Early Changes in Soil Organic Carbon and Nitrogen and Microbial Communities in Maize Cropping Systems in Mollisol, Battambong Province

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Introduction

There is a need to amplify the assessment of SOC and Nitrogen under different land uses and contrasted cropping systems. This assessment is key to raise awareness of policy-makers and land managers at the local and central levels and to feed on-going or future financial mechanisms aiming at rewarding farmers and rural communities who invest into land restoration.

Objective

- ❖ Assessment of the impacts of conservation agriculture on soil organic C and for annual upland cropping systems
- ❖ Study the microbial communities and their relationship with SOC and nutrient cycling in the soil

Methodology

The experiment is located at Borun village, Teng Commune, Rattanak Mondoul district, Battambang (12°57'47.4"N 102°45'28.4"E). In May 2020, soil samples were obtained from five points for each plot and composited. Soil bulk density (ρb) was measured by the core method (Blake and Hartge, 1986). The same procedure will be applied for the sampling that will be conducted in October 2022. Sub-samples of < 2-mm bulk soil will be finely ground (< 150 mm) for measuring SOC and total N concentrations by the dry combustion method using an elemental CN analyser. The SOC and N stocks will be estimated to 0.4-m depth, and computed on an equivalent soil mass-depth basis (Ellert and Bettany, 1995). The rates of change of SOC (Mg ha−1 yr−1) among NV and CT, and among NT and CT, will be estimated:

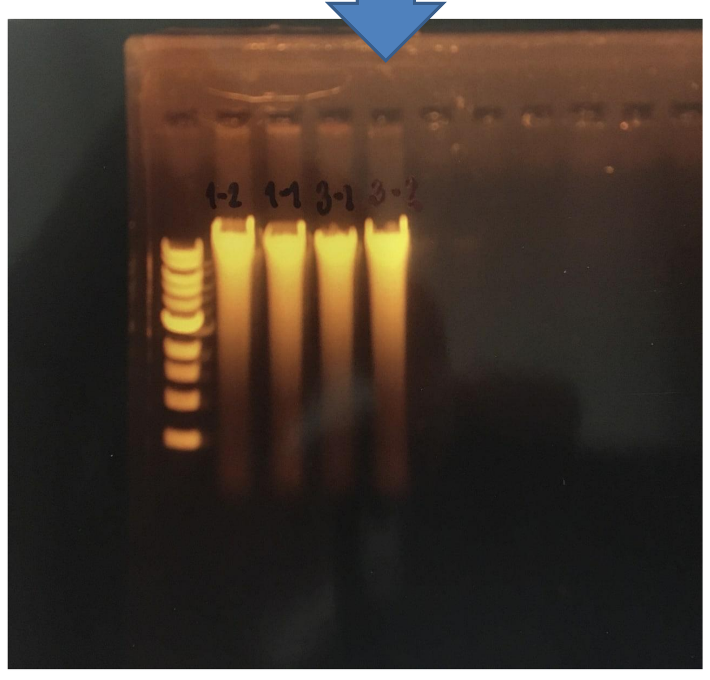
Depletion rate = (SOCNV – SOCCT)/t (Eq. 1)

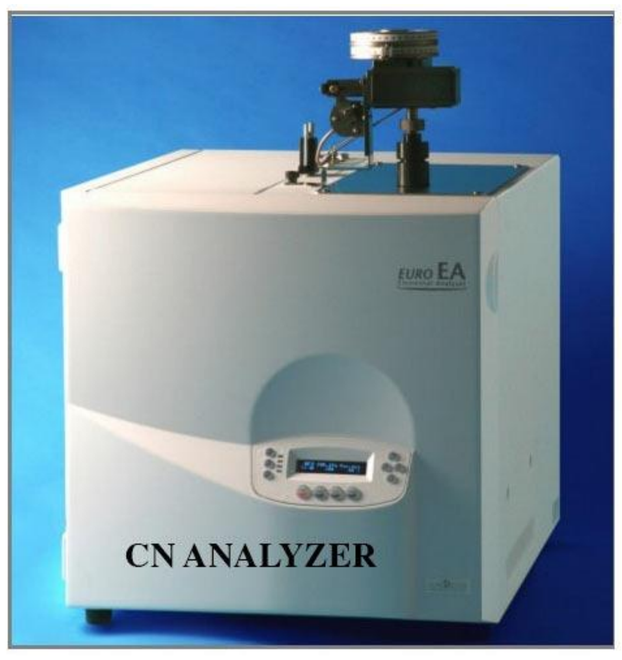
Recovery rate = (SOCCA – SOCCT)/t (Eq. 2)

where, SOCNV, SOCCA and SOCCT refers to C stock under NV, CA and CT, respectively, and t is the time (years) since the conversion from NV to CT, and from CT to CA.

In addition to samples collection of SOC and total N, in 2021 and 2022, the samples from top two layers will be used for analysis of microbial communities and their relationship SOC and nutrient cycling in the cropping systems.

T1:	Monocropping CT maize with cover crops as green manure/maize
T2:	Classic CA maize monocropping under mix cover crops. The cover crops will be established in association or as biopump depends on the rainfall from year to year.
T3:	Classical DMC of maize under Stylo (2022)/Classical of cassava planting (2023)
T4:	Classical of cassava planting (2022)/Classical DMC of maize under Stylo (2023).
T5:	Bi-annual rotation of maize (2022) under conventional tillage (CT) with 2 plough + terminate cover crop by roller +cutting discs before maize (only one cycle/year).)/cassava (2023) under green sowing with biopump of pearl millet.
T6:	Bi-annual rotation of cassava (2022) under green sowing with biopump of pearl millet /maize (2023) under conventional tillage (CT) with 2 plough + cover crop as a green manure before maize (only one cycle/year).
T7:	Permanence cover crops (Phaseolus vulgaria) for mono-cropping maize
T8:	Full conventional tillage-based maize monocropping as reference.





Soil Analysis Result (2020)

Block	SOC %	TN %	pH-H2O	pH-KCl	Clay %
1	2.3331 a	0.2122 a	6.2966 a	5.5591 a	49.816 a
2	2.3253 a	0.2113 a	6.2875 a	5.6016 a	45.77 b
3	2.4569 a	0.2297 a	5.8409 a	4.8816 a	39.359 c
4	2.3887 a	0.2156 a	5.9494 a	5.0119 a	40.042 c
Treatment	**SOC %**	**TN %**	**pH-H2O**	**pH-KCl**	**Clay %**
1	2.1812 a	0.2031 a	5.9037 a	4.9612 a	40.947 a
2	2.3406 a	0.2056 a	6.0744 a	5.1712 a	43.337 a
3	2.4437 a	0.2256 a	5.9013 a	5.1044 a	44.044 a
4	2.3806 a	0.2163 a	6.2462 a	5.4800 a	43.341 a
5	2.3881 a	0.2112 a	6.1431 a	5.2675 a	44.337 a
6	2.4688 a	0.2281 a	6.3200 a	5.4850 a	44.903 a
7	2.4194 a	0.2294 a	6.0125 a	5.1725 a	44.612 a
8	2.3856 a	0.2181 a	6.1475 a	5.4662 a	44.453 a
Depth	**SOC %**	**TN %**	**pH-H2O**	**pH-KCl**	**Clay %**
0-5cm	2.6894 a	0.2472 a	6.2584 a	5.3653 a	43.167 b
5-10cm	2.4375 b	0.2244 b	6.0834 ab	5.3028 ab	42.881 b
10-20cm	2.2825 c	0.2087 c	6.0456 ab	5.3006 ab	42.105 b
20-40cm	2.0947 d	0.1884 d	5.9869 b	5.0853 b	46.834 a

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Investing into Soil Organic Carbon management for resilient upland farming (ISOC)

Soil functions Assessment of Short-term Conservation Agriculture on Farm Practices in the Upland of Cambodia

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Introduction

Maize cropping systems under conservation agriculture (CA) and conventional tillage (CT) were assessed for soil functions (carbon transformation, nutrient cycling and structure maintenance). Green sowing practice was used with CA for this experiment. Green sowing technique is the direct sowing of a main crop on standing cover crops without delaying time of sowing of seed of cash crop or wait for several weeks for cover crop to die as in classical CA.

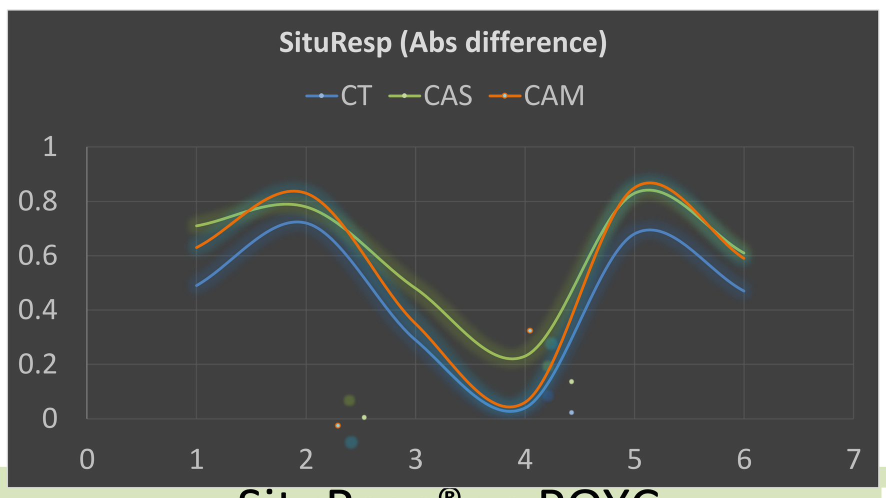
Objective

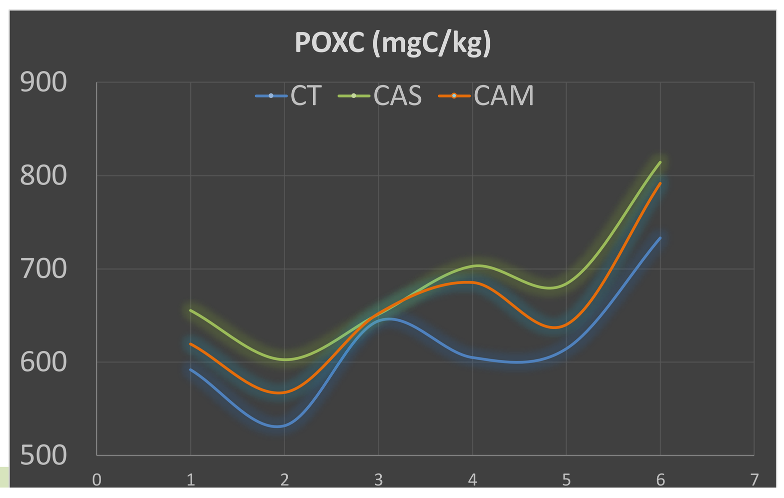
This study aimed to see the differences among maize cropping systems (CAS, CAM and CT management) which once is better in term of soil carbon stabilization and soil functions

Materials and Methods

Soil were assessed by Biofunctool® on six farmers' plots in Sangha village, located in the rainfed upland area of Rattanak Mondul district, Battambang province, with soil type classified as Mollisols. These plots were one hectare size and were randomly split into three main cropping systems: (1) CT: conventional plough based with maize (*Zea mays* L.) without cover crops, (2) CAS: conservation agriculture (CA)-based cropping system with maize direct seeded on green standing single cover of *Crotalaria juncea* L. and (3) CAM: CA-based cropping system with maize direct seeded on mixed cover crops (*C. juncea* + *Pennissetun glaucum* L. + *Vigna unguiculata* L.). Temporal soil carbon dynamics were assessed during different stages of the cropping systems starting before the rolling of cover crops and maize sowing until the harvest of maize representing six sampling times. Each time, soil labile carbon permanganate oxidizable carbon (POXC) and soil basal respiration (SituResp®) were measured from soil samples collected from 0-10 cm depth with 450 samples (6 times x 6 plots x 3 treatment x 5 inner-replications). On the sixth time of the sampling, the full set of Biofunctool® was applied to see the interaction and effect of the practices on soil quality index.

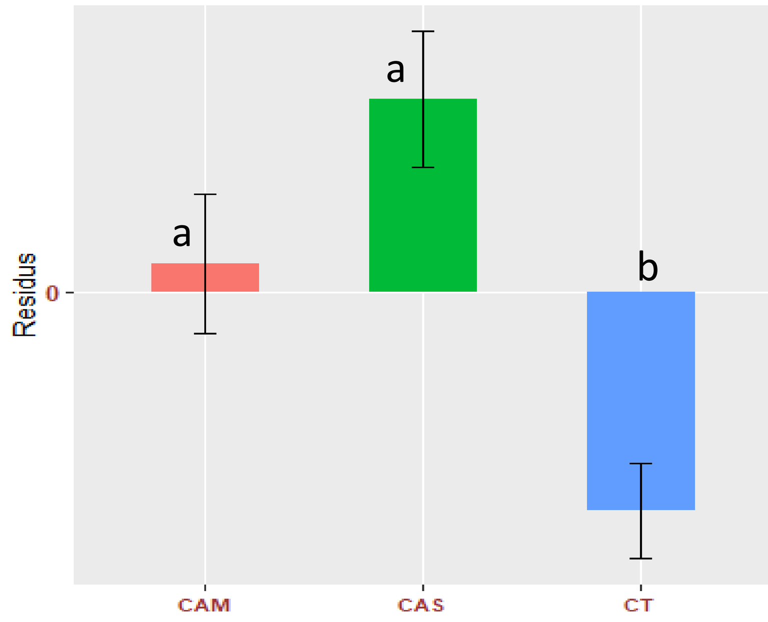
Results and Discussion





SituResp® vs POXC

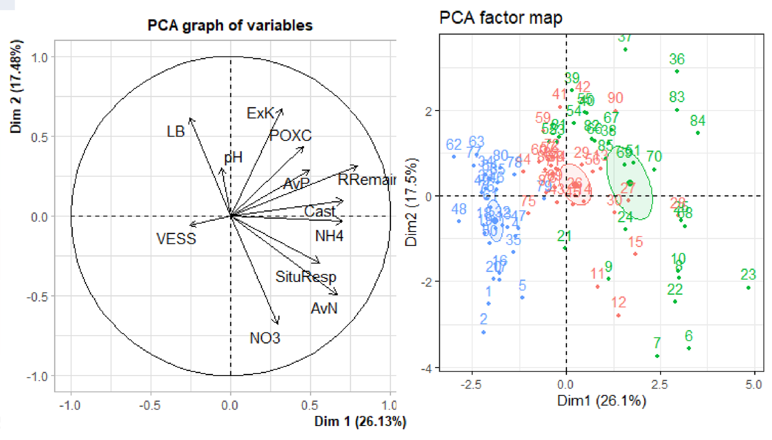
- ❖ Overall POXC and SituResp® are higer in CAs compared to CT. It indicated more microbial activities and more available nutrients in CAs compared to CT
- ❖ POXC vs SituResp® showed CAs had more soil carbon stabilization while CT had temporal soil Carbon depletion



Practice	*AggSurf	*AggSoil	Avail P (ppm)	Ex K(cmol/kg)	NO_3(ppm)	NH_4(ppm)
CT	5.51 b	5.64 a	0.43 b	0.65 b	17.11a	12.306b
CAS	5.82 a	5.74 a	0.76 a	0.99 a	17.18a	26.759a
CAM	5.86 a	5.79 a	0.60 ab	0.78 a	15.94a	15.262b

	**VESS	Cast (T/ha)	Remaining Cover Crop residue (T/ha)
CT	3.2 a	4.47 b	0 c
CAS	2.7 a	38.7 a	6.51 a
CAM	2.8 a	30.58 a	5.73 b

*Aggregate stability in water score from 0-not stable to 6-very stable
** VESS-evaluation of soil structure which range from 1-very good for agriculture to 6-too compacted



- ❖ Available phosphorous in CT was 0.43mg/kg while CAS and CAM were 75% and 38% higher, respectively
- ❖ Exchangeable potassium were also followed the same manner that CT has only 0.65 meq/100g while in CAS and CAM were 0.99 and 0.77 meq/100g, respectively
- ❖ At this stage of assessment (two years of practice) we did not find the difference of the rate of substrate degradation in all systems, but we observed much more activities of earthworm in CA fields compared to the CT that total earthworm cast in CAS was 38.7T/ha and CAM was 30.58T/ha, while CT was only 4.47T/ha
- ❖ The analysis of PCA had proved that soil functions in CT and the two CAs systems were far different from each other and most of the parameters were affected by CA practices, while soil quality index were significantly higher than CT practice

Conclusion

- ❖ Conservation agriculture practices with green showing management in both single and mixed cover crops have carbon stabilization, while maize under plough-based management without cover crop have more carbon mineralization from the soil.
- ❖ Overall soil functions (carbon transformation, nutrient cycling and structure maintainance) are better under CAs while a few functions are similar in all the systems.

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Investing into Soil Organic Carbon management for resilient upland farming (ISOC)

Multi-Services Assessment of Short-term Conservation Agriculture on Farm Practices in the Upland of Cambodia

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No	Activity	Time
1	Biodiversity at landscape level -SNH conservation -Aerial photo	❖ Early July, 2022
2	Potential Pollinator	❖ In Between 20-45DAS of cover crop ❖ At flowering stage of maize
3	On the ground biodiversity (Pit-fall)	❖ At 20-45DAS of cover crop (2 times) ❖ At 7-14DAS of maize (2 times) ❖ At flower stage of maize (1 time) ❖ Before harvest of maize (1 time)
4	Soil meso and macro fauna	❖ Before harvest of maize (1 time)
5	Biofunctool®-C transformation, nutrient cycling, soil structure maintainance	❖ Nov, 2022

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