Oil palm-based agroforestry for regenerative agriculture

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Regenerative agriculture

Regenerative agriculture describes holistic farming systems that, among other benefits, improve water and air quality, enhance ecosystem biodiversity, produce nutrient-dense food, and store carbon to help mitigate the effects of climate change.

These farm systems are designed to work in harmony with nature, while also maintaining and improving economic viability

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
- Agroforestry is a nature-based approach to production and land use
- Agroforestry is a land use that combines trees with crops, trees with livestock, or trees with both crops and livestock.

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?

After millennia of polyculture, intensive monoculture became the norm for most of plantation crops

The colonial plantation system relied 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 also revealed several weaknesses (need for mechanization, labor shortages).

Diversified systems are more resilient and more able to resist to price volatility (more stable income from multiple activities).

The EFForTS Project

The Biodiversity Enrichment Experiment

- The EFForTS project is for Ecological and Socioeconomic Functions of Tropical Lowland Rainforest Transformation Systems (Sumatra, Indonesia)
- In the EFForTS project, more than 160 researchers from the University of Göttingen in Germany and the Indonesian universities IPB University (Bogor), UNTAD (Tadulako University, Palu) and UNJA (University of Jambi) worked for 12 years in close cooperation,
- A wide range of disciplines including ecology, forestry, agriculture, remote sensing, economics, human geography, and cultural anthropology.
- EFForTS-BEE is part of the global network of 323 tree diversity experiments *TreeDivNet* - https://treedivnet.ugent.be/.

Oil palm-based agroforestry

The Biodiversity Enrichment Experiment

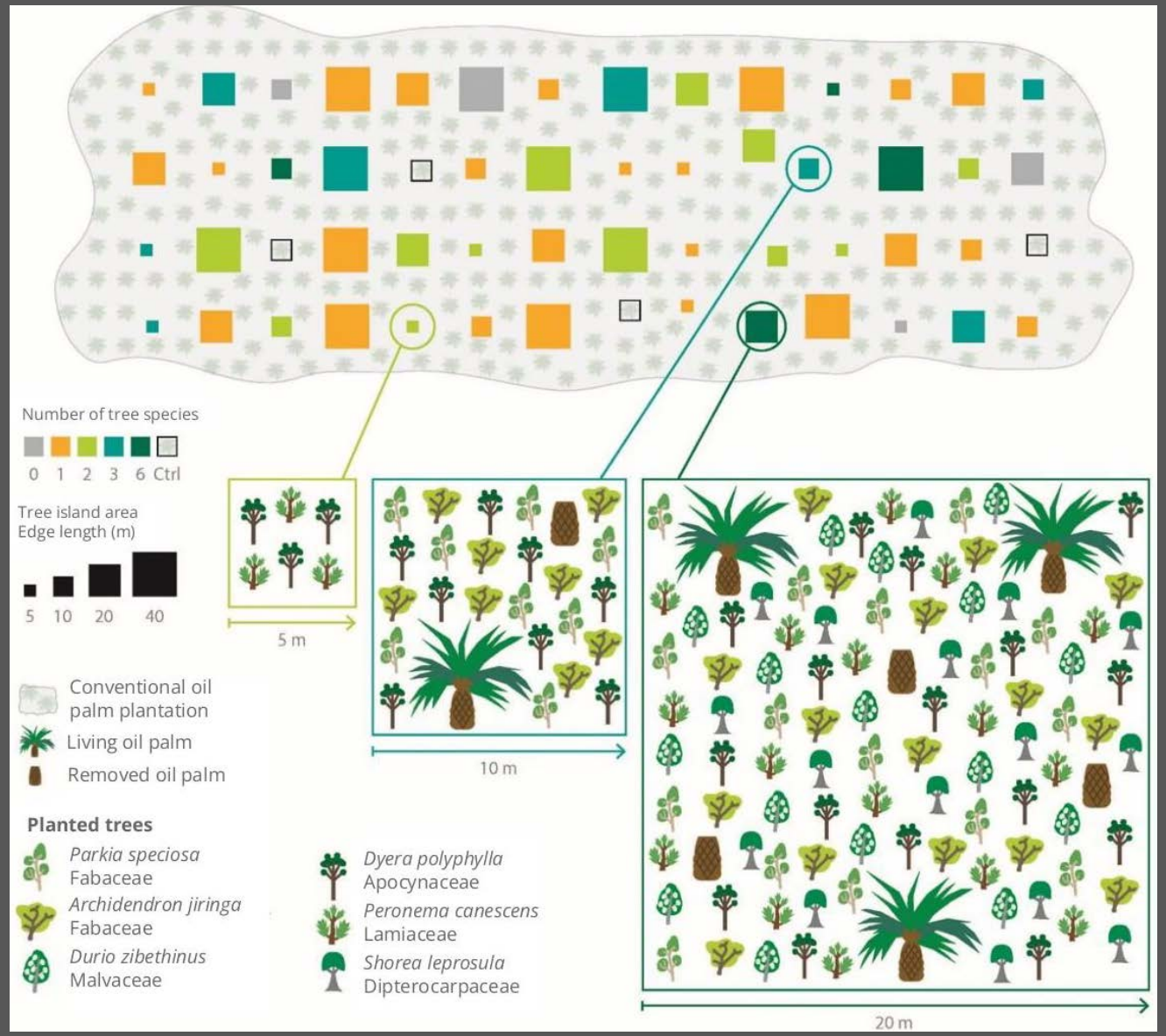
- In December 2013, 52 experimental plots (i.e. tree islands) were established in a conventional 140 ha oil palm plantation.
- Experimental design followed a random partition plot area (25, 100, 400 and 1600 m2) and tree species diversity (0, 1, 2, 3 and 6 species).
- Six different tree species were planted:

Archidendron jiringa (Fabaceae)	fruits
Parkia speciosa (Fabaceae)	fruits
Durio zibethinus (Malvaceae)	fruits
Dyera polyphylla (Apocynaceae)	fruits
Shorea leprosula (Dipterocarpaceae)	timber
Peronema canescens (Lamiaceae)	timber

- Species are native to the region and widely used for their fruits, timber or latex.

Zemp et al (2022) Tree islands enhance biodiversity and ecosystem functioning in oil palm landscapes. Nature 618, 316–321 (2023)

Oil palm-based agroforestry



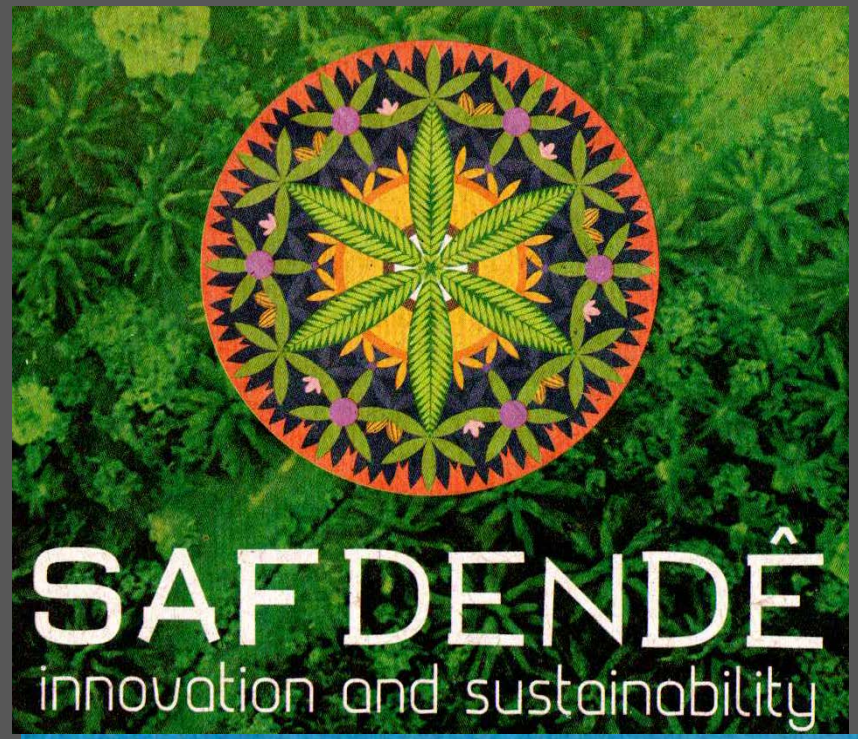
- This experimental design tests the restoration outcomes of tree island establishment in oil palm dominated landscapes.
- Tree islands vary in area (25 - 1600 m2) and planted tree diversity (0 - 6 species), with a total of 52 tree islands established in an industrial oil palm plantation in Sumatra, Indonesia.
- Control plots represent conventionally managed oil palm monocultures.

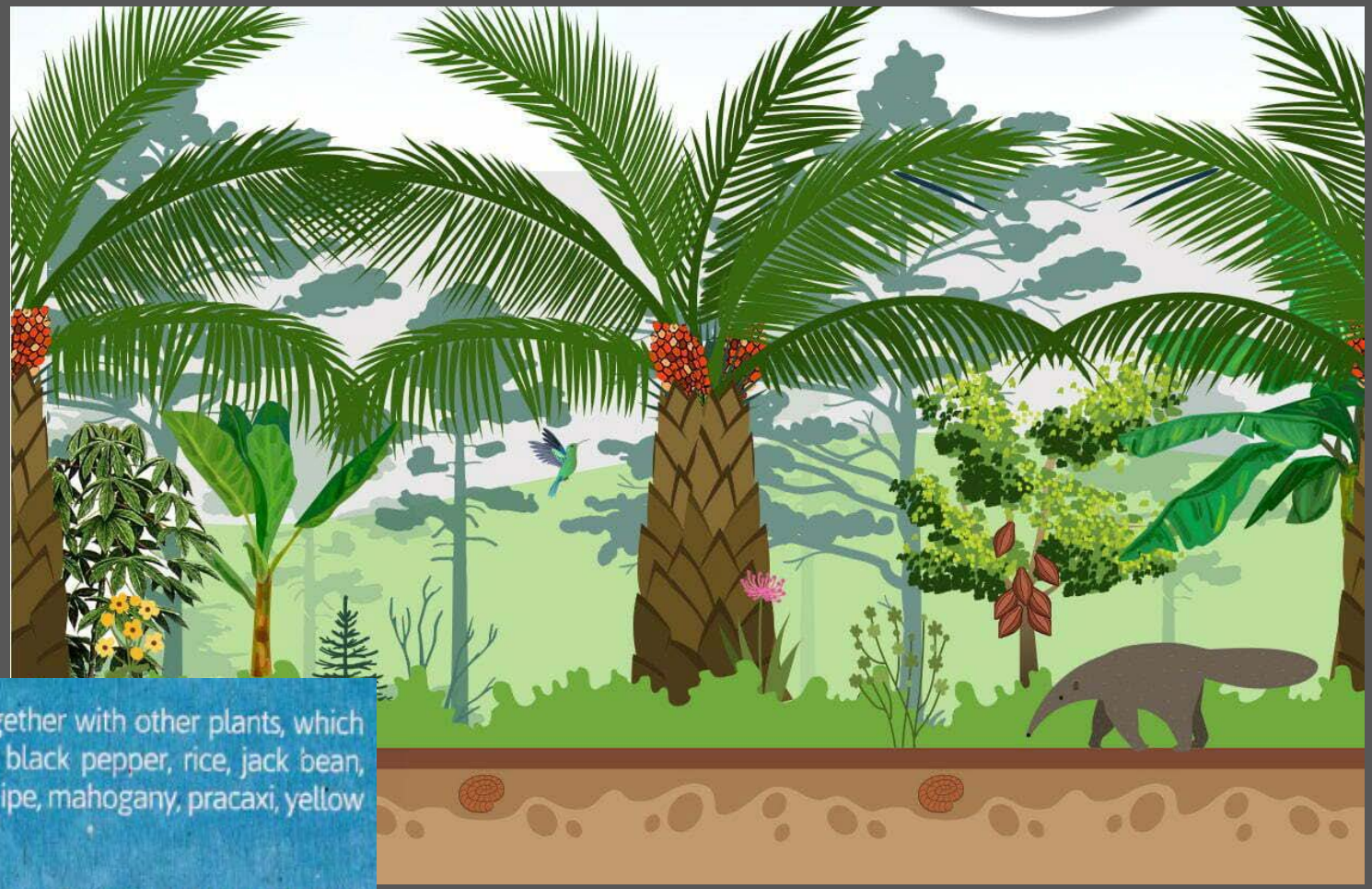
Zemp, D.C., Guerrero-Ramirez, N., Brambach, F., Darras, K., Grass, I., Potapov, A., Röll, A., Arimond, I., Ballauff, J., Behling, H. and Berkelmann, D., 2023. Tree islands enhance biodiversity and functioning in oil palm landscapes. Nature, pp.1-6.

Oil palm-based agroforestry

- A large-scale, five-year ecosystem restoration experiment in an oil palm landscape enriched with 52 tree islands, encompassing assessments of ten indicators of biodiversity and 19 indicators of ecosystem functioning.
- Tree enrichment enhanced multiversity by 250% and ecosystem multifunctionality by 75% compared to conventional monocultures.
- Tree enrichment did not significantly decrease landscape-scale oil palm yield.
- Such results demonstrate that enriching oil palm-dominated landscapes with tree islands is a promising ecological restoration strategy.

Oil palm-based agroforestry



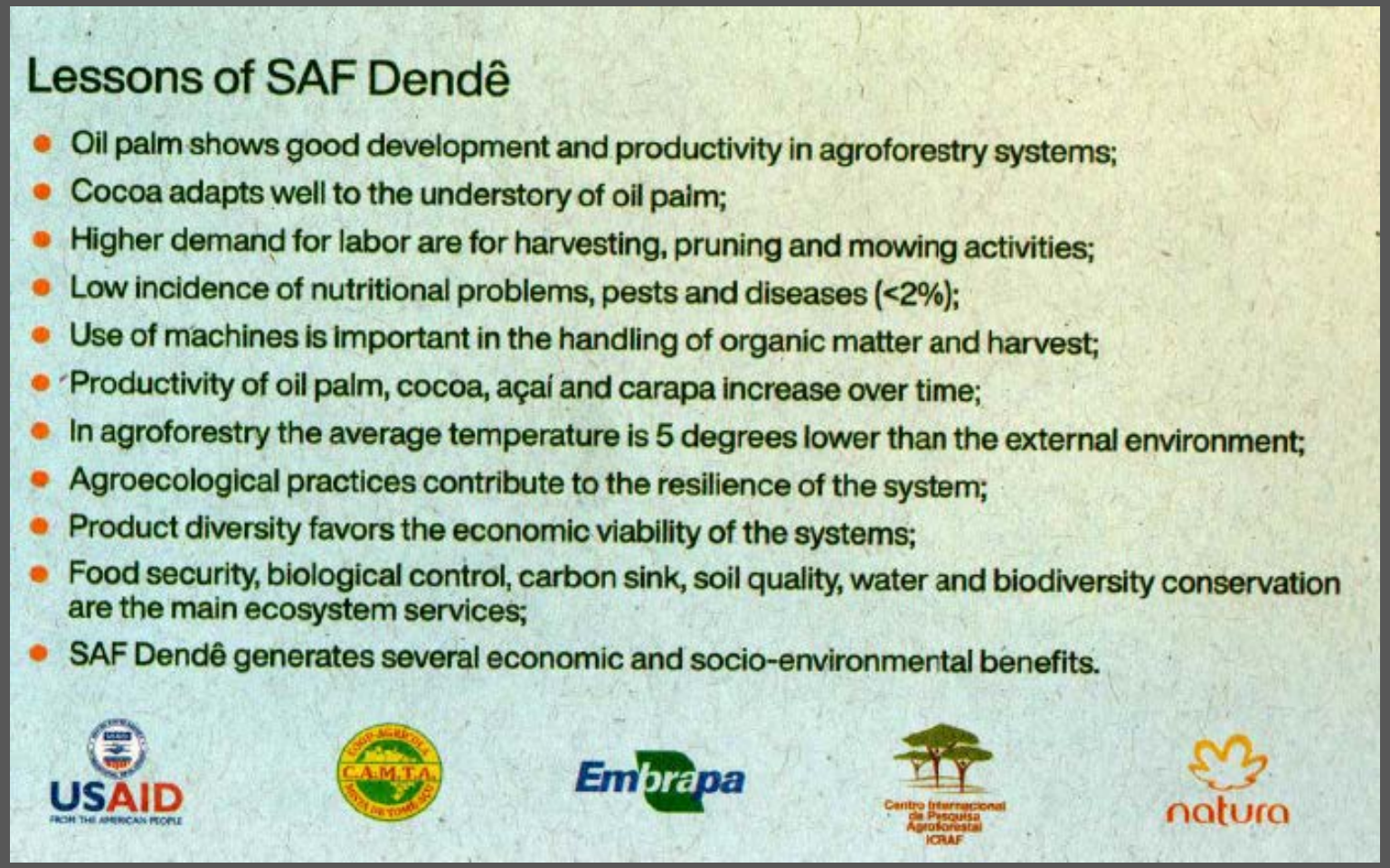


SAF Dendê is an agroforestry production system where oil palm is grown together with other plants, which can be used food or even wood production. Cassava, banana, passion fruit, black pepper, rice, jack bean, pigeon pea, tree marigold, inga, gliricidia, achiote, cocoa, açaí, bacaba, carapa, ipe, mahogany, pracaxi, yellow mombin and ucuuba were part of these systems with oil palm.

In partnership with local farmers, this participatory study showed that the cultivation of oil palm in agroforestry systems (SAF Dendê), with high biodiversity, presents good growth and productivity, generates different products, increases income and benefits for families without harming the environment, being an example for the world.

Oil palm-based agroforestry

Lessons learned



- First plantation in 2008
- 81 to 99 palms/ha
- 2008: 6 different agroforestry systems amounting 18ha in total
- 2019: 18 demonstration units on 61 ha
- SAF DENDE generates 3 X more environmental services than monoculture

Oil palm-based agroforestry

General Objectives

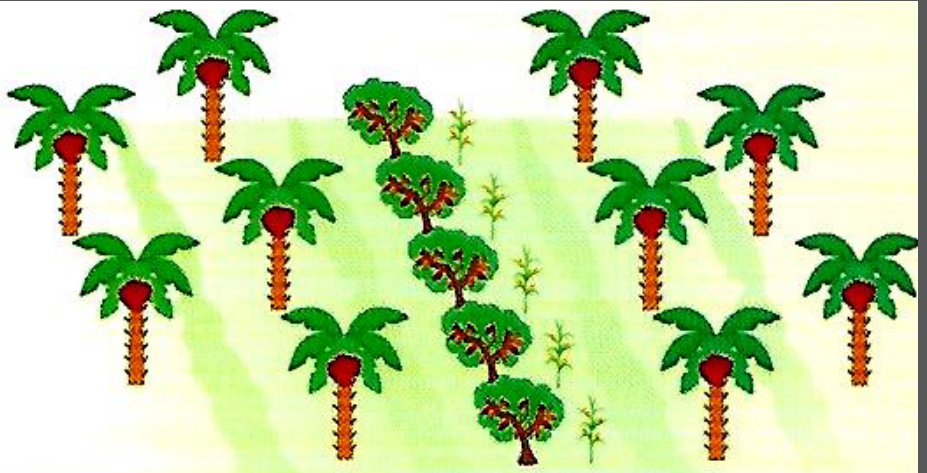
1.Enhance understanding of oil palm agroforestry options and practices for independent oil palm smallholders in the context of North Sumatra and promote sustainable models, both agronomically and economically.

2.Technical capacity strengthening of farmers in designing and adopting oil palm agroforestry systems through SNV staff, and farmer champions.

Oil palm-based agroforestry

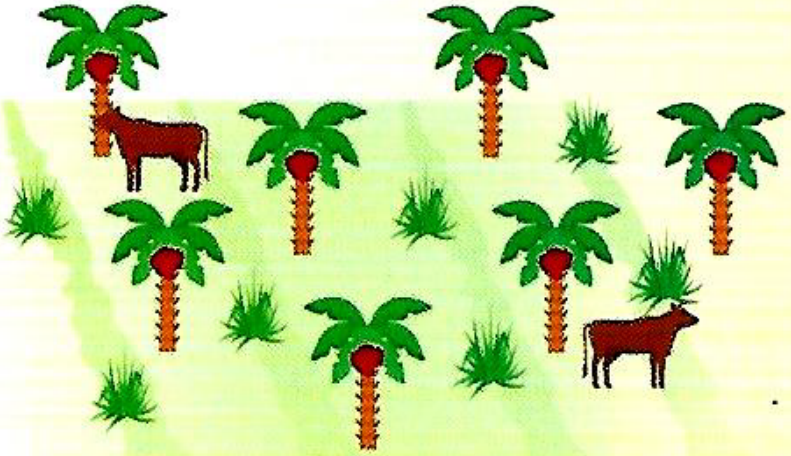
TIPE BARIS

Umumnya dirancang dari lahan kosong atau ketika tanaman sawit masih muda.



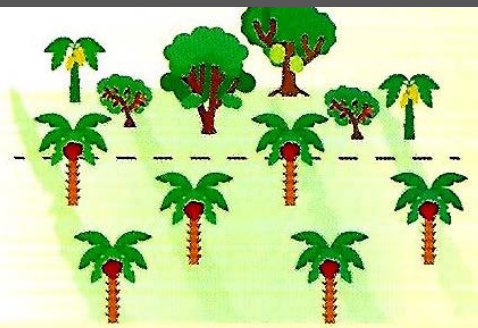
TIPE SAWIT-TERNAK

Umumnya disarankan di daerah yang banyak gangguan hama monyet, babi dan bajing.



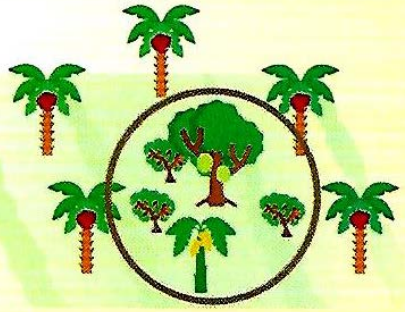
TIPE BLOK

Umumnya pada kebun sawit yang masih produktif (umur 5-15 tahun).



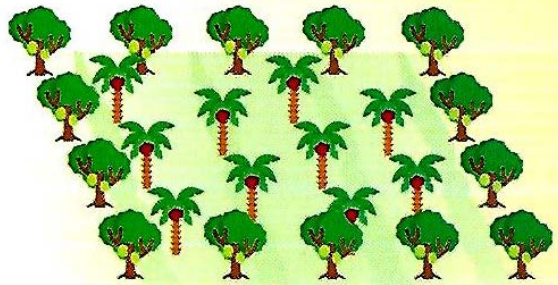
TIPE SISIPAN

Umumnya pada kebun sawit yang tumbang pohonnya karena penyakit ganoderma di kebun produktif (5-15 tahun) dan kebun tua (>15 tahun).



TIPE PAGAR

Umumnya pada kebun sawit yang masih produktif ataupun tua.



Oil palm-based agroforestry

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.

The TRAILS Project, Malaysia (Sabah)

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 regeneration of biodiversity in specific areas: agroforestry plantings, riparian corridors, and oil palm plantations in comparison with native forest.
- ✓ To comparatively study oil palm performance in different systems: growth and development, phenology, fruit yields and bunch characteristics.

The TRAILS Project, Malaysia (Sabah)

Specific objectives

To understand the key characters of climatic resilience and the bioclimatic condition of the agroforestry parcels

To assess the ability of mixed planting at improving environmental services, such as:

- ✓ increased biomass and photosynthetic capacity,
- ✓ soil health,
- ✓ water quality
- ✓ abundance of pollinators…

To analyse the socioeconomic impact of the transition from oil palm monospecific plantation to diversified agroforestry systems.

The TRAILS Project, Malaysia (Sabah)

TRAILS in numbers

- ✓ Allocated area : 100 ha
- ✓ Present planted area : 37 ha
- ✓ Planted forest species : 15
- ✓ Planted trees : 3,000
- ✓ Specific planting designs : 3

The TRAILS Project, Malaysia (Sabah)

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

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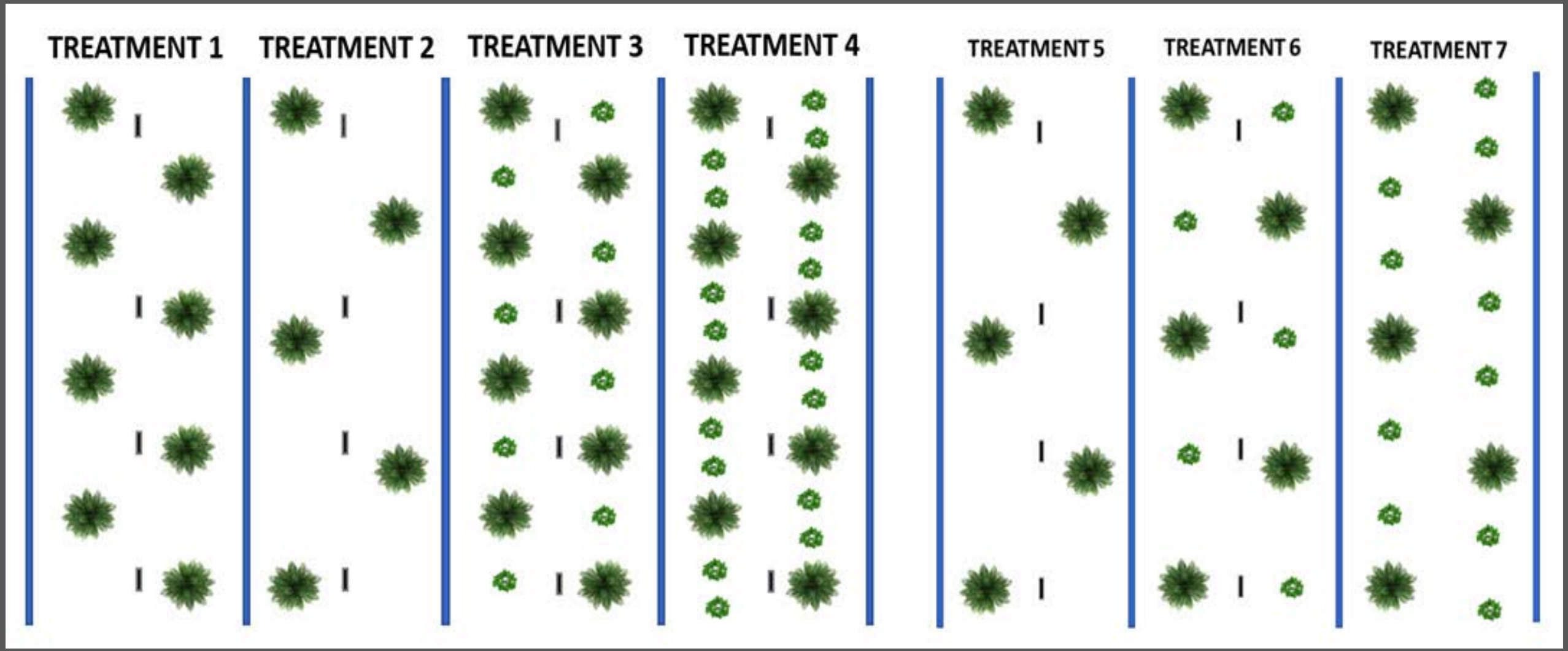
Interplanted rows



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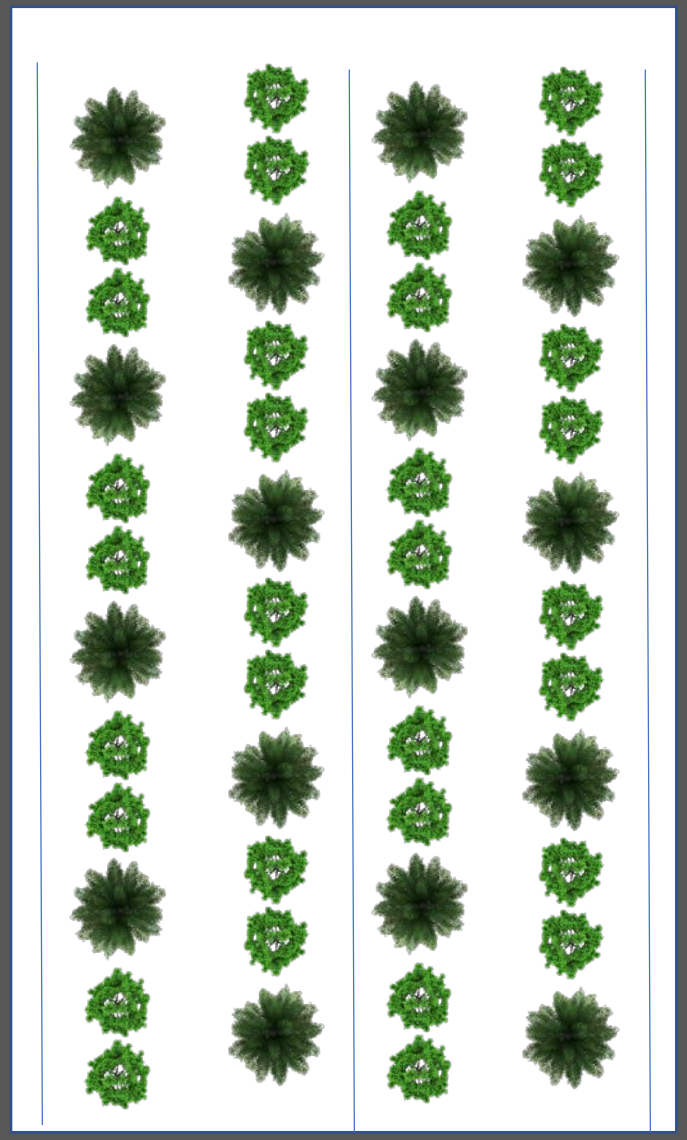

Expected results

- 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.

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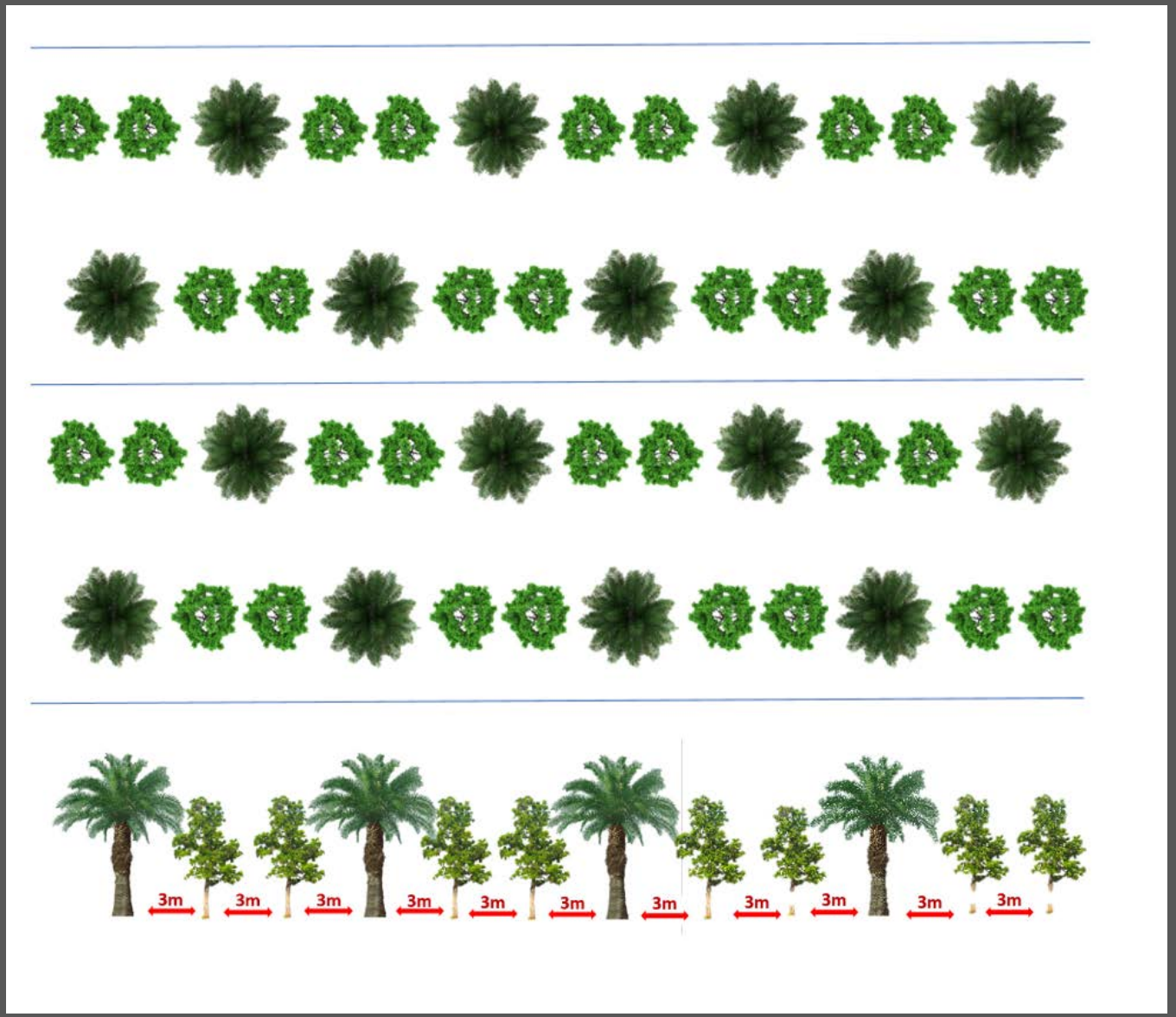

Schematic representation of an example of agroforestry planting (Treatment 4) involving the “Interplanted rows” design

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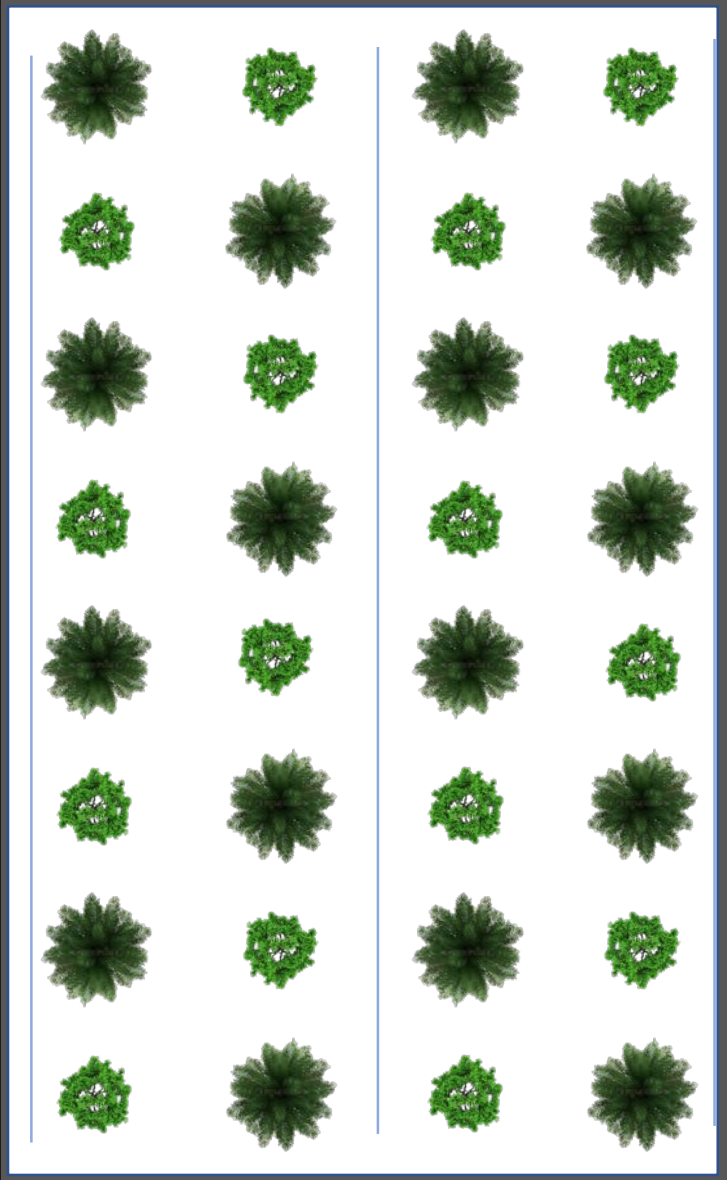
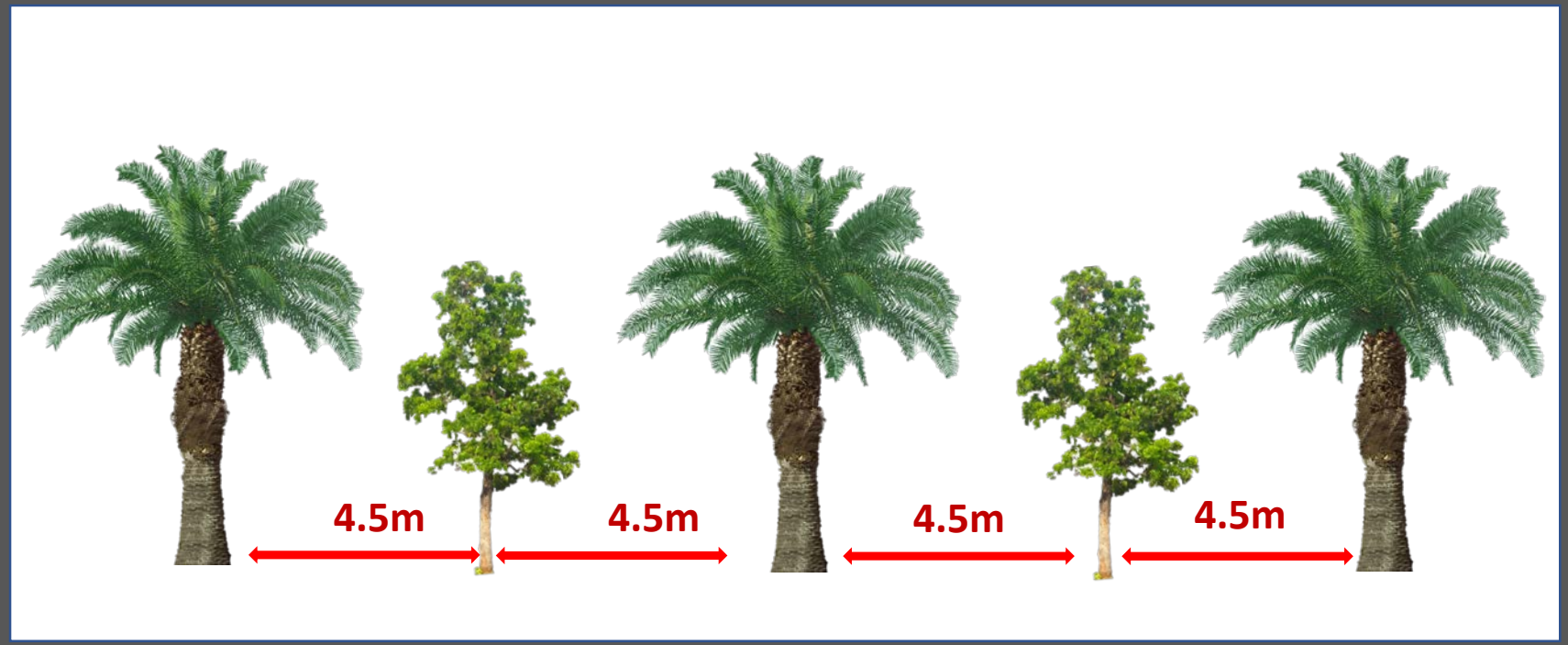


Interplanted Rows

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



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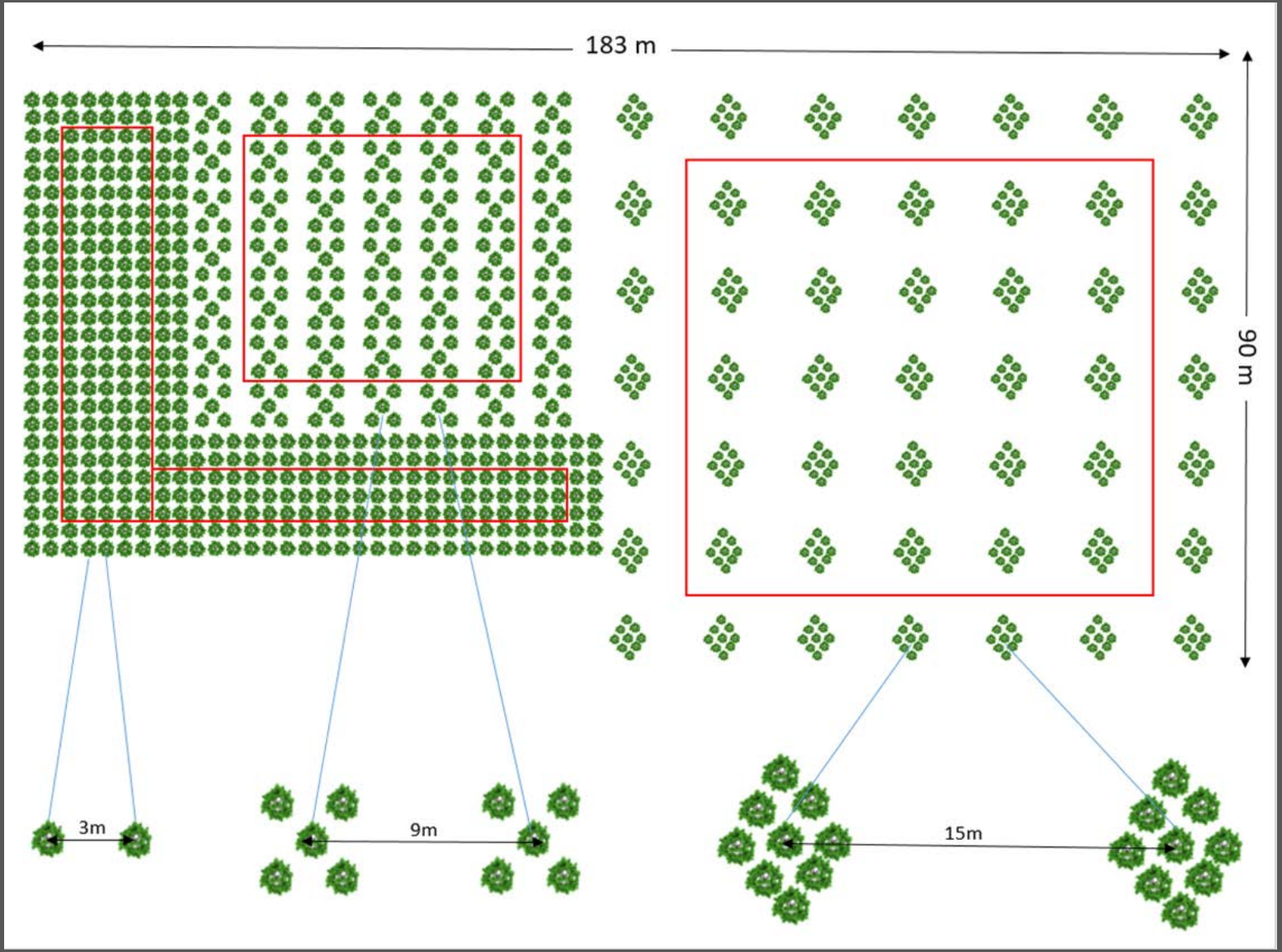

Experimental design

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

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1	2	3	4	5	6	7	8	9
3	27	19	22	7	22	11	3	14
4	27	26	11	12	4	11	3	26
22	19	7	27	26	12	3	4	11
11	4	3	14	26	12	7	26	19
26	14	27	12	7	4	14	11	22
4	11	22	26	27	14	12	19	7
3	7	19	12	14	11	22	19	27
26	22	14	7	11	19	27	3	4
4	3	12	22	26	26	11	7	14
14	12	3	11	4	22	3	26	27
3	26	4	27	7	19	11	22	14
14	26	22	11	12	4	12	3	19
26	12	3	4	27	22	7	19	27
22	19	7	27	26	12	3	4	11
11	4	3	27	14	14	7	26	4
26	19	11	26	12	4	3	11	22
4	11	22	14	27	19	19	26	7
3	7	19	22	14	4	14	3	7
22	11	14	12	27	12	26	4	22
12	7	4	14	4	11	3	12	27
3	4	4	27	7	22	19	11	14
12	7	22	11	12	4	14	3	26
27	19	3	4	14	27	7	27	27
22	19	7	27	14	12	3	11	11

3	FICUS SEPTICA	35
4	PTEROSPERMUM JAVANICUM	42
7	EUGENIA CERASSIFORMIS	40
11	EUGENIA SP	35
12	KOODERSIODENDRON PINNATUM	35
14	MICROCOS CRASSIFOLIA	43
19	TOONA SURENI	35
22	MALLOTUS MUTICUS	41
26	EXCOECARIA INDICA	35
27	EUGENIA CERASIFORMIS	47

27	4	14	19	22	14	7	26	12	26	27	7	22	11	19	14	22	19	7	4	3	11
26	12	14	27	19	27	3	26	22	7	14	4	27	22	12	26	3	14	19	19	12	12
4	22	26	14	11	12	12	3	7	26	3	14	22	27	19	7	11	19	22	26	11	3
3	7	14	12	14	27	22	26	27	22	19	26	12	3	4	14	4	7	27	22	7	27
27	22	14	11	7	11	12	27	4	11	4	22	14	7	26	14	11	3	4	27	22	12
7	12	12	19	27	27	7	14	14	27	19	19	4	27	22	14	14	12	7	22	26	22
14	7	27	4	4	19	19	27	4	27	7	7	12	19	7	27	27	22	27	4	4	11

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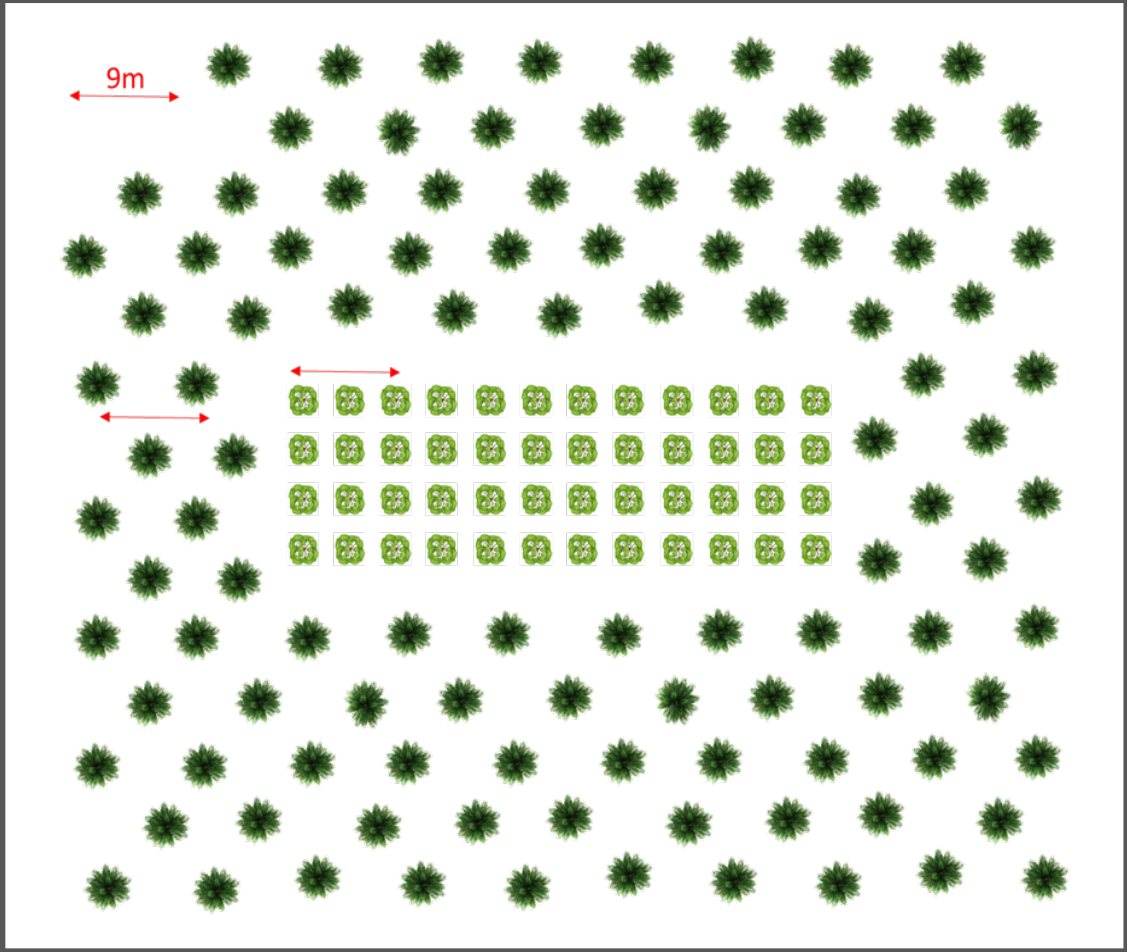
Expected results

- The present trial was planted with forest trees only, aiming at assessing the ability for agroforestry plantation of ten different selected species of native forest trees.
- Three different planting densities and three types of trees associations (individual trees, group of 5, group of 9) were tested.
- We will improve our knowledge on growth and development characteristics of 10 forest specieds, natives of the Kinabatangan Basin,
- Assessed suitability of native forest species to be successful in agroforestry plantations

Forest Islands



Goal

To document the interactions between palms and specific tree species

Experimental design:

- 5 replicates x 48 trees = 240 trees per species
- First set of 4 species:
- *Nauclea subdita, Microcos crassifolia, Meiogine* sp, *Mallatus muticus*

Specific objectives

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

The TRAILS Project, Malaysia (Sabah)

A 10-years work plan

PROJECT PHASE	YEARS	ACTIVITIES	BUDGET
TRAILS 1	2020 - 2023	• Construction of partnership • Baseline Assessment • Planting Design • Socioeconomic Studies	• 1,000 k€ • 2 years • Private/Public funding
TRAILS 2	2024 - 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

The TRAILS Project, Malaysia (Sabah)

September 2022

The TRAILS Project, Malaysia (Sabah)

October 2023

The TRAILS Project, Malaysia (Sabah)

July 2024

The best time to plant an oil palm-based agroforest was 20 years ago.
The second best time is now.

Thank you.
Terima kasih.