Tree management in monocultures and agroforestry systems affect microclimatic growing conditions and fine-root growth

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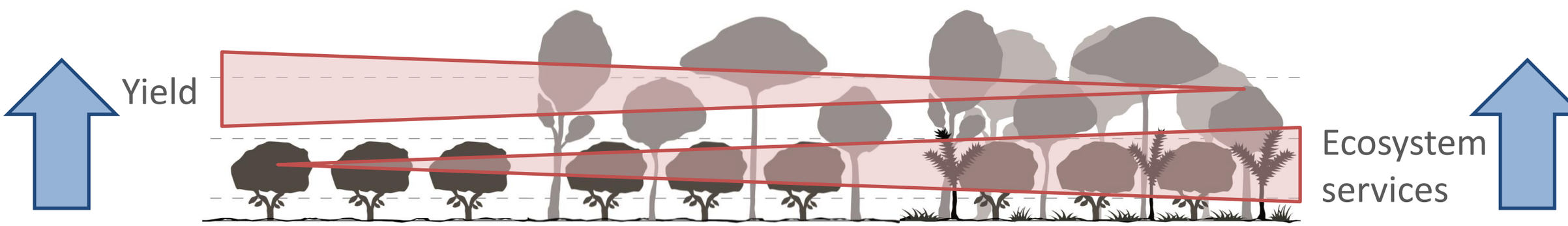
Tree management for cacao cultivation

- Production systems:
  - Monocultures → simple agroforestry systems → complex agroforestry systems

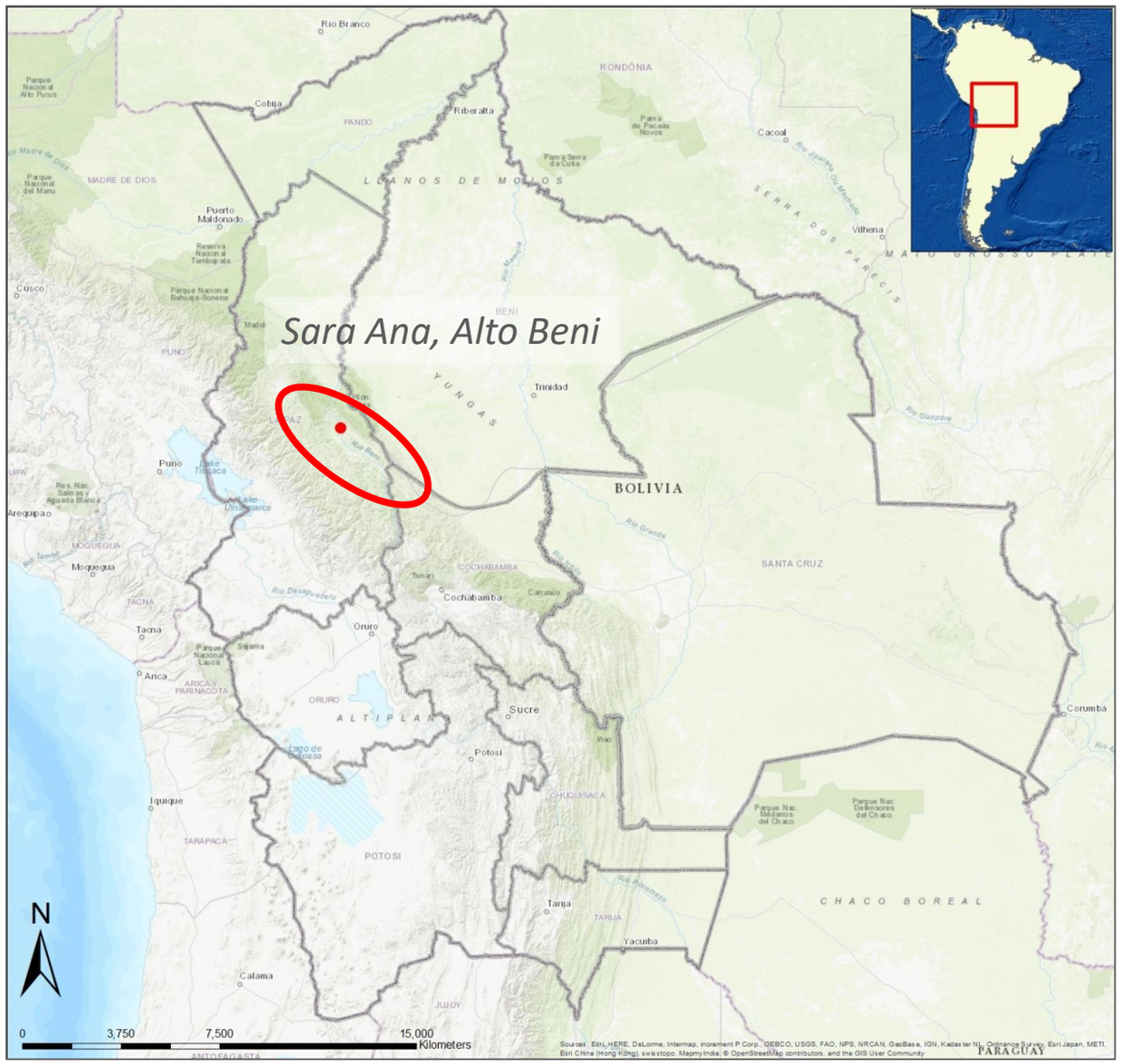


Trade-off

- Microclimate: incoming light, throughfall, temperature, humidity
  - Buffer function of shade trees → less stressful environmental conditions
- Biomass
  - Aboveground carbon sequestration
  - Root development

- Tree management
  - **Stem density**
  - **Species composition**
  - **Pruning**

Study area



Map of Bolivia

´Sara Ana´

- Alluvial terrace, 380 m a.s.l.
- Luvisols and Lixisols
- 25.2 °C
- 83% relative humidity
- 1439 mm, 78% from October to April

Sara Ana, Alto Beni, Bolivia

Long-term experiment and land-use systems

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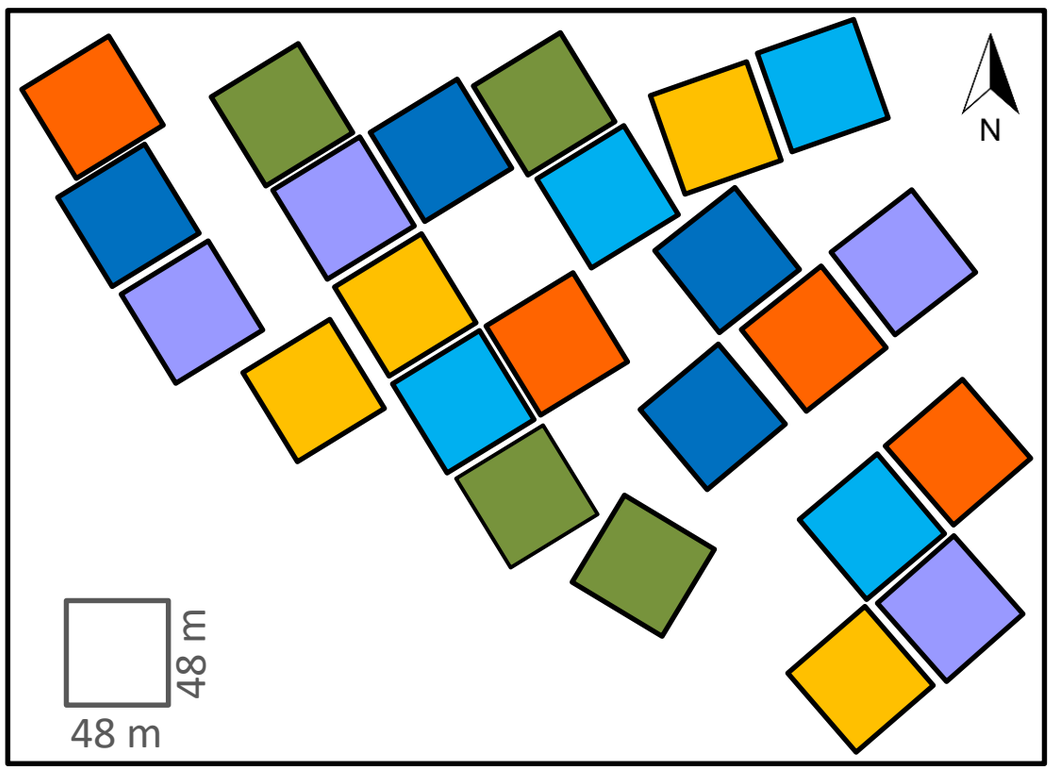
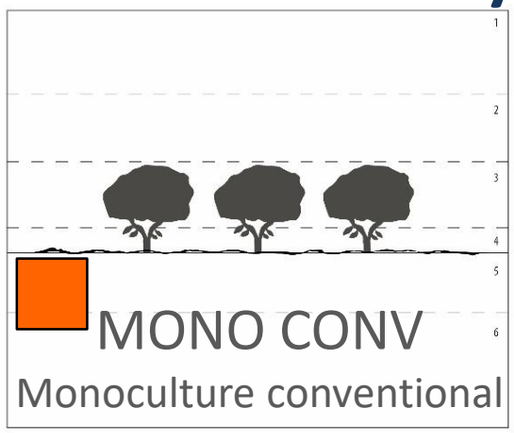
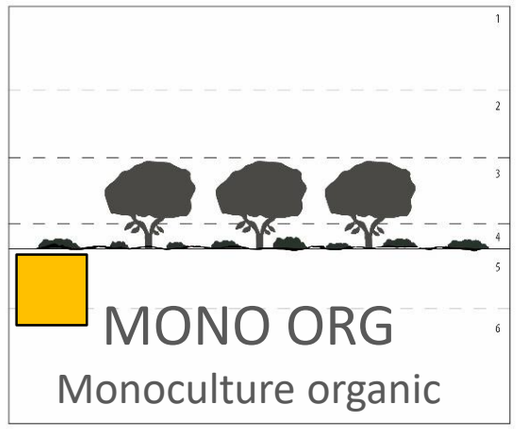
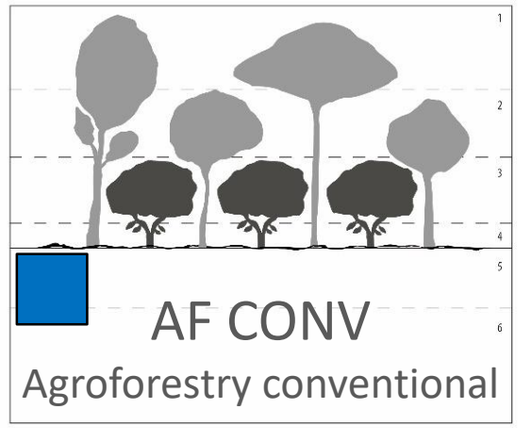
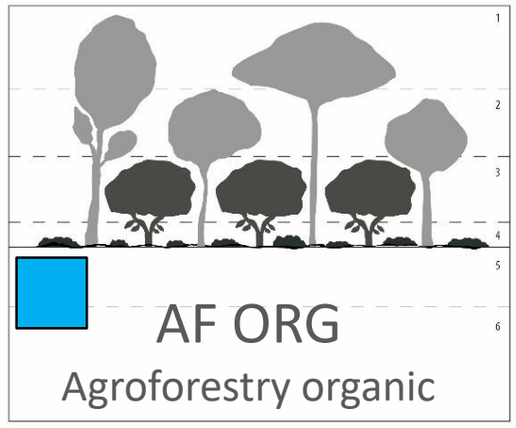
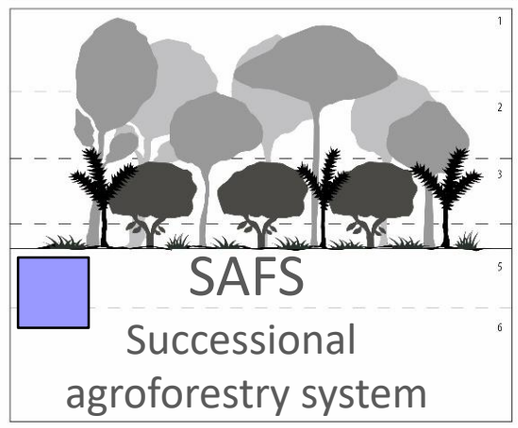


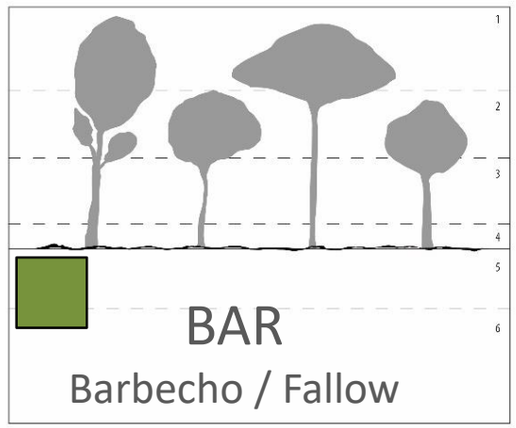




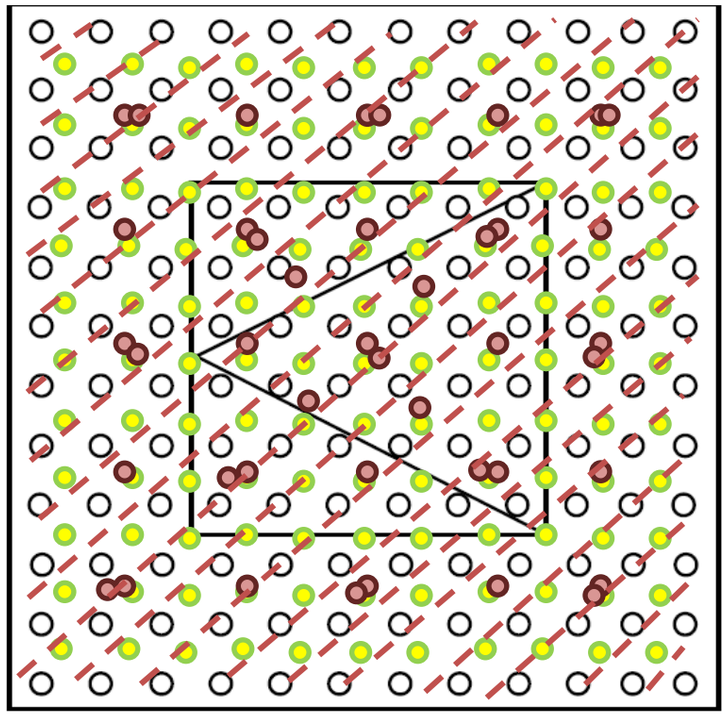








Plot structure



Plot: 48 x 48 m

- Cocoa trees
- *Musa*
- Woody trees
- Successional plants

Net-plot: 24 x 24 m

V-shaped transect: 52 m

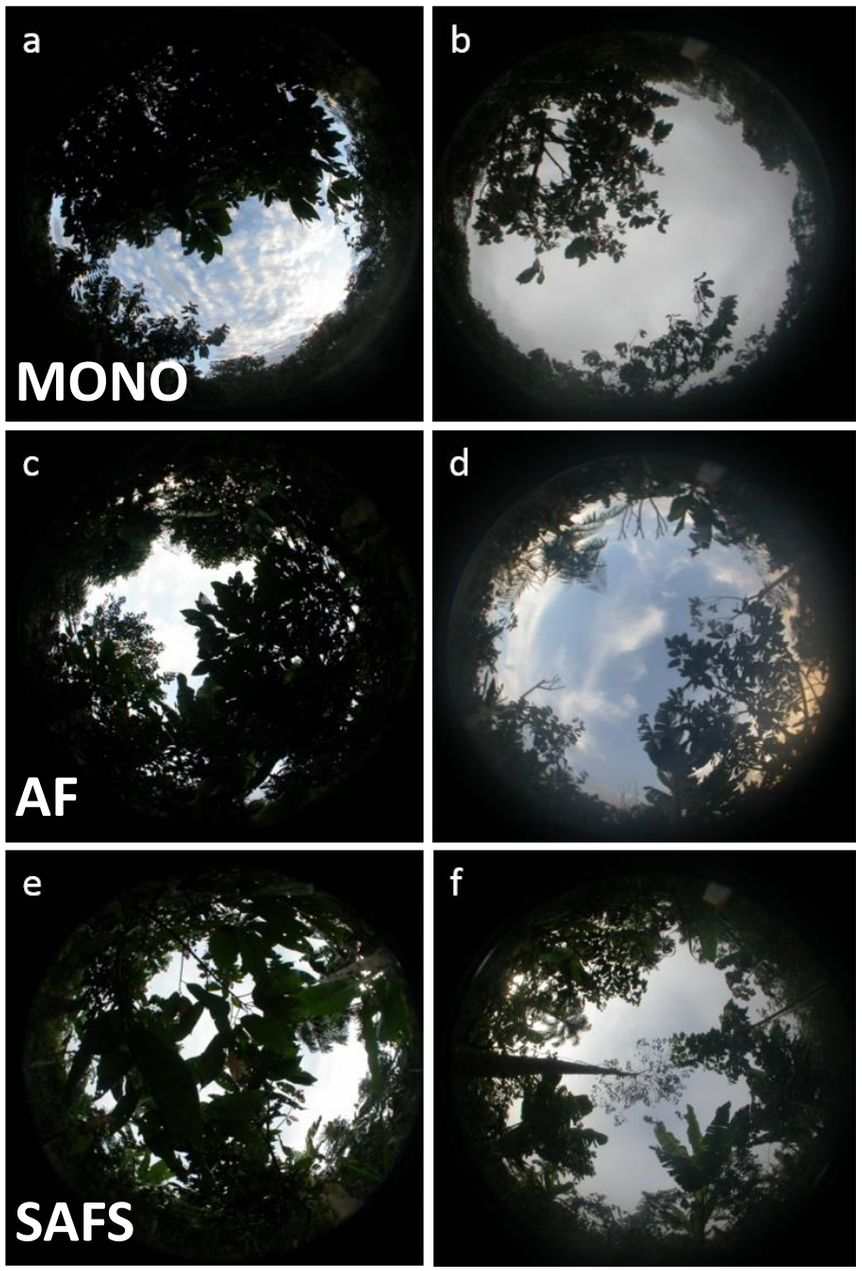
Data collection (2013-2015)

- Stand structure
  - Height (stratification), basal area — Before pruning
  - Canopy openness — Before + after pruning
- Microenvironment
  - Radiation
  - Precipitation / throughfall
  - Temperature, relative humidity

  — Before + after pruning
- Root develoment
  - *Theobroma cacao, Erythrina* ssp.
  - 0-25 cm; 25-50 cm

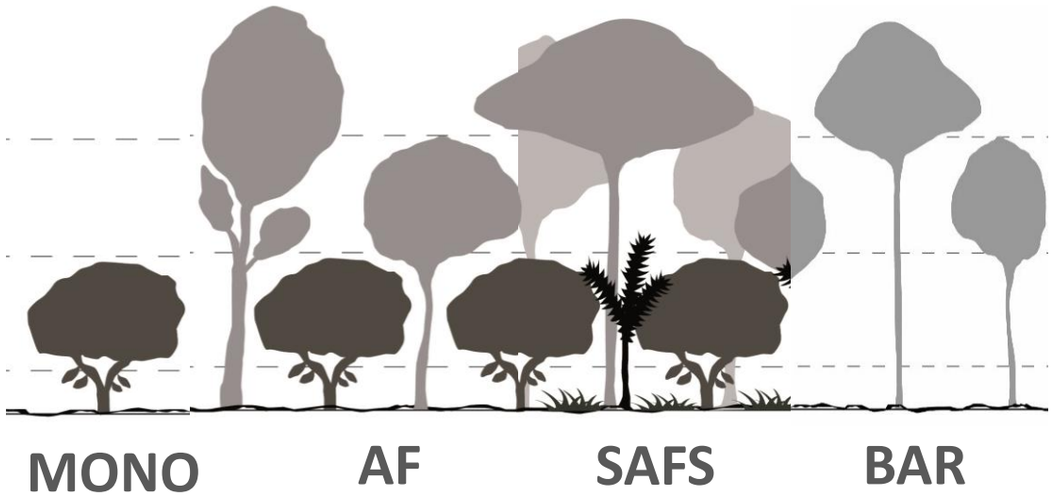
  — Ingrowth donuts (1 year)

Before pruning After pruning



Pruning effect on microclimate

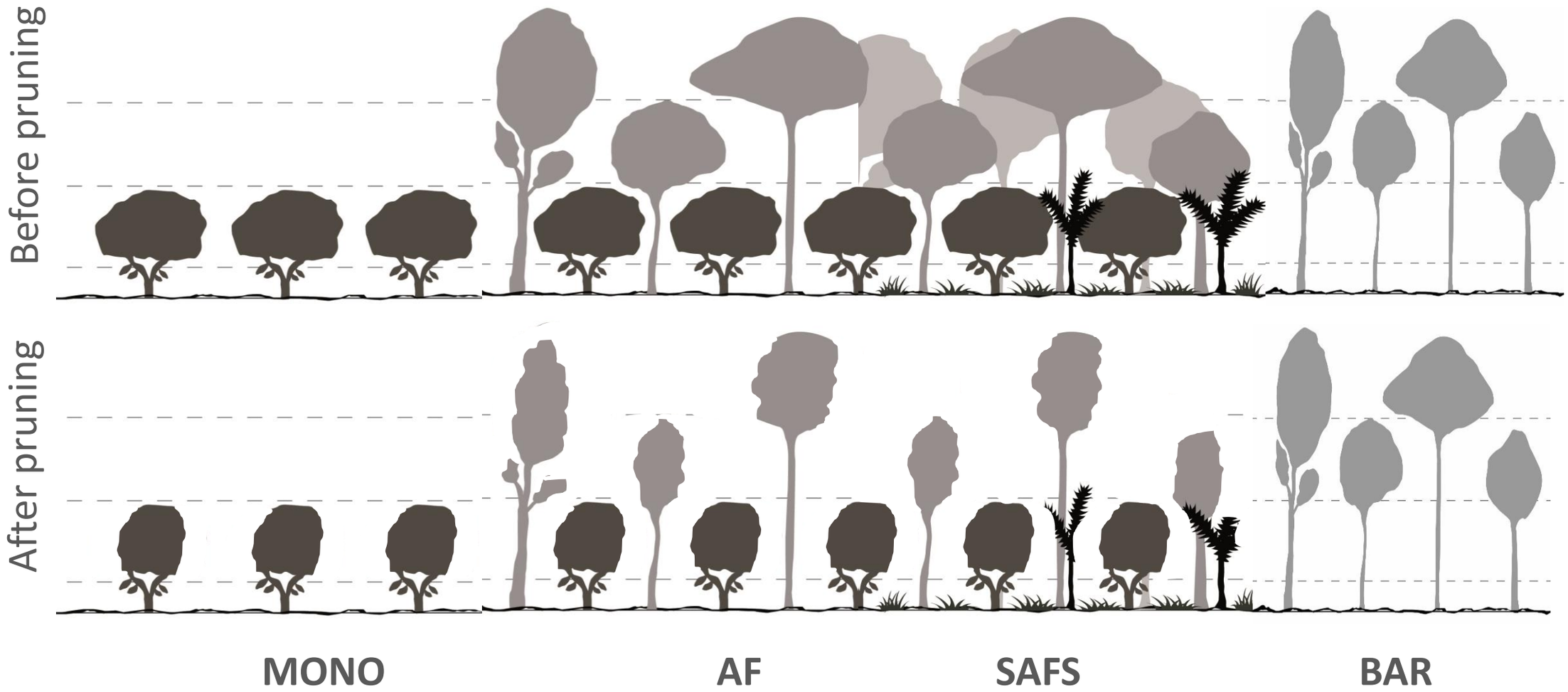
	MONO	AF	SAFS	BAR
Canopy openness %	**+13**	**+21**	**+7**	0



PPFD: photosynthetically active photon flux density
VPD: vapor pressure deficits of the air

Pruning: Effective tool to manage the system

→ Overlays the stand structure effect (rapid effect, but decreases over time)
→ Has to be adapted to season and in intensity to not increase environmental stress



Stand structure and root development

- Stem density [stems ha^{-1}]

625 | 1536 | 2431

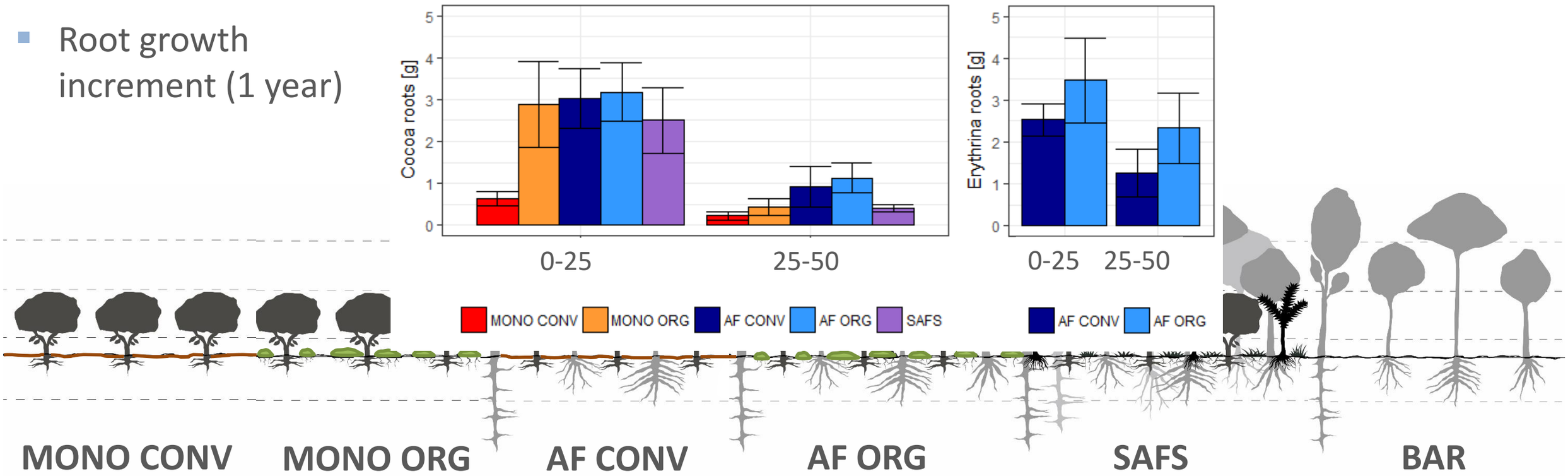
- Stem basal area [m^2 ha^{-1}]

7 | 22 | 23

- Species diversity [number]

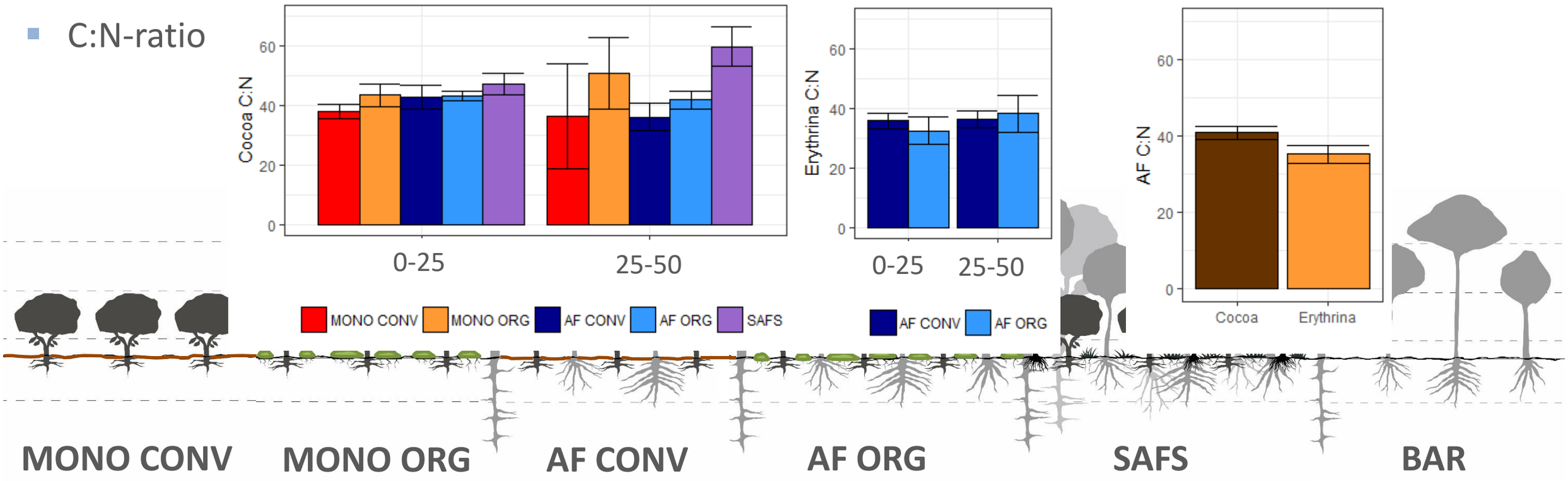
1 | 2 | 13 | 15 | > 20

- Root growth increment (1 year)



Root quality

- C:N-ratio



Biomass and rooting systems

- Higest stem density in SAFS but trees are smaller than in AF (stem diameter)
- 80% of cacao roots in the upper 25 cm
- MONO ORG > MONO CONV: cover crop!
- *Erythrina* still much in 25-50 cm

Root quality

- Cacao C:N-ratio increases with complexity
- More variable in 25-50 cm
- *Erythrina*: C:N-ratio not different between ORG and CONV
- CN-ratio: cacao > *Erythrina*

Thank you Gracias Merci

Project partners:

FiBL

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EL CEIBO BOLIVIA

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