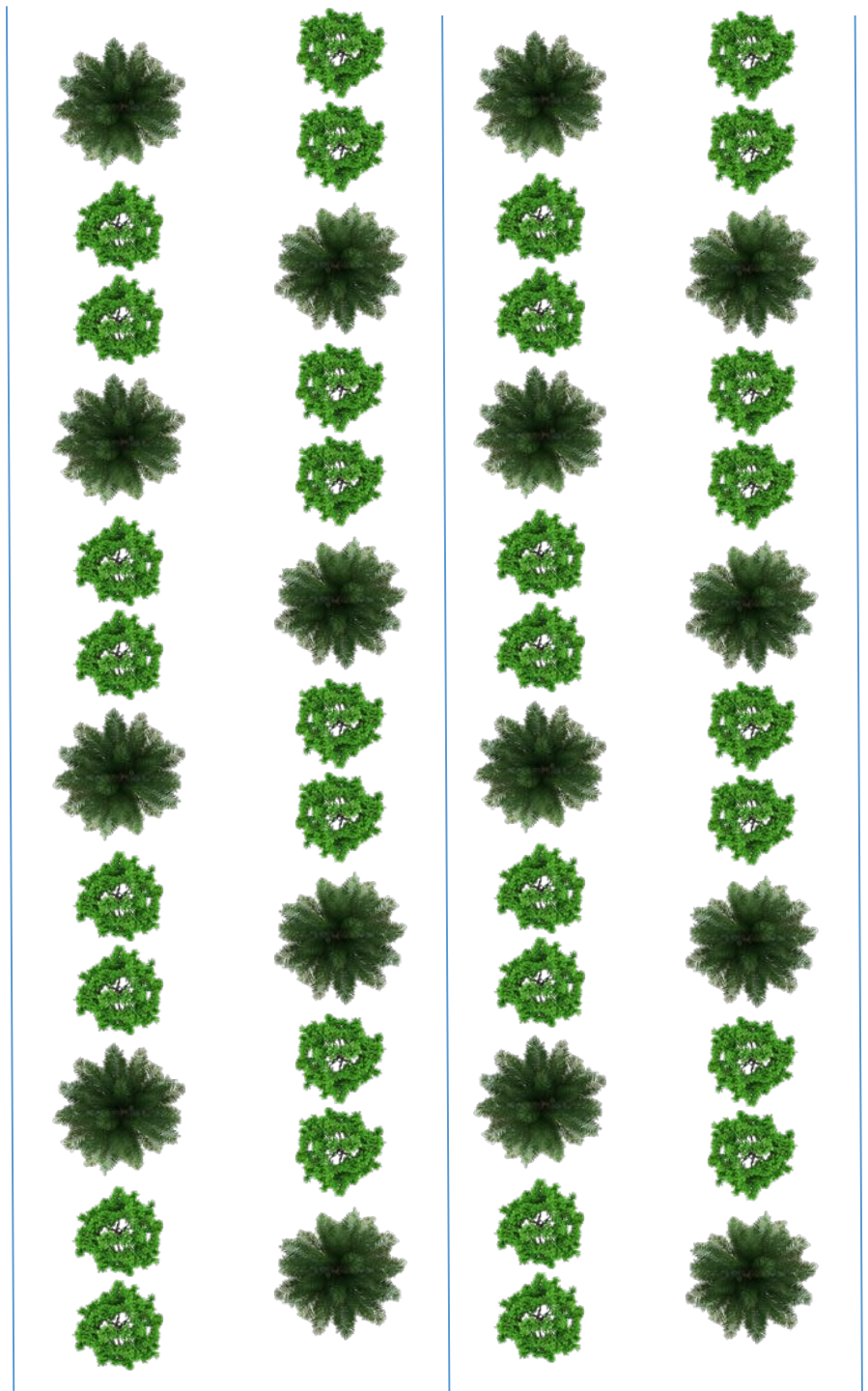


TRIAL 1 : MIXED PLANTATION (TREES & PALMS)

TREATMENT 3

1 forest tree is planted
between 2 palms on the line (64 trees)
trees & palms Spacing is 4.5m

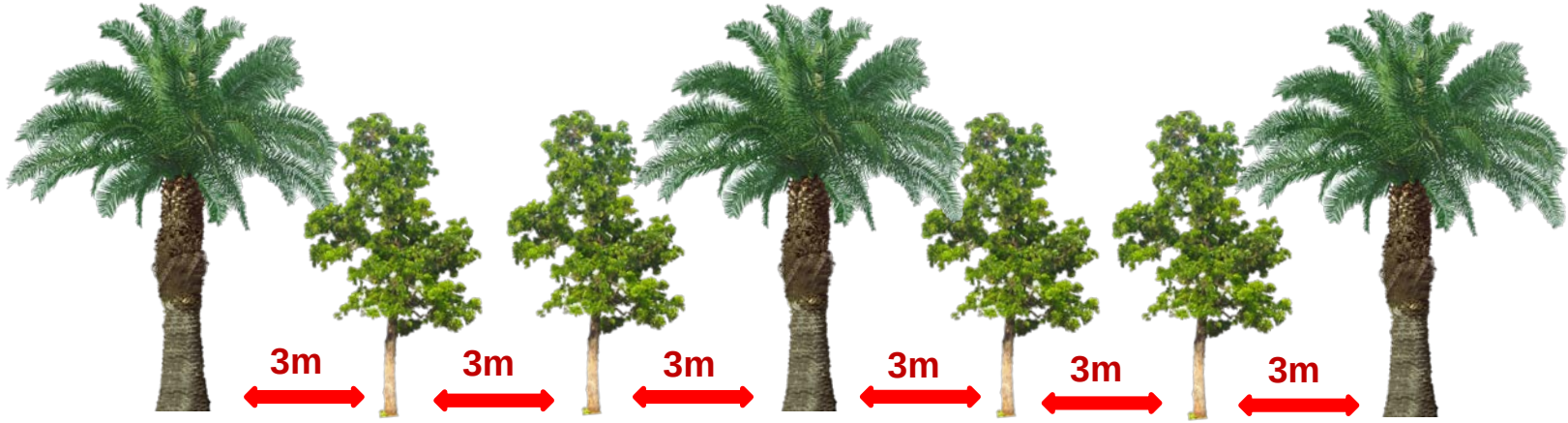




TRIAL 1 : MIXED PLANTATION (TREES & PALMS)

TREATMENT 4

2 forest tree are planted
between 2 palms on the line (128 Trees)
trees & palms spacing is 3m



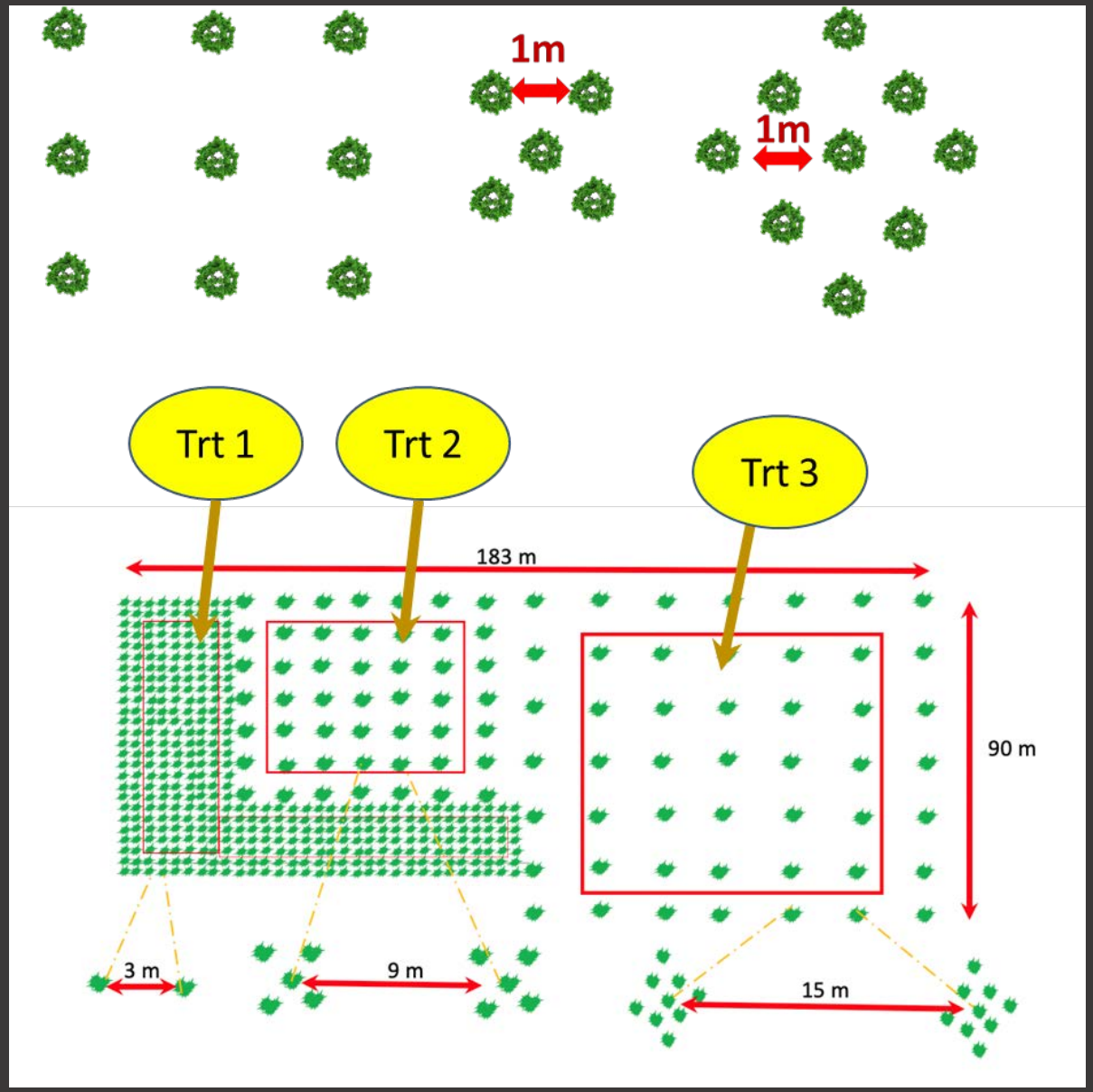
Expected results

- Suitability of native forest species to be part of agroforestry plantations
- Monitoring of the ability of each forest species to grow in association
- Assessment of the nucleus-type regeneration strategy

Design

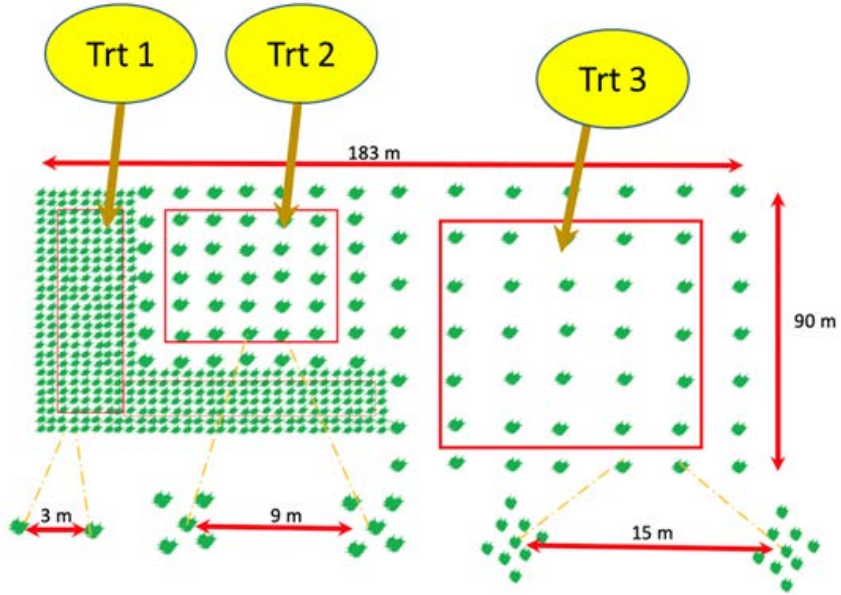
3 treatments

- Treatment 1 : 10 species 3 X 3 m, comparison of species ; 25 trees per species needed for measurements.
- Treatment 2 : 5 trees per nucleus 1 X 1 m , spacing between nuclides is 9 m.
- Treatment 3 : 9 trees per nucleus 1 X 1 m, spacing between nuclides 15 m.

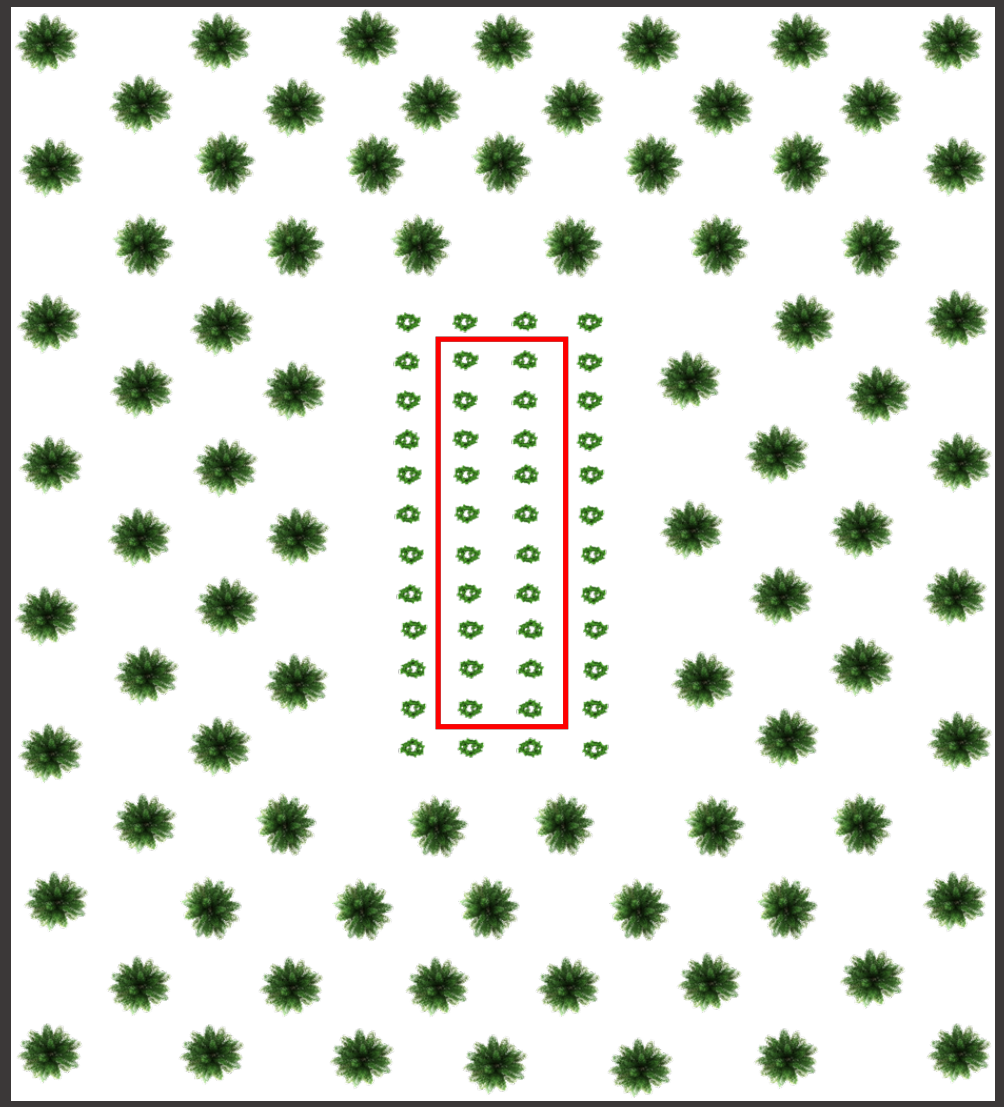


2 - Assessment of native forest species

3	LINTOTOBU
4	BAYOR
7	OBAH JANGKANG
11	OBAH PUTIH
12	RANGGU
14	KERODONG DAMAK-DAMAK
19	LIMPAGA
22	MALLASTUS PAYA
26	APID-APID
27	OBAH MERAH



3 - Forest Islands



Goal

To document the interactions between palms and specific tree species

Specific objectives

- To assess the productivity of palms around the islands
- To assess the changes in microclimate inside and around the islands
- To assess possible contamination or symbiosis through the microflora (*Ganoderma*)

Forest species

5 replicates x 48 trees = 240 trees per species

10-years work plan

PROJECT PHASE	YEARS	ACTIVITIES	BUDGET
TRAILS 1	2020 - 2022	• Construction of partnership • Baseline Assessment • Planting Design • Socioeconomic Studies	• 1,000 k€ • 2 years • Private/Public funding
TRAILS 2	2023 - 2026	• Protocols for evaluation - Agronomy • Protocols for evaluation - Biodiversity • Establishing participatory research • Protocols for statistical analysis • Data Collection • Data Treatment (Statistical Analysis) • Training (4 PhDs) • Publications	• 2,000 k€ • 4 years • Private/Public funding
TRAILS 3	2027 - 2030	• Data Collection • Data Treatment (Statistical Analysis) • 2 Post Doctoral Fellows • Publications • Recommendations	• 2,000 k€ • 4 years • Private/Public funding

September 2022