MOLLESNEJTA - Centre of Andean Agroforestry

Cochabamba/Bolivia since 1999

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Objectives*:* Agroforestry remediates soil and enables crops to adapt to climate change. It's suitable to mitigate the effects of extreme temperatures and reduced precipitation, and was already known to the Incas, who applied agroforestry during a previous climate change event, roughly a thousand years ago.

Located in the Cochabamba Valley, MOLLESNEJTA – Centre of Andean Agroforestry on 16 hectares is situated above the irrigation canal of the village of Combuyo, on the southern slopes of the Tunari mountain at an elevation of ~ 2.800 m above sea level. Climate is semi-arid with an average air temperature of 18°C, and an average annual precipitation of 500 mm from December to March. From April to November is dry season. The ground is very stony and situated on a hillside with varying degrees of inclination. In 1998, before the implementation of agroforestry, the topsoil was degraded by overgrazing livestock and traversed by numerous eroding rills.

The soil recovers through the application of agroforestry: The main focus lies on identifying the best combinations of different crops and fruit trees with company shrubs and trees, mostly of them native species, in order to create productive plant communities under extreme conditions. The high biodiversity establishes a natural equilibrium of pests and their natural predators. The closed ground cover enables an increase of the soil fertility and its water retention capacity.

Several experimental plots are managed and scientifically guided under cooperation with Bolivian and European universities. In 2015, the UN's international year of soil, experiments for soil remediation with *Terra Preta* and ramial chipped wood started, all the material originating from pruning within Mollesnejta. All the experiences and results are shared in workshops and published.

Additional Information can be found under mollesnejta.wordpress.com, and on the homepage of the agroforestry network ***E**spacio **CO**mpartido en **S**istemas **A**gro**F**orestales **ECO-SAF*** **(http://www.ecosaf.org).**

In 2018, there are 42 different agroforestry-plots implemented in Mollesnejta:

2001 Successional agroforestry parcel with olive trees as the primary species (0,25 ha)

2001 Mixed agroforestry parcel with fruit trees in community with native species (0,5 ha)

2001 Parcel with a combination of olive trees and tagasaste (*Chamaecystisus proliferus*) (0,25 ha)

2004 Mixed parcels with several different pine species, native species and fruit trees (0,5 ha)

2004 Parcel with grape vine (Cabernet) to test the effects of water stress (0,25 ha)

2005 Agroforestry parcel with species from different climatological regions (SAF Tropical; 0,1 ha)

2005 Mixed parcel with trial specials to test for the suitability against landslides (0,01 ha)

2006 Successional agroforestry parcel with avocado trees as the primary species (1 ha)

2006 Successional agroforestry parcel with walnut trees as the primary species (1,25 ha)

2006 Agroforestry parcel with grape vines from Tarija and tagasaste as support structure and leguminose (0,25 ha)

2007 Parcel with different pine species (0,5 ha)

2007 Mixed parcel with oak, pine, and native species (0,25 ha)

2007 Mixed parcel with fruit trees and Peruvian pepper (*Schinus molle*) (Artemisia anua 2007/08) (0,25 ha)

2008 Mixed parcel with woody species, exemplary for watershed management (0,5 ha)

2008 Mixed parcel with pines and native woody species (0,5ha)

2008 Agroforestry parcel segmented into terraces by tara (*Caesalpinia spinosa*) and fruit trees (1,5 ha)

2008 Mixed forestry parcel on the banks of an eroding rill (0,25 ha)

2009 Grape vine parcel with legume trees for nitrogen fixation and support structure (0,1 ha)

2009 Vegetable garden with sample plots to test the effects of *Terra Preta* (0,05 ha)

2010 Mixed parcel with native hardwood species and pines (0,5 ha)

2010 Mixed woody parcel (*Pinus radiata, Eucalyptus globulus, Acacia dealbata*) (0,25 ha)

2010 Observatory parcel to test the effects of *Opuntia ficus-indica* and native species on soil remediation (1 ha)

2010 Observatory parcel to test the effects of native species (Kewinhua, Kishuara) on soil remediation (1 ha)

2011 Parcel with Ginkgo and medicinal plants originating from naturally succession (0,5 ha)

2011 Agroforestry parcel with *Opuntia ficus-indica* other naturally occurring species (1 ha)

2012 Agroforestry parcel of three woody species (Pinus, Eucalyptus, A. dealbata) plus *Opuntia ficus-indica*

2012 Miniature agroforestry parcel with native species, tree tomato, and insect repellent species (0,01 ha)

2012 Experimental parcel with sea-buckthorn (0,01 ha)

2013 Parcel with fruit trees, native species and medicinal plants (0,1 ha)

2013 Experimental lucerne plot with native species and fruit trees as a living fence (0,1 ha)

2013 Two parcels with animal fodder in blackwater retention ponds (0,01 ha)

2014 Silvopastoral parcel with natural succession species and Tipuana tipu as a living fence (1 ha)

2014 Silvopastoral parcel with natural succession species as a living fence (0,5 ha)

2014 Parcel with native crops and fruit trees as a living fence (0,1 ha; SAF-Tara 6)

2015 Parcel with animal fodder in combination with acacia (0,01 ha)

2015 Experimental parcel for sea-buckthorn cultivation (0,01 ha)

2015 Round successional agroforestry parcel with camuesa apple and fig trees (0,25 ha)

2015 Round successional agroforestry parcel with different crops (0,1 ha)

2016 Silvopastoral parcel with a living fence made up of native species, woody and fodder species (1 ha)

Titles of selected thesis realized in MOLLESNEJTA – Centre of Andean Agroforestry:

Diego Amurrio: *Characterizing trees and shrubs that emerge naturally within the agroforestry parcels in Mollesnejta, Combuyo – Cochabamba. Thesis in the Field of Forestry, ESFOR - Universidad Mayor de San Simón, Cochabamba/Bolivia, 2009.*

Conclusion: The higher the biodiversity and vegetation density inside an agroforestry parcel, the quicker the soil recovers, which is measurable in the species richness of self-seeding plants.

Erika Alba Gamboa: *Evaluating the physical, chemical and biological soil properties among three different forms of land use (local-traditional, bio-dynamical, and agroforestry) in the district of Vinto, Bolivia. Thesis in the Field of Environmental Sciences - Universidad Católica Boliviana, Cochabamba/Bolivia, 2012.*

Conclusion: Soils of agroforestry parcels have a higher share of organic material and a higher amount of soil bacteria and fungi, when compared to soils of bio-dynamical or traditionally local land use.

Mario Jaldín: *Improving the initial growth and further development of three woody species (Eucalyptus globulus, Pinus radiata, Acacia dealbata) after planting seedlings out on the testing ground of Mollesnejta, Combuyo, under consideration of soil moisture as a limiting factor for growth. Thesis in the Field of Forestry, ESFOR - Universidad Mayor de San Simón, Cochabamba/Bolivia, 2012.*

Conclusion: The best performing trees were those covered with mulch around their stem during the initial growth and development phase. The soil moisture beneath the mulch was at 70%, beneath stones at 12%, and without any soil cover at 8%.

Andrea Bolaños Angulo: *Evaluating the influence of three perennial species*, *Opuntia ficus-indica L., Dodonea viscosa Jacq. und Schinus molle L., on the soil properties of the agroforestry parcels in Mollesnejta, Combuyo. Thesis in the Field of Environmental Sciences - Universidad Católica Boliviana, Cochabamba/Bolivia,* 2014.

Conclusion: Within two meters around the stems of all three species, an elevated content of the plant available phosphate and nitrate was observed. *Dodonea viscosa Jacq* contributed the most to the

organic matter content of the soil; *Schinus molles L* had the highest soil respiration. Every soil moisture measurement was above the reference value for the respective soil texture.

Lucas Landenberger: *Analysing the cross-section of soils with methods of in situ soil sciences. Survey performed within a framework of an internship*; Albert-Ludwig-University. Freiburg/Germany, 2014.

Conclusion: The amount of organic material in the upper 30 cm of soil, can be increased from <1% to >6% within 10 years through the application of agroforestry.

Stefan Nahstoll: *Irrigation water conservation through the usage of charcoal within a plot of vegetables in Mollesnejta, Combuyo. Survey performed within the framework of an internship*; Technische Universität München/Germany, 2015.

Conclusion: The application of charcoal increased the water storage capacity of the soil; the more charcoal is applied, the better the water availability for plant growth.

Lorenz Beister: *Conserving soil moisture through ramial chipped wood in the semi-arid Andean valleys. Survey performed within the framework of an internship;* Technische Universität München/Germany, 2015.

Conclusion: The application of 30l/m² of ramial chipped wood, half of it worked into the top soil and the other half as a mulch cover, results in 30% savings of irrigation water. It should be further analyzed, whether the fragmented limb wood of legume species results in an increase of plant growth, due to the closer carbon-to-nitrogen-ratio.

Marco Guarachi Condori: Soil fertility and irrigation water conservation under the application of ramial chipped wood, tested on three different onion species. Thesis for Universidad Pública de El Alto/Bolivia, 2016.

Conclusion: The application of ramial chipped wood in the production of onions assure the crop even when the soil has low fertility and little irrigation water is available.

Marcelo Bustamante: Irrigation water conservation by application of charcoal and foliage in onion cultivation. *Thesis in the Field of Environmental Sciences - Universidad Católica Boliviana, Cochabamba/Bolivia,* 2016.

Conclusion: The application of 2 kg of biochar in a square meter of meagre soil increases about 25% the production of onion.

Fabian Sauter: *Andean agroforestry systems in the valley of Cochabamba – Investigation within an internship*; Technische Universität München/Germany, 2017

Conclusion: The species *Dodonaea viscosa* and *Chamaecytisus proliferus ssp palmensis* support through mycorrhiza the resilience of maize crop.

Note: in *Mollesnejta*, the primary material for biochar and ramial chipped wood is obtained from pruning in the own agroforestry systems; biochar is made in a KonTiki charcoal burner; the ramial chipped wood is produced in a wood chipper.

Images:

Image 1: MOLLESNEJTA – Center of Andean Agroforestry in 1999.

Image 2: Citrus tree with fruit in an agroforestry system with native species