



CHANGES IN SOIL AGGREGATION, SOIL WATER-HOLDING CAPACITY AND SOIL BIOLOGICAL ACTIVITY UNDER NO-TILL SYSTEMS AND CROPPING SEQUENCES IN THE LAO PDR

By Florent Tivet, Hoà Tran Quoc, Johnny Boyer, Chansamone Inthavong, Sompasith Senephansiri, Laty Keodouangsy, Thisadee Chounlamountry, Chanthasone Khamxaykhay, Khamkeo Panyasiri, Lucien Séguy

CONTENT

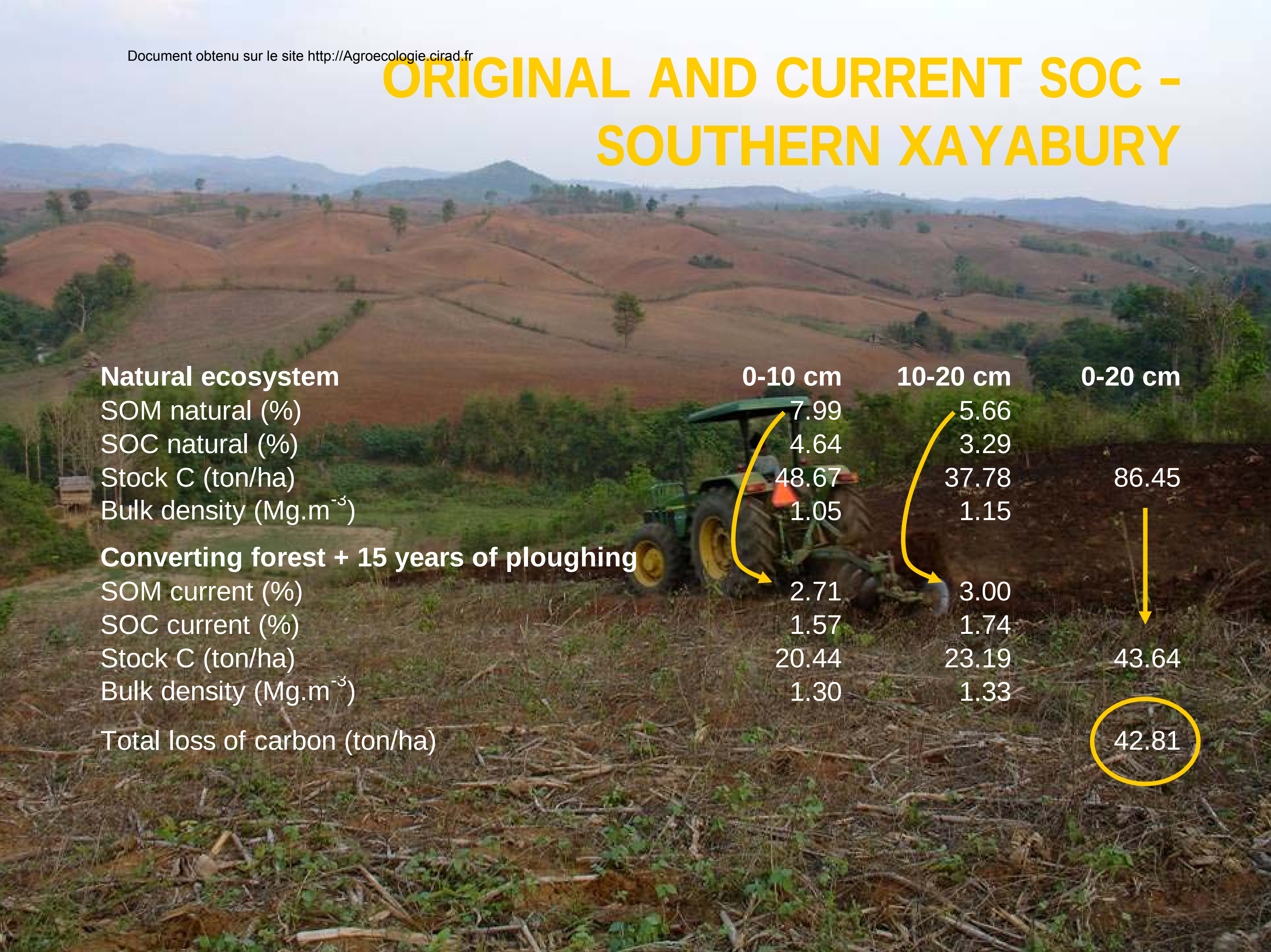
1. Brief presentation of the context in the Southern Xayabury
2. Materials and methods
3. Results
4. Discussion and Prospective

Rising pressure on the natural environment and on farming systems...

... to increase productivity to generate marketable commodities

Marked land degradation and depletion of natural resources

ORIGINAL AND CURRENT SOC – SOUTHERN XAYABURY



Natural ecosystem	0-10 cm	10-20 cm	0-20 cm
SOM natural (%)	7.99	5.66	
SOC natural (%)	4.64	3.29	
Stock C (ton/ha)	48.67	37.78	86.45
Bulk density ($Mg.m^{-3}$)	1.05	1.15	
Converting forest + 15 years of ploughing			
SOM current (%)	2.71	3.00	
SOC current (%)	1.57	1.74	
Stock C (ton/ha)	20.44	23.19	43.64
Bulk density ($Mg.m^{-3}$)	1.30	1.33	
Total loss of carbon (ton/ha)			42.81

SOIL PHYSICAL PROPERTIES UNDER CONVENTIONAL PRACTICES

Steep slope, tillage

Gentle slope, tillage

Soil is disrupted by tillage, high frequency of small macro aggregates is observed. Increasing mineralization rate and loss of SOC by runoff.

OBJECTIVE

‘This study set out to analyse soil aggregation, soil water-holding capacity and soil biological activity under tillage and no-tillage conditions in relation to the cropping sequence’

CONTENT

THREE CROPPING SYSTEMS

Maize monoculture (4.8 $t.ha^{-1}$ DM)



Maize (5.1) / Rice bean (3.1)



Maize (5.2) + *B. ruziziensis* (4.0) / Rice bean (3.1)



SOIL AGGREGATION

Water stable aggregates: aggregate size fraction through the wet sieving method (Yoder, 1936).

Soil samples are collected at 0–10, 10-20 and 20–30 cm depth (6 replicates per depth).

The samples are moistened by capillarity, by placing them on a filter paper at the top sieve. The water volume is then raised inside the water tank to wet the filter paper and, consequently the soil.

Each test uses six sieves of 8, 4, 2, 1, 0.5 and 0.25 mm. The wet sieving process for 10 minutes. The aggregates retained in each sieve are weighed 24h at 105°C.

SOIL WATER HOLDING CAPACITY

Soil samples are collected at 0–10, 10-20 and 20–30 cm depth to measure bulk density.

The samples are moistened by capillarity until full capacity and then weighted.

Weight of dry soil is recorded after drying the sample for 24h at 105°C.

SOIL MACRO FAUNA

Fauna sampling is done on square of 25cmx25cm on the top soil and at 3 depths: 0-10, 10-20 and 20-30 cm.

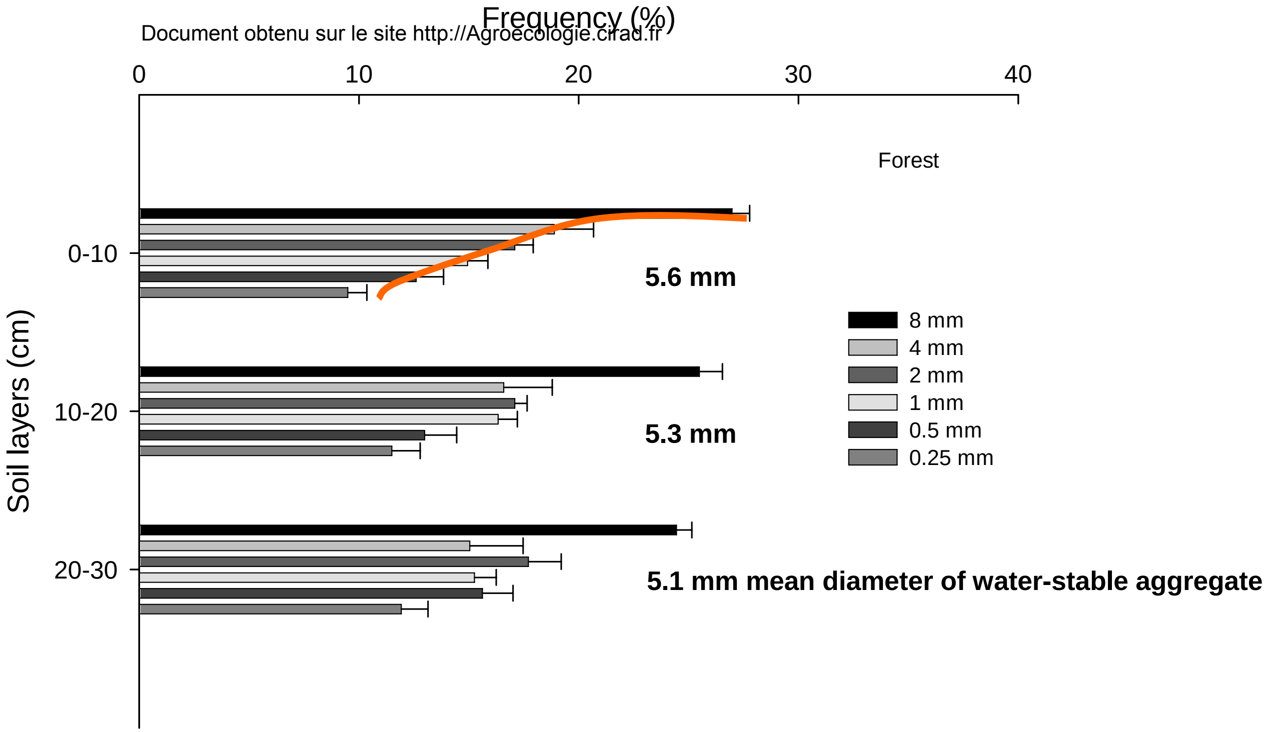
Minimum of 9 repetitions are required for each system. Total fauna is collected on each depth using pliers and put into alcohol for identification in laboratory.

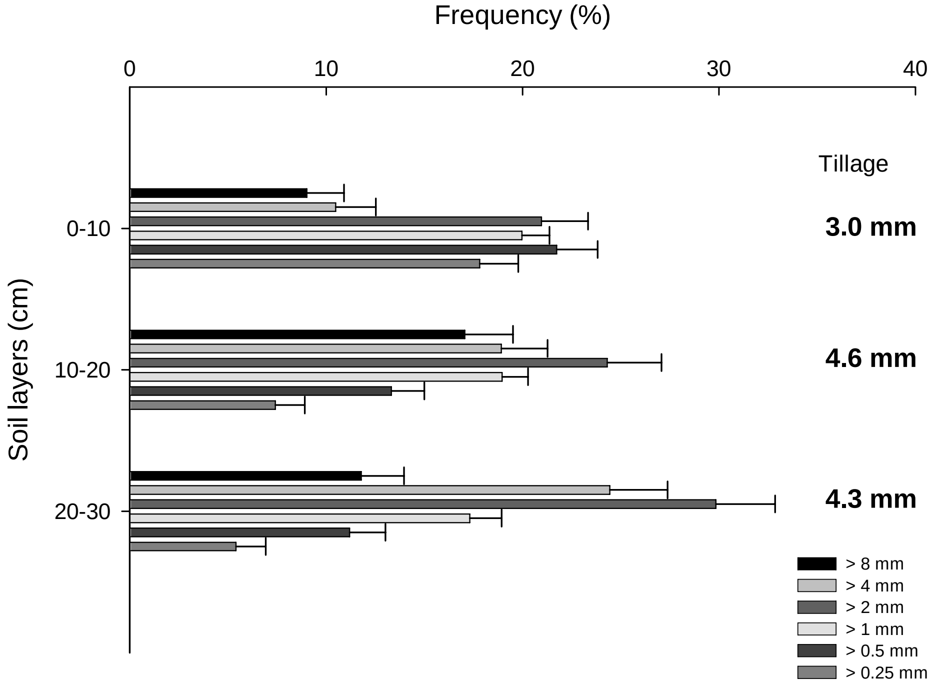
Fauna identification and accounting is done under binocular glass. Fauna weight is done for each treatment at every depth and for each specie.

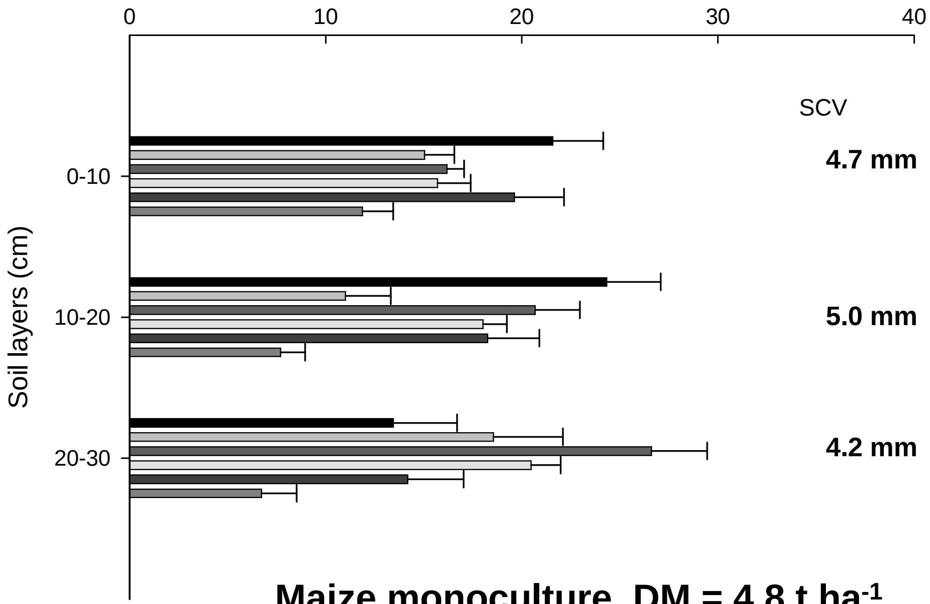
CONTENT

1. Brief presentation of the context in the Southern xayabury
2. Materials and methods
3. Results
4. Discussion and Prospective

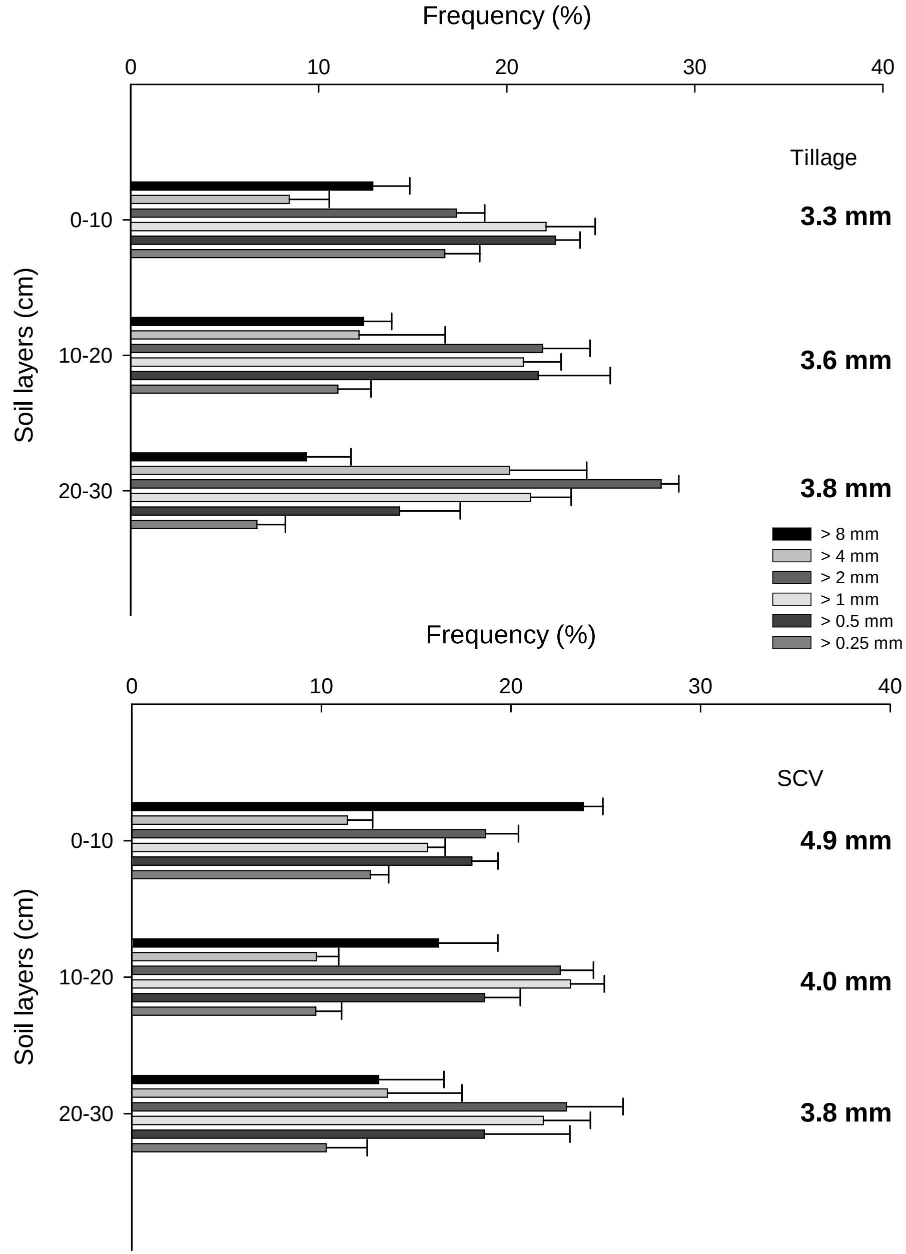
SOIL AGGREGATION



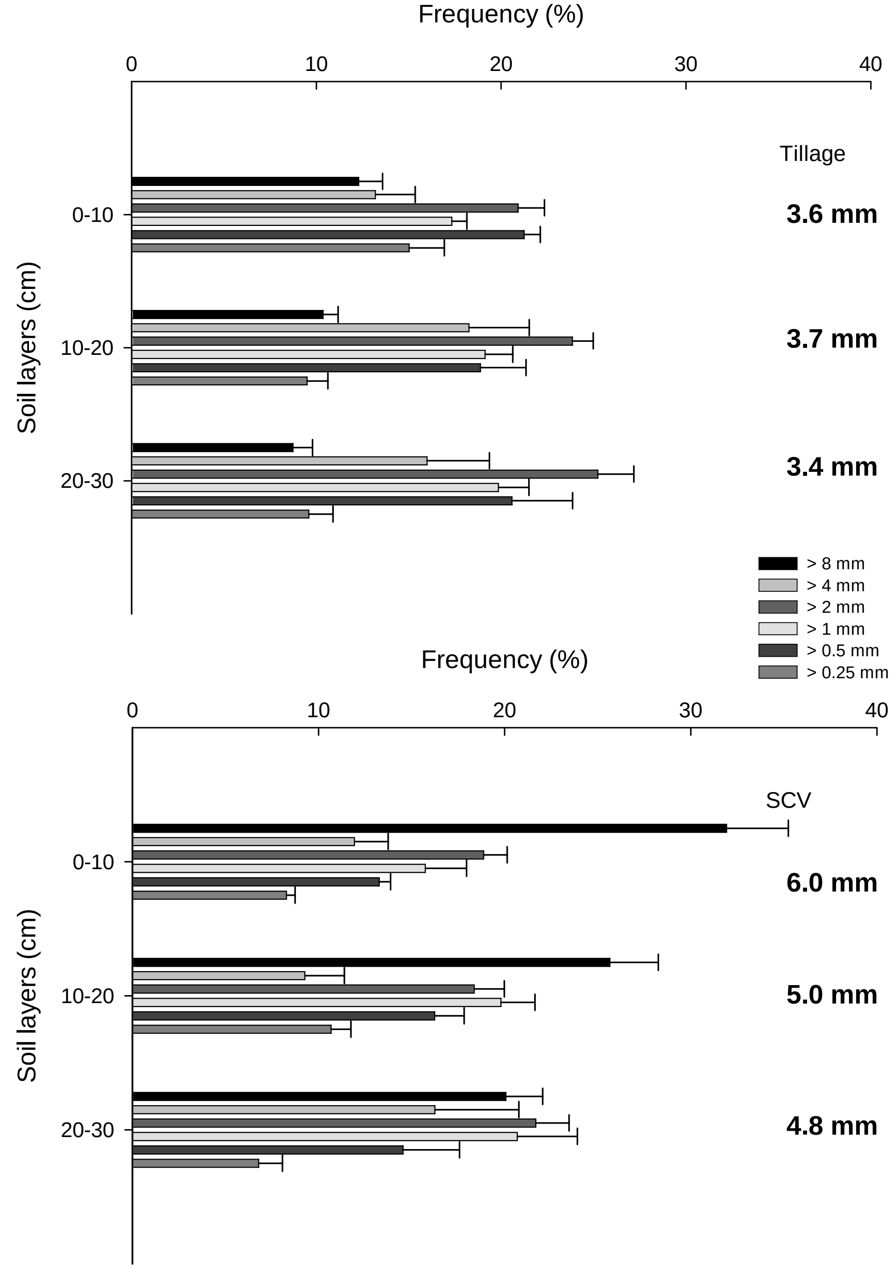




Maize monoculture, DM = 4.8 t.ha^{-1}

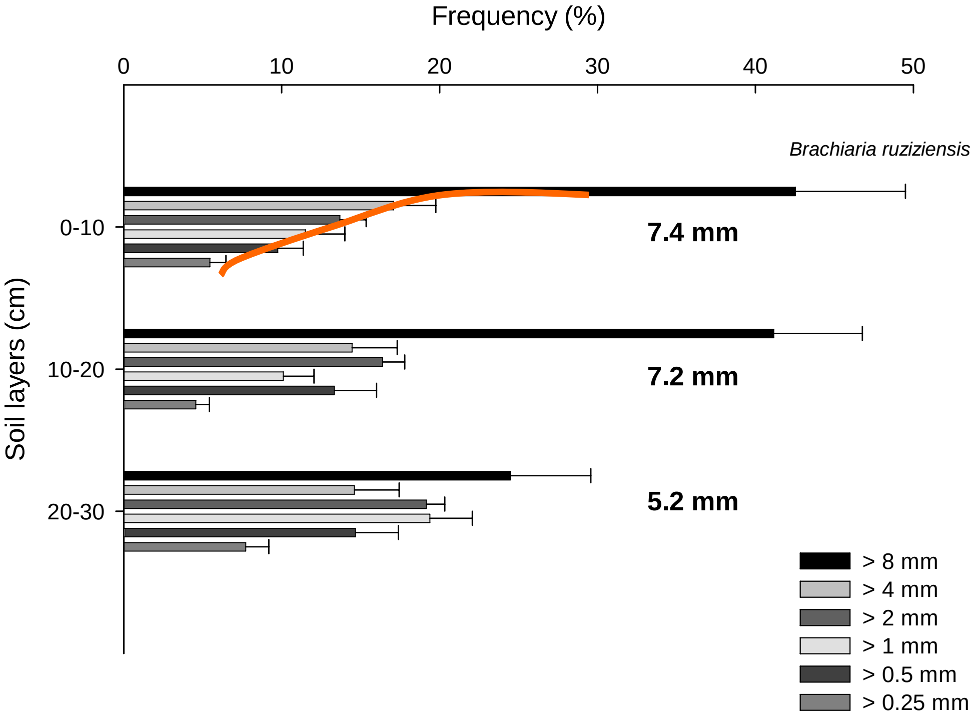


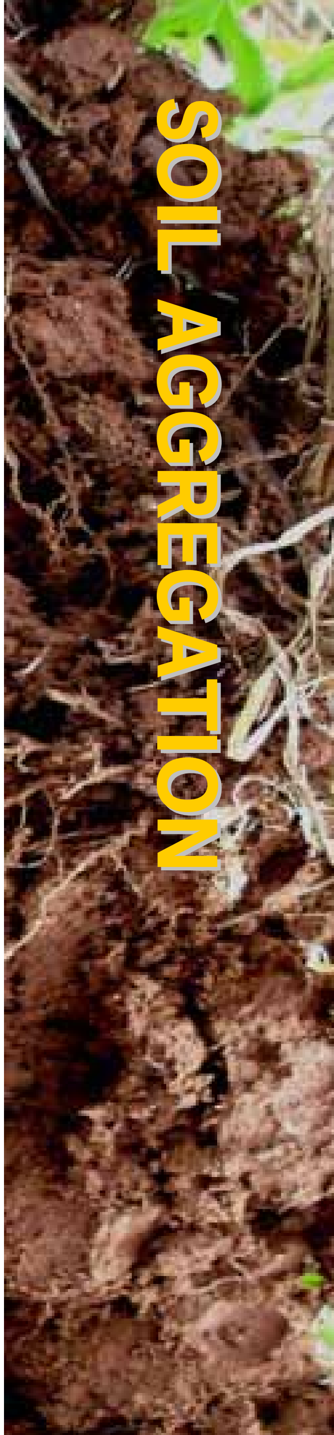
Maize (DM = 5.1 $t.ha^{-1}$) / Rice bean (DM = 3.1 $t.ha^{-1}$)



Maize (DM = 5.2 t.ha^{-1}) + *B. ruziziensis* (4 t.ha^{-1}) / Rice bean (3.2 t.ha^{-1})

The temporary (roots hairs and hyphae) and transient (polysaccharides) binding agents are the most important aggregation components.





Soil aggregation under [No-till and cropping sequence maize + *B. ruziziensis* – rice bean] showed results close to the natural ecosystem.

Land preparation	Cropping sequence	Water Stable Aggregate (mm)		
		0-10 cm	10-20 cm	20-30 cm
Tillage	maize monoculture	3.0^{c}	4.6^{ab}	4.3^{abc}
No-till		4.7^{b}	5.0^{a}	4.2^{abc}
Tillage	maize - rice bean	3.3^{c}	3.6^{c}	3.8^{bc}
No-till		4.9^{b}	4.0^{bc}	3.8^{bc}
Tillage	maize + *B. ruziziensis* - rice bean	3.6^{c}	3.7^{c}	3.4^{c}
No-till		6.0^{a}	5.0^{a}	4.8^{ab}
Forest		$\mathbf{5.6^{a}}$	$\mathbf{5.3^{a}}$	$\mathbf{5.1^{a}}$

SOIL AGGREGATION

DMC maize + *B. ruziziensis* – rice bean

High frequency of big macro aggregates. Enhanced soil structure, increase soil water holding capacity and protect soil organic carbon (oxidation reduction). Soil sensitivity to erosion decreases due to soil cohesion improvement.

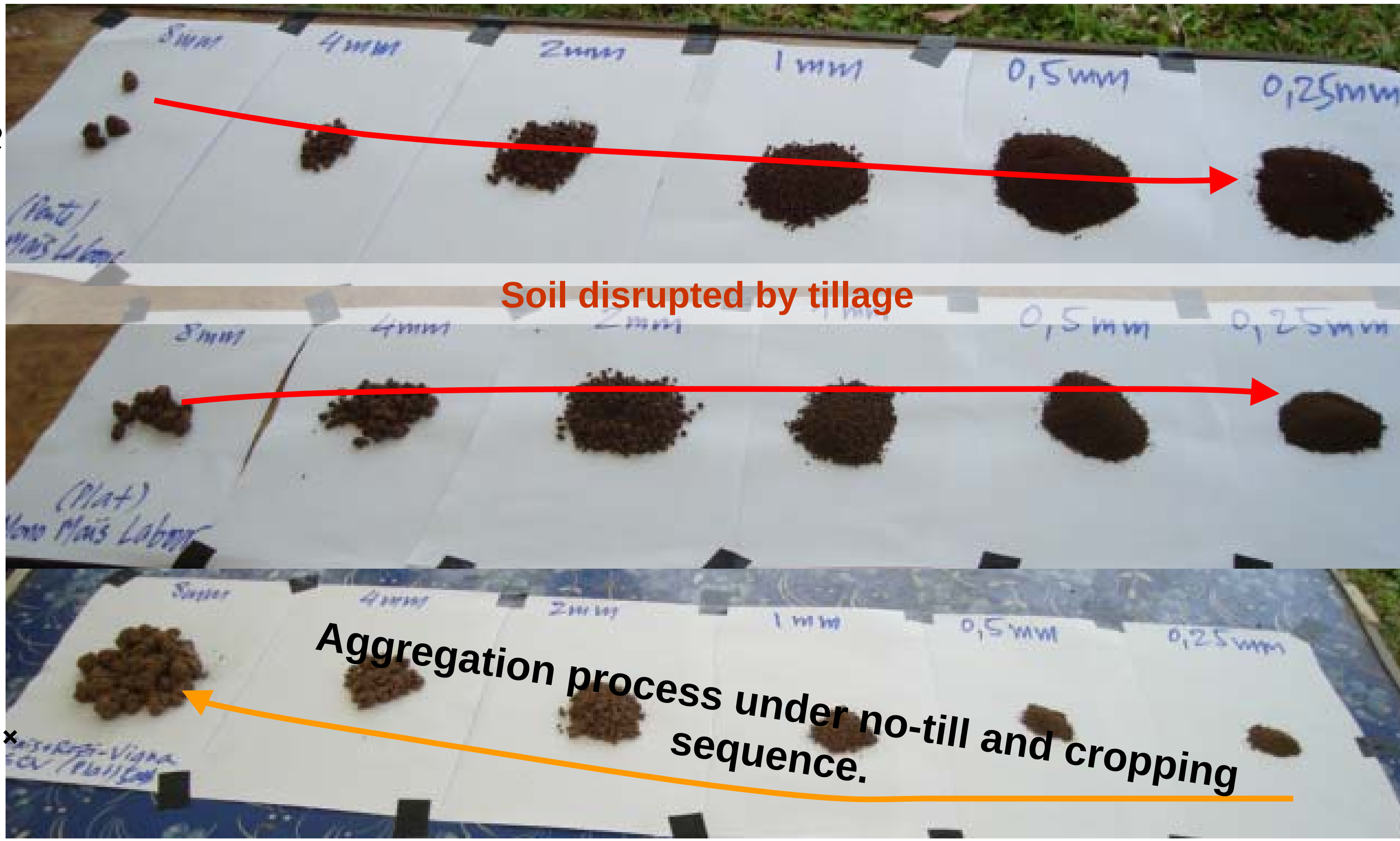
Macro aggregation (and pattern of aggregate size) is linked to continuous C flux (dry matter/residue input) and enhancement of soil biological activity

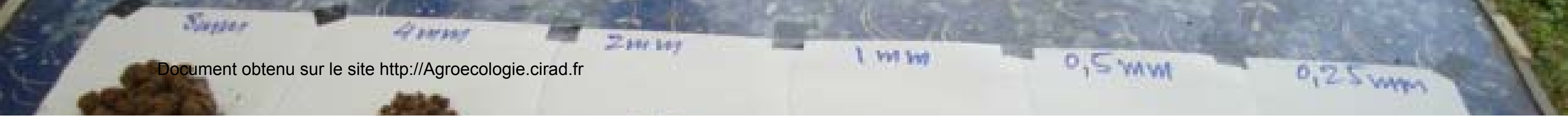
SOIL AGGREGATION

Steep slope, ploughing

Gentle slope, ploughing

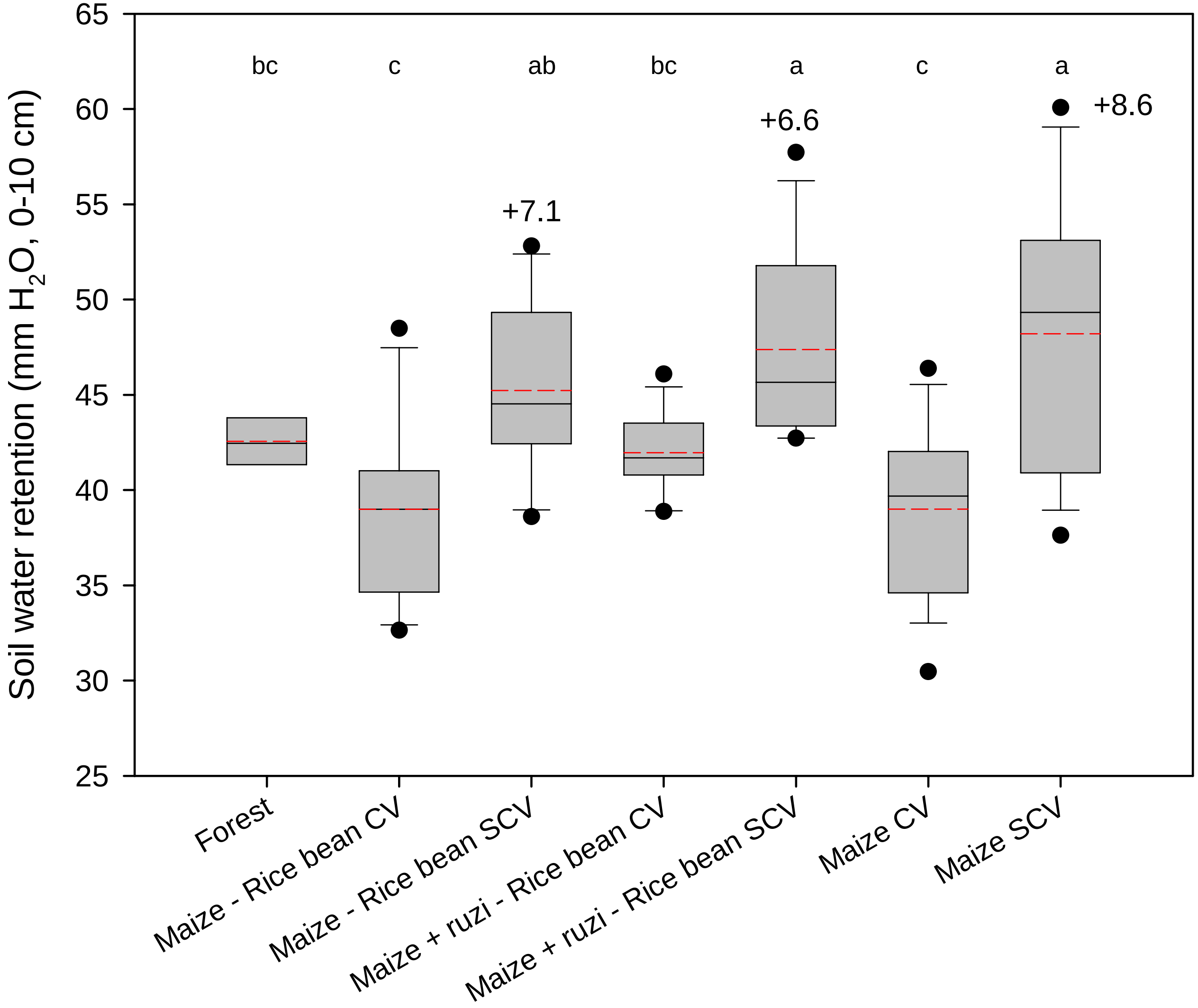
DMC maize + B. ruziziensis – ricebean



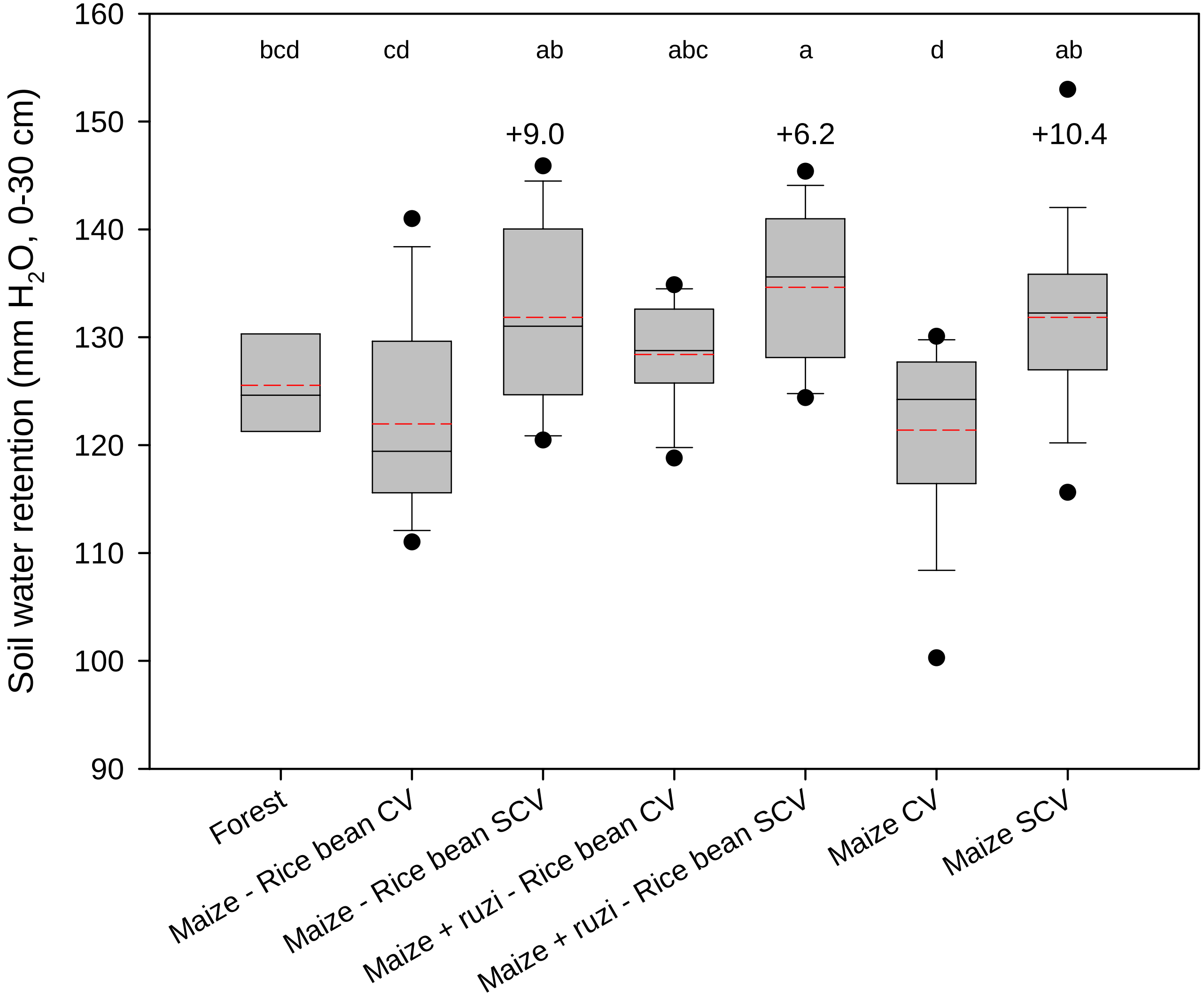


“The macroaggregation is the main way to protect the C released from the crop residues decomposition and stimulate the interactions among soil chemical, physical and biological attributes”

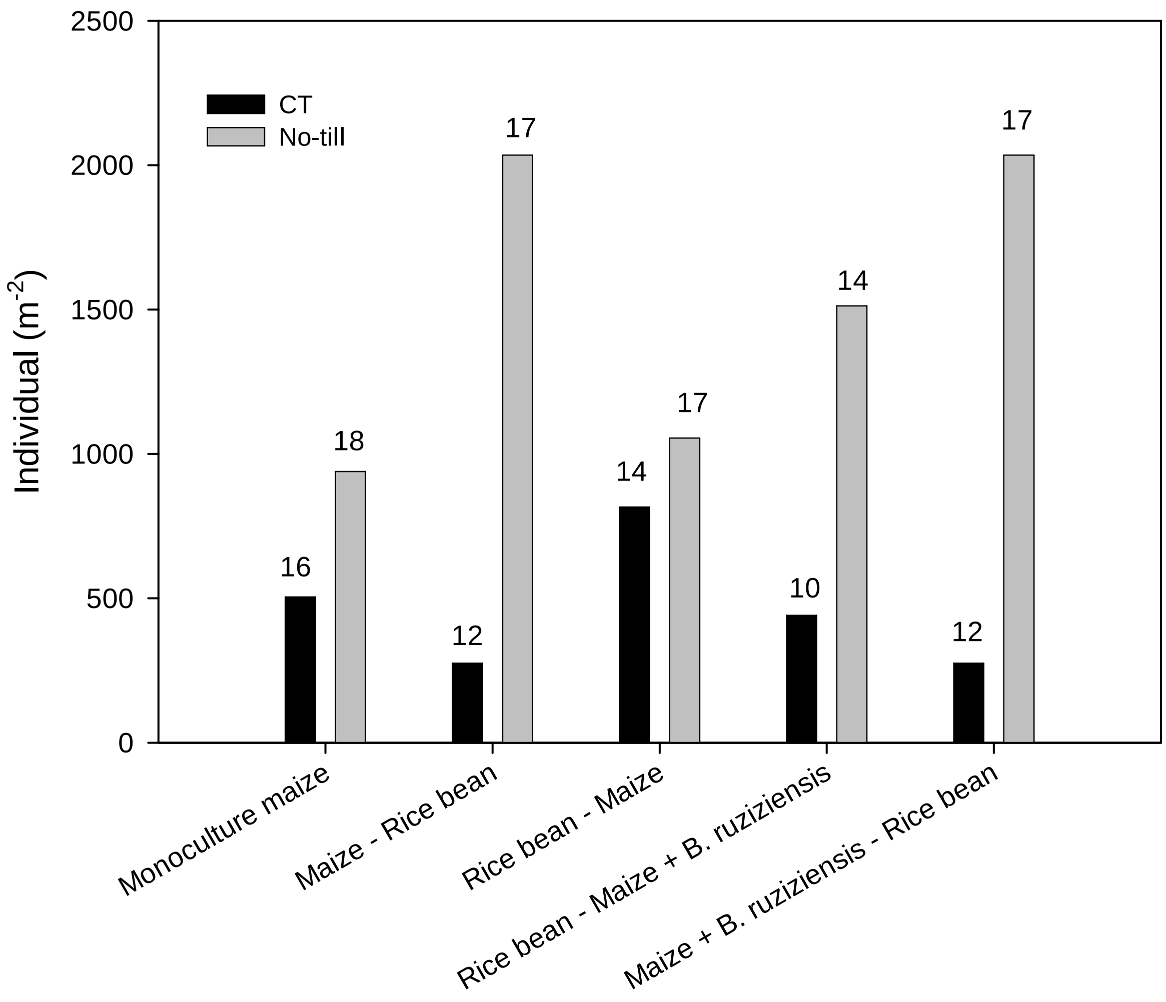
SOIL WATER HOLDING CAPACITY



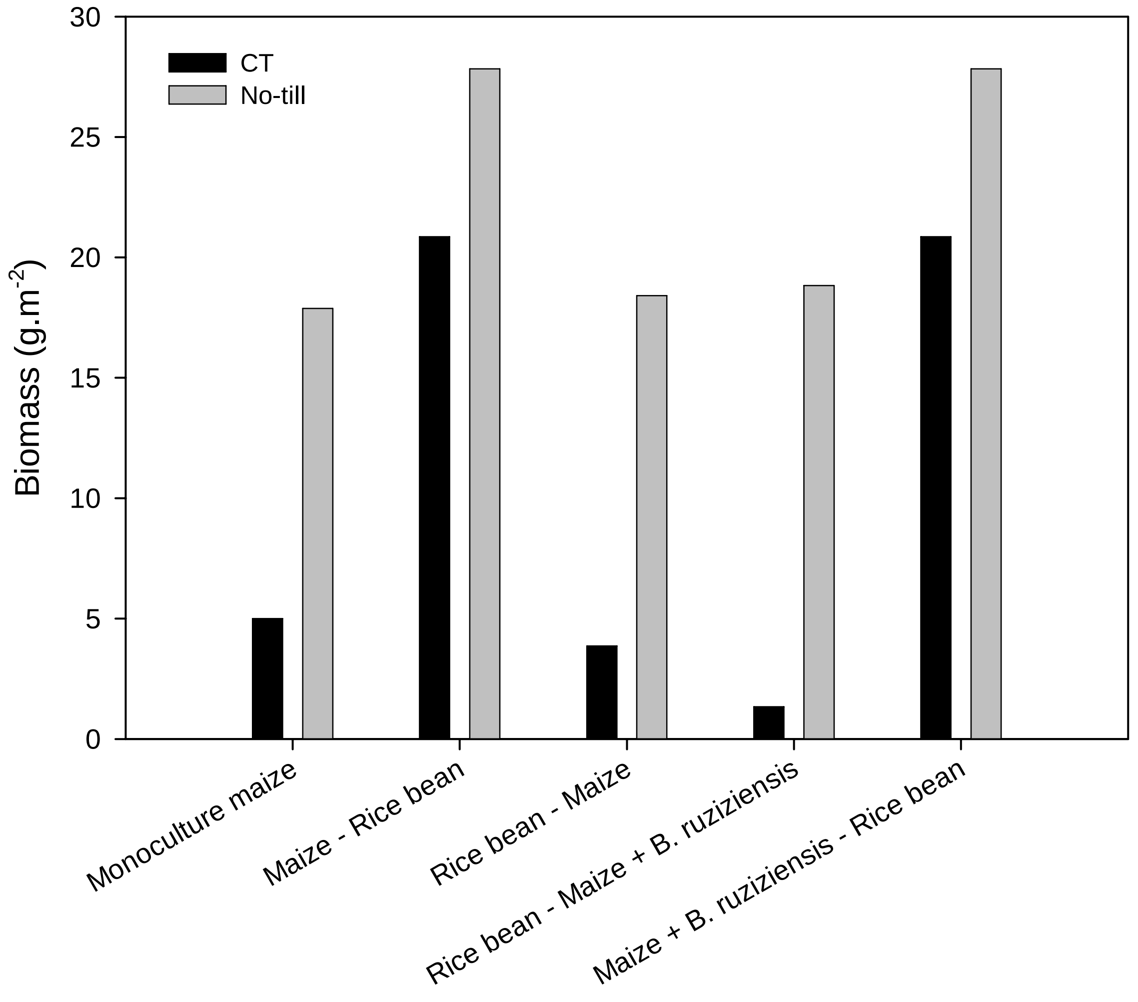
SOIL WATER HOLDING CAPACITY



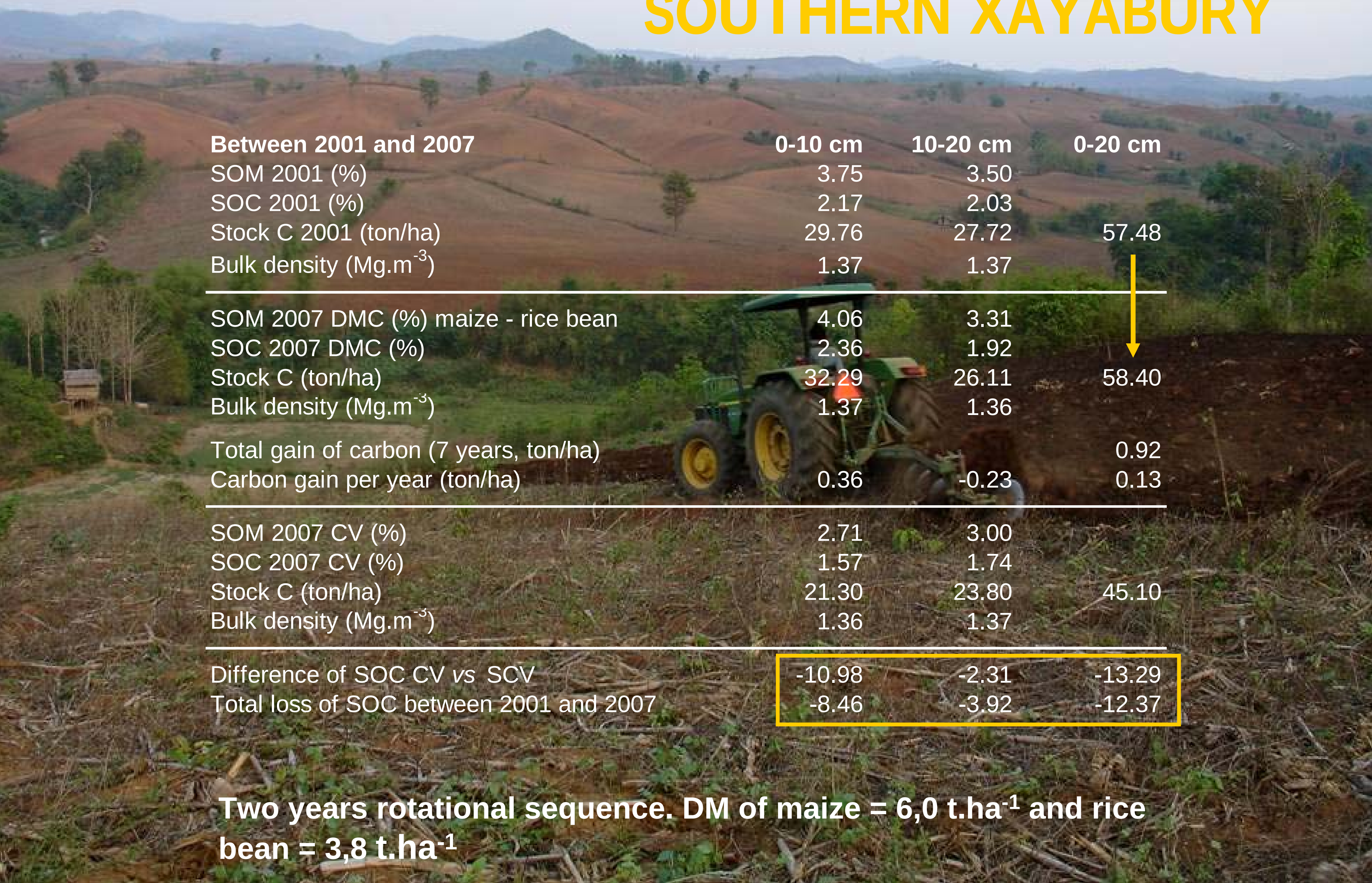
SOIL MACRO FAUNA ACTIVITY



SOIL MACRO FAUNA ACTIVITY



ORIGINAL AND CURRENT SOC – SOUTHERN XAYABURY



Between 2001 and 2007	0-10 cm	10-20 cm	0-20 cm
SOM 2001 (%)	3.75	3.50	
SOC 2001 (%)	2.17	2.03	
Stock C 2001 (ton/ha)	29.76	27.72	57.48
Bulk density ($Mg.m^{-3}$)	1.37	1.37	
SOM 2007 DMC (%) maize - rice bean	4.06	3.31	
SOC 2007 DMC (%)	2.36	1.92	
Stock C (ton/ha)	32.29	26.11	58.40
Bulk density ($Mg.m^{-3}$)	1.37	1.36	
Total gain of carbon (7 years, ton/ha)			0.92
Carbon gain per year (ton/ha)	0.36	-0.23	0.13
SOM 2007 CV (%)	2.71	3.00	
SOC 2007 CV (%)	1.57	1.74	
Stock C (ton/ha)	21.30	23.80	45.10
Bulk density ($Mg.m^{-3}$)	1.36	1.37	
Difference of SOC CV *vs* SCV	-10.98	-2.31	-13.29
Total loss of SOC between 2001 and 2007	-8.46	-3.92	-12.37

Two years rotational sequence. DM of maize = 6,0 $t.ha^{-1}$ and rice bean = 3,8 $t.ha^{-1}$

ORIGINAL AND CURRENT SOC – SOUTHERN XAYABURY

Between 2001 and 2007	**0-10 cm**	**10-20 cm**	**0-20 cm**
SOM 2001 (%)	3,88	3,29	
SOC 2001 (%)	2,25	1,91	
Stock C 2001 (ton/ha)	30,83	26,09	56,92
Bulk density ($Mg.m^{-3}$)	1,37	1,37	
SOM 2007 DMC (%) maize - rice bean	4,46	3,80	
SOC 2007 DMC (%)	2,59	2,21	
Stock C (ton/ha)	34,74	30,20	64,93
Bulk density ($Mg.m^{-3}$)	1,34	1,37	
SOM 2007 CV (%) maize - rice bean	2,71	3,00	
SOC 2007 CV (%)	1,57	1,74	
Stock C (ton/ha)	21,49	23,78	45,27
Bulk density ($Mg.m^{-3}$)	1,37	1,37	
Difference of OM CV *vs* SCV	-1,75	-0,80	
Difference of SOC CV *vs* SCV	-13,24	-6,42	-19,67

Two years rotational sequence. DM of maize = 10,6 $t.ha^{-1}$ and rice bean = 3,8 $t.ha^{-1}$

CONTENT

1. Brief presentation of the context in the Southern xayabury
2. Materials and methods
3. Results
4. Discussion and Prospective

DISCUSSION AND PROSPECTIVE

Soil aggregation, water holding capacity and biological activity increase under no-till and cropping sequence but…

DISCUSSION AND PROSPECTIVE

…we have to generate no-till and intensive (high dry matter production > 15 $t.ha^{-1}$) cropping sequence to optimize the main functions of SCV systems: nutrients recycling, water use efficiency, integrated weeds management, SOC sequestration and profitability.



DISCUSSION AND PROSPECTIVE

DM = 7.8 $t.ha^{-1}$ (maize) + 10.6 $t.ha^{-1}$ (*B. ruziziensis* + *C. cajan*)

DM = 7.4 $t.ha^{-1}$ (maize) + 7.9 $t.ha^{-1}$ (*C. cajan*)

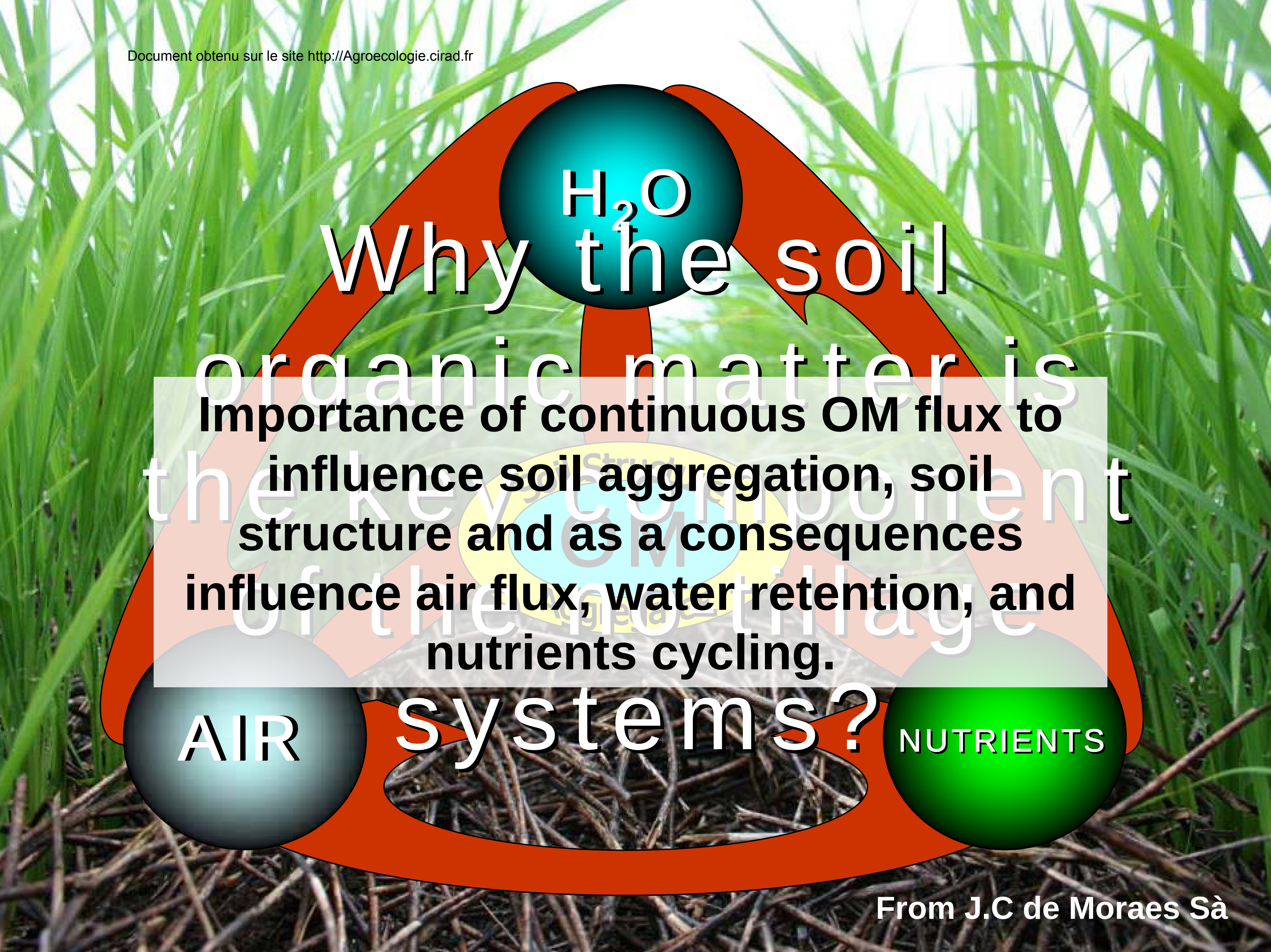
DM = 7.2 $t.ha^{-1}$ (maize) + 4 $t.ha^{-1}$ (*V. umbellata*)

Analyze SOC for a range of no-till and cropping sequence in 'station' and in farmers' fields:

- To record the potentialities of these systems in sequestrating C and the impact of each specie on the form of C (stable and active pool).
- To establish relationships between SOC and profitability.

Why the soil organic matter is the key component of the no-tillage systems?

Importance of continuous OM flux to influence soil aggregation, soil structure and as a consequences influence air flux, water retention, and nutrients cycling.



From J.C de Moraes Sà


THANKS FOR YOU
ATTENTION