

Four-dimensional Agriculture

Successional Agroforestry for Ecological and Socio-economic Resilience Building

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Successional agroforestry

In the humid tropics, one of the main reasons for deforestation and soil degradation is slash-and-burn cultivation for annual crops. Cultivated with permanent cultures such as cocoa, coffee, fruit and timber trees, crops are more resilient to stress factors such as heavy rains or droughts than in monocultures.

Successional agroforestry systems in particular have proven to recover soil fertility and to enhance adaptation to difficult climate conditions in highly vulnerable tropical regions.

Successional agroforestry is characterized by a diversity of crops (horizontal and vertical), trees, shrubs and other naturally regenerating species of the local ecosystem. Making use of the dynamic successional processes and of all storeys occupying as much ecological niches as possible, similar to the natural vegetation (spatial and temporal), the combination of a high plant density and diversity provides a wide range of ecosystem services and self regulation processes.

An important management aspect is pruning of the accompanying species and those who completed their life cycle. The pruned branches and leaves cover the soil protecting it from intense solar radiation, erosion and increase soil organic matter and metabolic rate of energy as well as the availability of organically bonded water.



Figures 1 and 2: the same plot in 2000 and 2007, before and after the implementation of a successional agroforestry system without irrigation, near Cochabamba, Bolivia. Photos: N. Stadler-Kaulich

Principles: working with space, time and diversity

- Comprehension of structure and function of natural ecosystems
 - Perennialism and diversity
 - Vegetation strategies: optimal use of local resources (solar energy, water, nutrients)
 - Succession: 1. Maximum accumulation of biomass
2. Association of functional different species
- Short cycles of water and nutrients, reduction of losses

Concept: imitation of natural succession

- **Imitation** of succession cycles of the **local ecosystem**
- **Acceleration** of natural processes through systematic interventions:

→ **dense seeding** of fast growing plants (with pioneer colonizers e.g. Leguminosae as the main element of the first successional step)

→ **systematic trimming and selective weeding** → production of mulch for a fast accumulation of organic material

→ **systematic creation of gaps** through selective logging for the plantation of crops of a higher successional level



Figures 3 and 4: successional agroforestry as an alternative to slash-and-burn-cultivation. Photos: W.Pinto

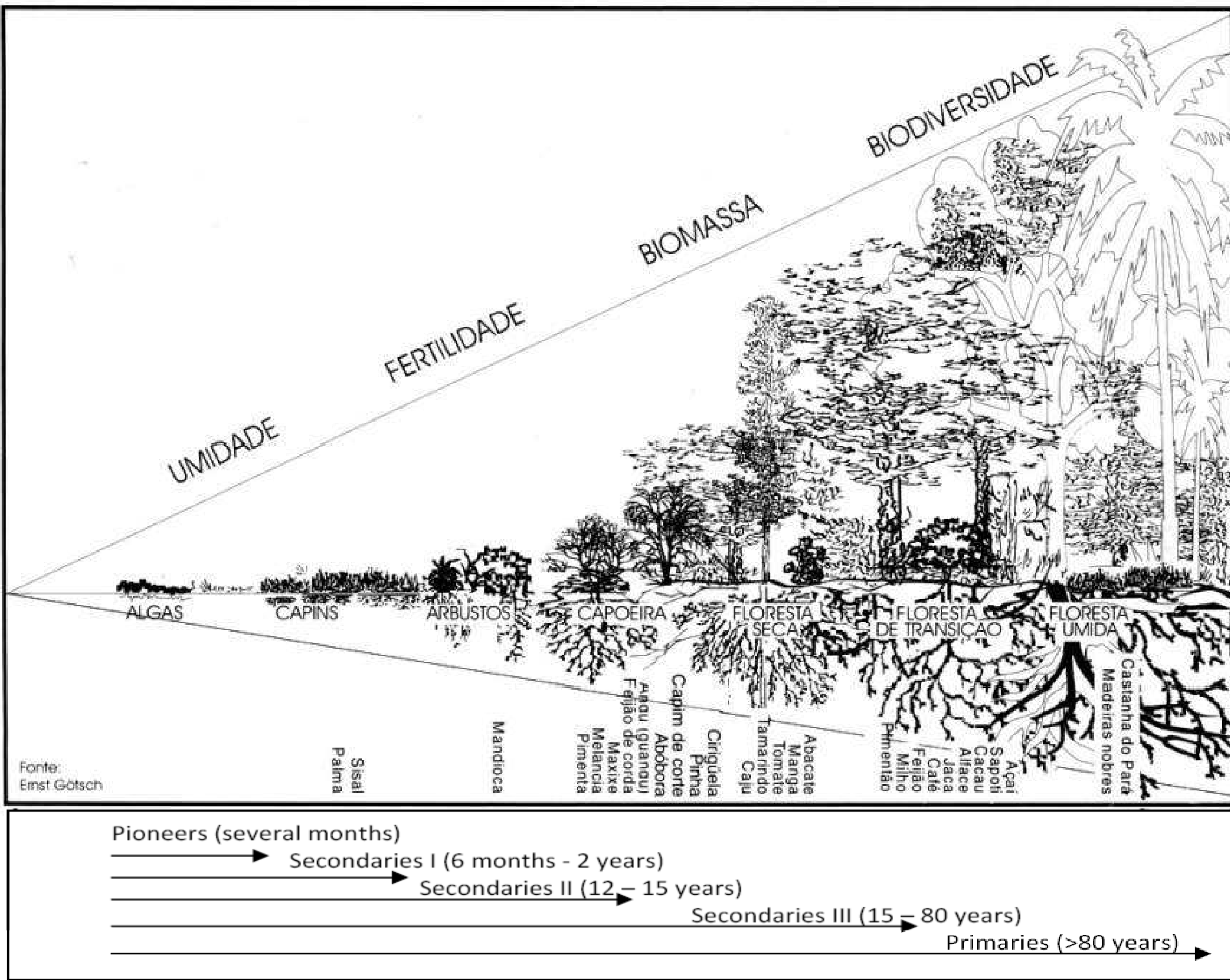


Figure 5: scheme of the different stages in successional agroforestry. Source: Ernst Goetsch, altered.

Progress & ongoing research

Recent research from Bolivia indicates less abundance of fruit flies (*Anastrepha spp.* and *Ceratitis capitata*) in orange production in successional agroforestry with significantly higher yields and the same sugar content [1], significantly higher N, P and K concentrations [2], more humus in soils and a deeper Ah-horizon than in comparable monocultures.

Economic viability of successional agroforestry matches up with monocultures concerning area equivalent of the respective crops. Furthermore, the high diversity of crops decelerates economic risks and diversifies the diet of local small scale farmers [3].

In the region Alto Beni, Bolivia, a long-term field trial started in 2008 to compare organic and conventional cocoa cultivation which also includes successional agroforestry with cocoa as a primary forest species [4]. This is combined with on-farm research to link the biophysical research with farmers' perceptions and needs (Fig. 6).

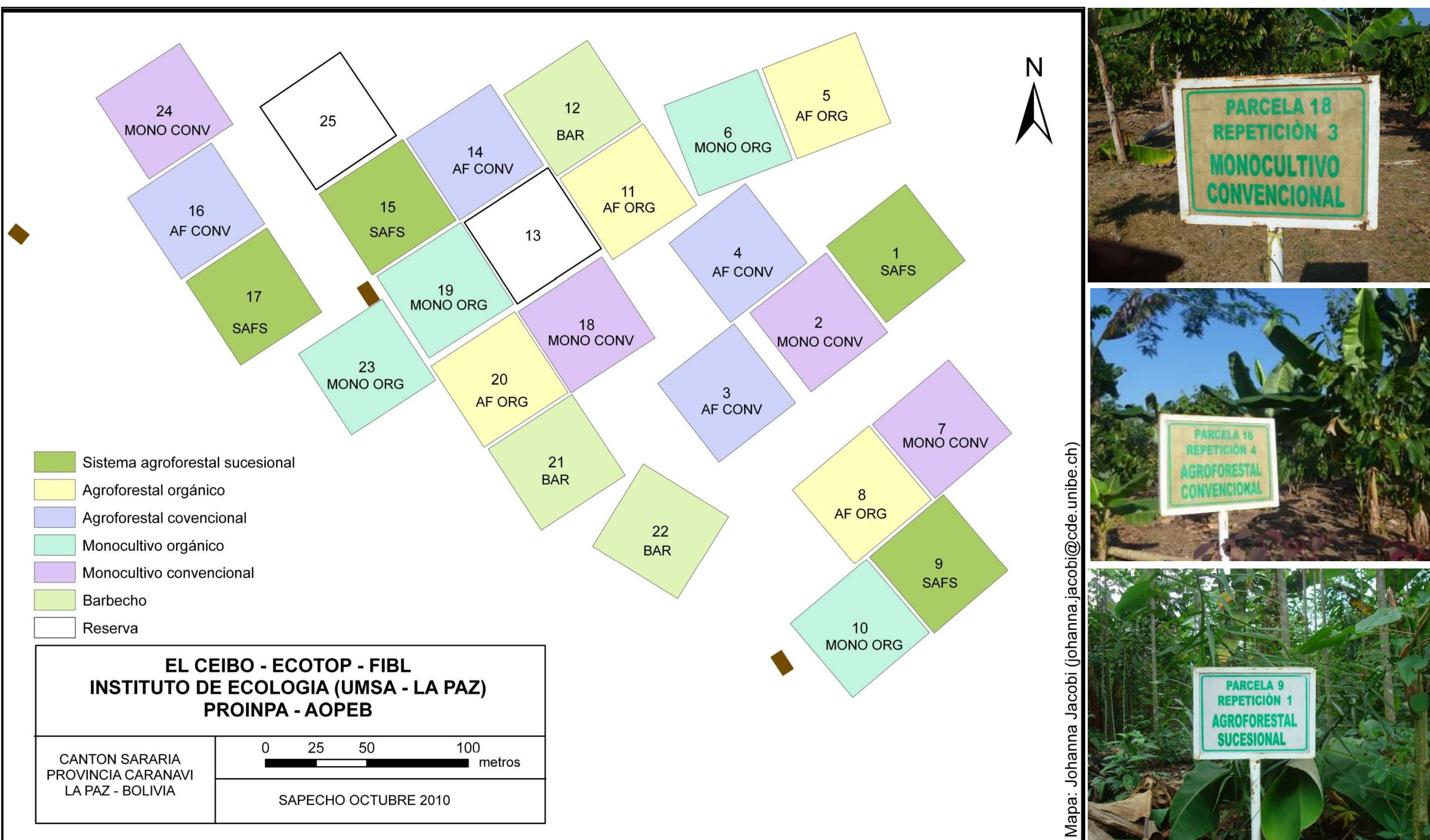


Figure 6: sampling plots and three out of the four treatments from the long-term field trial by the Research Institute of Organic Agriculture (FiBL) in Bolivia .

Outlook

Critical aspects for the dissemination of successional agroforestry are:

- To adapt and to support **livelihood strategies** of farmers
- two aspects of **capacity building**:
 - local knowledge in exchange with external expert consultancy
 - training of trainers

→ **organisation of local knowledge exchange** and the creation of farmers' associations

→ **development of local market chains** for agroforestry products

References:
[1] Milz, J. (2010): Producción de Naranja (Citrus sinensis) en sistemas agroforestales sucesionales en Alto Beni, Bolivia - Estudio de caso. Biodiversidad y Ecología en Bolivia
[2] Todt, B. (2010): Soil fertility in Monoculture and Successional Agroforestry Land Use Systems for Citrus sinensis in Alto Beni, Bolivia . Diploma Thesis, Geor-August-Universität Göttingen, Deutschland.
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[4] Zundel, C. et al. (2007): What can organic agriculture contribute to sustainable development? Long-term farming system comparisons in the tropics. FiBL, Switzerland.