



C-Enrichment experiment set up: addition of organic matter on Tropical Agricultural Soil (Ferrasol) (Malte Unger)

Enrichment of Tropical Agricultural Soil with Organic Matter (Brazil)

Enriquecimento de solo de lavoura com matéria orgânica

DESCRIPTION

Enrichment of tropical agricultural soils with local available organic matter in the cerrado agroscape, Brazil.

Aims / objectives: Use local available organic matter (OM) to enrich Tropical agricultural soil (Ferrasol) as a strategy for sustainable land use to improve efficiently soil fertility and/or crop production in the Brazilian Cerrado agroscape. The applied OM's are either cost-efficient or waste materials from nearby industrial suppliers.

Methods: We applied three different types of OM amendments. They include (a) Filter cake of sugarcane residues (*Saccharum officinarum* from alcohol/sugar-production, (b) sawdust of Peroba and Cedrinho (Peroba jauna and *Erisma uncinatum*, respectively) and (c) coarse chips of *Eucalyptus* sp.

We added 0 (control), 6, 12 and 18 tons of each amendment per hectare; using two disposition methods: direct on the soil and with harrow incorporation. Each treatment was done in triplicate. Subsequent to the first amendment application; there have not been further experimental OM additions. The experimental site was not fenced to allow the land user to continue with their arable field routines on all treatment plots.

By sampling soil and biomass, we have assessed the effect of OM addition on soil organic carbon, nutrients, water holding capacity and crop (soy and corn biomass and grain) production, after one, two and three years of a single application.

Stages of implementation: The experiment was set up in February 2012. The last soil and biomass sampling was carried out in February-March 2015.

Role of stakeholders: Mr. Antonio Huebner, owner of the Farm Rio Engano, provided us an experimental area in his farm.

The local industries supplied the applied OM amendments.

Professors and researchers from the Christian-Albrechts University of Kiel (CAU Kiel), Federal University of Mato Grosso (UFMT) and François Rabelais University have given academic and scientific support to the approach.

Other important information: From our outcomes, we intend to provide information for the development of soil C-enrichment schemes and carbon-friendly landscape management programs for land users, applying local resources in the Brazilian Cerrado.

LOCATION

Location: Campo Verde, Mato Grosso, Brazil

Geo-reference of selected sites

- n.a.

Initiation date: 2011

Year of termination: 2016

Type of Approach

- ☐ traditional/ indigenous
- ☐ recent local initiative/ innovative
- ☒ project/ programme based



C-Enrichment experiment set up: addition of organic matter on Tropical Agricultural Soil (Ferrasol) (Malte Unger (unger_malte@web.de))

APPROACH AIMS AND ENABLING ENVIRONMENT

Main aims / objectives of the approach

The Approach focused mainly on SLM with other activities (crop production)

We aim to identify a feasible combination of types, amounts and disposition methods of OM amendments to improve efficiently soil fertility, carbon stock and/or crop production in the Brazilian Cerrado agroscape.

The SLM Approach addressed the following problems: Croplands have shown a reduction of organic matter, due to some traditional agricultural practices, such as soil plowing and tillage. These practices break down soil aggregates and expose organic matter to microbial decomposition, causing its loss to the atmosphere by mineralization (Zech et al. 1997; Tivet et al. 2013). It is especially critical in soil (Ferrasol) from the Brazilian Cerrado, as its OM content is relatively low, and tropical temperatures and humidity accelerate microbial activity (Price and Sowers 2004).

Conditions enabling the implementation of the Technology/ ies applied under the Approach

- **Legal framework (land tenure, land and water use rights):** The existing land ownership, land use rights / water rights greatly helped the approach implementation: Mr Antonio Huebner, land owner and user, grant us an area to implement the approach. In this area we were able to work for more than three years.

Conditions hindering the implementation of the Technology/ ies applied under the Approach

- **Knowledge about SLM, access to technical support:** There is not specific machinery for OM addition to soil. With the help of a bulldozer and farm workers, the OM amendments were distributed in the experimental plots. However, it increases the human workload required. Treatment through the SLM Approach: Designing or adapting machinery for this purpose. For fine particulate organic matter, the machinery used for soil liming can be used. For larger particles (wood or bark chips), machinery commonly used for mulch application can be used. However, tests with these machineries and evtl. improvement of the application method is desirable.
- **Workload, availability of manpower:** Treatment through the SLM Approach:

PARTICIPATION AND ROLES OF STAKEHOLDERS INVOLVED

Stakeholders involved in the Approach and their roles

What stakeholders / implementing bodies were involved in the Approach?	Specify stakeholders	Describe roles of stakeholders
local land users/ local communities	The farm owner where the soil C-Enrichment was done	
SLM specialists/ agricultural advisers	SLM specialists from the CAU University of Kiel, Federal University of Mato Grosso and François Rabelais University	
national government (planners, decision-makers)		
international organization	Carbiocial Project	

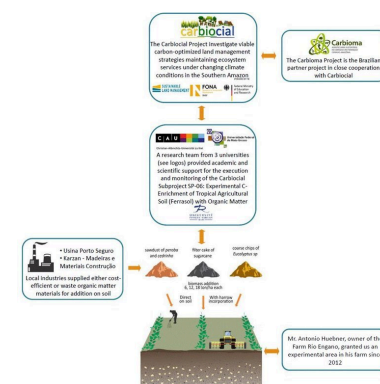
Involvement of local land users/ local communities in the different phases of the Approach

	none	passive	external support	interactive	self-mobilization
initiation/ motivation	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
planning	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
implementation	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
monitoring/ evaluation	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Research	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>

Carbiocial Project
Carbiocial Project. Scientific team of the Subproject 06 (SP-06: Experimental C-Enrichment of Tropical Agricultural Soil With Organic Matter) and land owner and user
Carbiocial Project (SP-06) and land owner and user
Carbiocial Project (SP-06) and land owner and user
Carbiocial Project

Flow chart

Organisation/flow chart of the experimental C-Enrichment of Tropical agricultural soil with organic matter amendments and monitoring (2012-2015) at the Farm Rio Engano, Brazilian Cerrado.



Author: Luisa F. Vega
(luisa.vega@gmail.com)

Decision-making on the selection of SLM Technology

Decisions were taken by

- ☐ land users alone (self-initiative)
- ☐ mainly land users, supported by SLM specialists
- ☐ all relevant actors, as part of a participatory approach
- ☒ mainly SLM specialists, following consultation with land users
- ☐ SLM specialists alone
- ☐ politicians/ leaders

Decisions were made based on

- ☐ evaluation of well-documented SLM knowledge (evidence-based decision-making)
- ☐ research findings
- ☐ personal experience and opinions (undocumented)

TECHNICAL SUPPORT, CAPACITY BUILDING, AND KNOWLEDGE MANAGEMENT

The following activities or services have been part of the approach

- ☒ Capacity building/ training
- ☒ Advisory service
- ☒ Institution strengthening (organizational development)
- ☒ Monitoring and evaluation
- ☒ Research

Capacity building/ training

Training was provided to the following stakeholders

- ☒ land users
- ☐ field staff/ advisers

Form of training

- ☐ on-the-job
- ☐ farmer-to-farmer
- ☐ demonstration areas
- ☐ public meetings
- ☐ courses

Subjects covered

Advisory service

Advisory service was provided

- ☒ on land users' fields
- ☐ at permanent centres

Name of method used for advisory service: Direct communication by visiting the land user; Key elements: Dialogue, Exchange of ideas

Advisory service is very adequate to ensure the continuation of land conservation activities; The extension system is very adequate to ensure continuation of activities. The research staff from the Soil and Rural Eng. Department, Federal University of Mato Grosso, Brazil have participated in this approach and plan to continue with research and monitoring activities.

Institution strengthening

Institutions have been strengthened / established

- ☐ no
- ☐ yes, a little
- ☐ yes, moderately
- ☒ yes, greatly

Type of support

- ☐ financial
- ☒ capacity building/ training
- ☒ equipment

at the following level

- ☒ local
- ☐ regional
- ☐ national

Describe institution, roles and responsibilities, members, etc.

Further details

In the frame of the Carbiocial Project, several students from the UFMT carried out their master or PhD thesis and undergraduate student got practical experience. Particularly, in SP-06 one student got his master degree. Different equipments were also donate to this university.

Monitoring and evaluation

bio-physical aspects were ad hoc monitored by project staff through observations; indicators: Experimental site observation during sampling campaigns by Carbiocial bio-physical aspects were regular monitored by project staff through measurements; indicators: Regularly sampling campaigns of soil and biomass economic / production aspects were ad hoc monitored by project staff through observations; indicators: Ideas exchange with land user economic / production aspects were regular monitored by project staff through measurements; indicators: assessment of grain and biomass crop production There were no changes in the Approach as a result of monitoring and evaluation There were no changes in the Technology as a result of monitoring and evaluation

Research

Research treated the following topics

- ☐ sociology
- ☐ economics / marketing
- ☐ ecology
- ☐ technology

A detailed study on the enrichment effects of different organic matter types on soil carbon enrichment was undertaken (laboratory analysis of field samples). Further topics covered include sustainable land management and crop production.

By research staff from the Department of Applied Ecology, Institute for Ecosystem Research, CAU university of Kiel, Germany; the Soil and Rural Eng. Department, Faculty of Agronomy, Veterinary Medicine, and Zootechnology (FAMEVZ), Federal University of Mato Grosso, Cuiabá, Brazil and the Interdisciplinary Research Center for Cities, Territories, Environment and Society (CITERES-CNRS UMR 7324), François Rabelais University, Tours, France.

Research was carried out on-farm

FINANCING AND EXTERNAL MATERIAL SUPPORT

Annual budget in USD for the SLM component

- ☐ < 2,000
 - ☒ 2,000-10,000
 - ☐ 10,000-100,000
 - ☐ 100,000-1,000,000
 - ☐ > 1,000,000
- Precise annual budget: n.a.

Approach costs were met by the following donors: international (Carbiocial Project): 100.0%; private sector (Donation of OM amendments); local community / land user(s) (Granted an experimental area on agricultural soil for at least 3 years)

The following services or incentives have been provided to land users

- ☒ Financial/ material support provided to land users
- ☐ Subsidies for specific inputs
- ☐ Credit
- ☐ Other incentives or instruments

Financial/ material support provided to land users

Private sector provided OM amendments for soil enrichment

IMPACT ANALYSIS AND CONCLUDING STATEMENTS

Impacts of the Approach

Did the Approach help land users to implement and maintain SLM Technologies?

With this approach was demonstrated that soil organic carbon in tropical agricultural soil (Ferrasol) can be enhanced by applying local available organic matter, starting from only 6 ton/ha. Even when the studied soil has been under conservational farming practices, i.e. no-tillage, for more than 20 years.

- No
- Yes, little
- Yes, moderately
- ☒ Yes, greatly

Did the Approach empower socially and economically disadvantaged groups?

- ☒
- ☐
- ☐
- ☐

Did other land users / projects adopt the Approach?

- ☒
- ☐
- ☐
- ☐

Main motivation of land users to implement SLM

- ☒ increased production

Sustainability of Approach activities

- ☐ increased profit(ability), improved cost-benefit-ratio
- ☐ reduced land degradation
- ☐ reduced risk of disasters
- ☐ reduced workload
- ☐ payments/ subsidies
- ☐ rules and regulations (fines)/ enforcement
- ☐ prestige, social pressure/ social cohesion
- ☐ affiliation to movement/ project/ group/ networks
- ☒ environmental consciousness
- ☐ customs and beliefs, morals
- ☐ enhanced SLM knowledge and skills
- ☐ aesthetic improvement
- ☐ conflict mitigation

Can the land users sustain what has been implemented through the Approach (without external support)?

- ☐ no
- ☒ yes
- ☐ uncertain

• OM addition to tropical agricultural soil (Ferrasol) can increase significantly soil organic carbon and water retention, even in small amounts such as 6 ton/ha • Biomass reapplication should be done in 2 years intervals • The biomass type and disposition method did not have a significant effect on increasing soil organic carbon

CONCLUSIONS AND LESSONS LEARNT

Strengths: land user's view

- The approach improves soil quality and could enhance crop resilience in dryer years.

Strengths: compiler's or other key resource person's view

- As this approach uses industrial biomass residues, we consider it a win-win solution for organic matter waste disposition and to improve soil quality. (How to sustain/ enhance this strength: The costs of transport and application can limit the extensive use of soil organic matter enrichment practices among land users in the Brazilian Cerrado. Therefore, subsidies could contribute to the adoption of this approach by a broader number of farmers.)

Weaknesses/ disadvantages/ risks: land user's view how to overcome

- The costs of OM transport and application Mr. Antonio Huebner, the land owner and user in this approach, has been cultivating with soybean and corn rotation under conservational farming practices, i.e. no-tillage, for more than 20 years. He thinks a possible more economic alternative for this approach is to create soy and corn varieties which have more abundant foliage and the same capacity of grain production. In an approach that combines these varieties and no-tillage, the farmers could continue cultivating in their traditional way, without having to incur in extra costs due to application of OM amendments; however, increasing organic matter inputs to the soil.

Weaknesses/ disadvantages/ risks: compiler's or other key resource person's view how to overcome

- Lack of adequate machinery for OM addition Designing or adapting machinery for this purpose.

REFERENCES

Compiler

Luisa F. Vega

Editors

Reviewer

Fabian Ottiger

Date of documentation: July 28, 2015

Last update: Aug. 3, 2017

Resource persons

Luisa F. Vega (luisa.vega@gmail.com) - SLM specialist
 Stefan Hohnwald (shohnwa@gwdg.de) - SLM specialist
 Karl Wantzen (karl.wantzen@univ-tours.fr) - SLM specialist

Full description in the WOCAT database

https://qcat.wocat.net/en/wocat/approaches/view/approaches_2541/

Linked SLM data

Technologies: Carbon-enrichment of tropical agricultural soil with organic matter
https://qcat.wocat.net/en/wocat/technologies/view/technologies_1250/
 Technologies: Use of Organic Fertilizers for Organic Crop Production on Infertile Soil
https://qcat.wocat.net/en/wocat/technologies/view/technologies_4176/
 Technologies: Carbon-enrichment of tropical agricultural soil with organic matter
https://qcat.wocat.net/en/wocat/technologies/view/technologies_1250/

Documentation was facilitated by

Institution

- Christian Albrechts Universität zu Kiel (CAU) - Germany
- François Rabelais University Tours - France
- Georg August Universität Göttingen (Georg August Universität Göttingen) - Germany
- Universidade Federal de Mato Grosso (Universidade Federal de Mato Grosso) - Brazil

Project

- Carbon optimized land management strategies for southern Amazonia (CARBIOCLAL / GLUES)

Key references

- Price PB, Sowers T (2004) Temperature dependence of metabolic rates for microbial growth, maintenance, and survival. Proceedings of the National Academy of Sciences of the United States of America 101:4631-4636:
- Tivet F, De Moraes Sa JC, Lal R, Briedis C, Borszowskei PR, Bürkner dos Santos J, Farias A, Eurich G, Da Cruz Hartman D, Nadolny Junior M, Bouzinac S, Séguin L (2013) Aggregate C depletion by plowing and its restoration by diverse biomass-C inputs under no-till in sub-tropical and tropical regions of Brazil. Soil and tillage research, 126 :203-218:
- Zech W, Senesi N, Guggenberger G, Kaiser K, Lehmann J, Miano TM, Miltner A, Schroth G (1997) Factors controlling humic G. ation and Mineralization of soil organic matter in the tropics. Geoderma 79 : 117-161:

This work is licensed under [Creative Commons Attribution-NonCommercial-ShareAlike 4.0 International](https://creativecommons.org/licenses/by-nc-sa/4.0/)

