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Full length Research paper

Soil mycorrhizal potential and carbon sequestration in an agroforestry fallow grassland type : "Cropping in plates under Green Mat", in Kisangani (DR Congo)

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An experiment was carried out in Kisangani (DR Congo) to examine, faced with the Slash-and-burn system, to what extent and what degree the system of "cropping in Plates under Green Mat" would favorably affect the mycorrhizal potential of the soil as well as the agroecosystem carbon stock and sink. A device plan with 5 completely randomized blocks, divided into 2 plots each, was chosen to test the factor "production system" (single-factor ANOVA x Duncan's test) ". It emerges from this study the following performance points :

- **A marked improvement in the density of mycorrhizal propagates, rhizobial nodules and aerobic microbial germs (15.2 vs 1.3 /g soil, 43.9 vs 21.3 /kg soil and 163.4x10^6 vs 45.7x10^6 /g soil, respectively);**
- **A marked improvement in the stable carbon stocks and sinks of agroecosystems up to 30 cm of soil depth (67.8 vs 14.5 t/ha and 20.3 vs 1.8 t /ha/year);**
- **An improvement in the efficiency of rainwater recovery by 4 times (62.2 vs 16.2 kgMS / mm rain) and in the efficiency of fertilizers recovery by 18 times (529 vs 29.3 kgMS /kg of fertilizer).**

This places Cropping on Plates under Green Mat among the most efficient technologies of Conservation Agriculture (Agro-ecology) and thus strengthens ecological and social resilience.

Key words: Mycorhizal potential, C Sequestration, Agroforestry, Depleted Ferralsol, Green Mat, Slash-and-Burn

INTRODUCTION

Agro-forest fallow-grassland would develop a remarkable fertilizing potential resulting from more integration of legumes and perennial grasses (Pyame *et al,* 2016b). In studies of the rhizosphere effect on perennial grasses, using stable isotopic tracers, Dormaar and Sauerbeck in Jones (2000) indicated that on average 70% of photosynthetates were regularly transferred to perennial roots, therefore invested in the C sink, versus only 30-40 % for annual plants.

Also, according to Séguy *et al.* (2009), perennial grasses exhibit, by far more than annual plants, a high efficiency in root extraction of nutrients. According to Samson *et al.* (2005), such a performance in perennial grasses can be explained by: (1) the presence of a rich microbial population in the root system, which is able to efficiently harvest labile C, achieving greater mineral availability in the soil and (2) greater photosynthetic capacity regularly supplying the soil with organic C. According to Karlen *et al*. (2019), Soil biological properties and processes are the new frontiers in soil health.

Mulching and no tillage develop a high potential in C sequestration (Fiorini *et al,* 2020).

The rhizo-bio-organic mat usually established under perennial grasses is essential for the promotion of the mycorrhizosphere.

This is an inextricable and interchangeable assembly of materials, most often formed by direct seeding under permanent plant cover, consisting of root hair, humus/organic inputs and edaphic bioagents (Pyame *et al,* 2016a). This continuous web of hairy

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roots ("mat layer" in English) embeds the most complex functional biological consortia, ensuring a notable reduction in emissions of GES (Newsham *et al,* 2000 ; Wang *et al,* 2019).

The improvement of the "sequestration-emission" balance of agroecosystems, previously mentioned and analyzed by renowned scientists (Lal, 2008), was finally the subject of the Vienna symposium which marked a decisive turning point in the international mobilization against climate change.

Thus, mycorrhizal symbioses, which are the most generalized in natural ecosystems, structure the rhizosphere both from a physical and chemical point of view; they therefore impact communities and entire ecosystems (Johson and Guerring, 2007 ; Gong *et al,* 2019).

According to Sturz and Nowak (2000) and Wang *et al,* (2020), crop successions should go through strategies of creation and maintenance, in crop rhizosphere, of beneficial and particularly active fungal and bacterial populations.

From studies on the bioecological effects of the conversion of the Amazon rainforest into savanna in Brazil (Leal *et al,* 2013) and the conversion of a permanent pasture to steppe in the USA (Klass *et al,* 2013), it was established that thisindeed affect the taxonomic composition of VAMs.

Finally, Gillespie and Allen (2006), in California, USA, reported that mycorrhizal inocula from a pasture invaded by exotic species had the exceptional ability to induce the highest crop growth, despite the differences and inconsistencies linked to the nature of the soil.

This is a clue that highly invasive plants would impart exceptional performance (ecological aggressiveness) to local strains of mycorrhizal fungi, thus greatly improving the productivity of the ecosystem (Gu*et al,* 2020).

The primary productivity and yield of food crops are considerably improved when moving from the traditional slash-and-burn system to cropping in plates under green mat.

Would the agroecological performance of "green mat cultivation" also embrace the mycorrhizal potential of the soil as well as the net carbon stock and sink in the agroecosystem?

MATERIALS AND METHODS

Site Location

The experiments were carried out in the research station of the Faculty of Renewable Natural Resources Management of the University of Kisangani (Faculty of Sciences concession) located in the Municipality of Makiso, city of Kisangani.

The test site is located at 404m altitude, 00° 30'05 "North latitude and 25° 12'41" East longitude. The slope of the terrain, which is highly variable, is 8.5% upstream, 3.6% downstream and 16.1% at mid-slope. Also, the tests undertaken extend from January 2008 to December 2012.

Vegetation

The vegetation of Kisangani is located in the central forest sector of the Guinean region, characterized by dense humid forests and various vegetation groups degraded as a result of human action (Mate, 2001). The hinterland of the city of Kisangani was initially made up of evergreen rain forests which constituted its climax. The experimental site had a previous crop marked by the continuous cultivation of cassava associated with maize.

The short-lived fallow areas were dominated by *Cynodon dactylon* with sparse patches of *Panicum maximum, Pueraria javanica* and *Calopogonium muconoides*. The lowland area along the stream had*P. purpureum* cover.

EDAPHO-CLIMATIC CONDITIONS

The soil of Kisangani (Fac. Des Sciences UNIKIS) carrying the agroforests evaluated presents, upstream, a heavy clay-silt-sandy texture with 42%, 30% and 28% of elementary particle content, respectively for clay, silt and sand.

The texture, downstream, is more variable but overall of a heavy to very heavy nature. Table 1 below gives the chemical and physicochemical properties of the soil at the study starting.

The city of Kisangani enjoys an equatorial climate of type Af according to the Koppen classification. It is a constantly hot and humid climate, thus identifying itself with a very high ecological productivity. The average annual precipitation is therefore around 1800 mm, with average daily temperatures varying between 24 and 25°C.

However, a considerable increase has been observed over the past 5 years, with annual rainfall reaching 2000-2400 mm and the average monthly temperature reaching 27-28°C. Figure 1 below shows the essential climatic data during the study period.

EXPERIMENTAL APPARATUS

The experimental device mounted in this study is given in figure. 2 below. The experimental sector, linked to the rainfed rice cultivation practiced under the fallow-green manure of Mucuna –Pennisetum, was established upstream of the watershed, on a sloping land (8-9%) with aslopegoing from west to the east.

Table N ° 1. Characterization of the soil at the end of the preliminary phase (morpho-edaphic optimization) in March 2011, before the start of the final phase of the experiment **

Systèmes de production	CO (%)	P assimilable + P organique (mg/kg sol)	Al^{3+}+H^+ (cmole /kg)	Saturation Al^{3+} (%)	Saturation en bases %	Bases totales (cmol/kg)	K^+ cmole/kg	Na^+ cmole / kg	Ca^{2+} cmole/ kg	Mg^{2+} cmole/ kg	N (%)	pH au Kcl	pH à $H_2$0	ECE Ccmole/ kg
	Strate de sol de 0 à 15 cm de profondeur													
Tapis vert	4,5	86	5.2	47.3	52.7	5.80	2.20	0.10	2.10	1.40	0,3	4,4	5.3	11,0
Abattis-brûlis	1,5	37,2	15.6	<u>87.6</u>	12.4	2.18	0.30	0.06	1.34	0.48	0,16	3,5	4.3	17,8
Champs voisins	0,3	25,0	17.6	<u>90.8</u>	09.2	1.77	0.20	0.06	1.13	0.58	0,08	3,5	4.1	19,4
	Strate de sol de 15 à 30 cm de profondeur													
Tapis vert	1,1	26	17.6	<u>91.6</u>	08.4	1.59	2.2	0.1	2.1	1.4	0,08	3,8	4.6	19,2
Abattis-brûlis	0,4	19	19.8	<u>94.3</u>	05.7	1.02	0.14	0.04	0.72	0.12	0,07	3,4	4.1	21,0
Champs voisins	0,2	13	23.0	<u>96.0</u>	04.0	0.94	0.10	0.03	0.69	0.12	0,05	3,3	4.1	23,9

* The underlined values of the aluminum saturation are those which do express the aluminum toxicity, the threshold of which is set at 60%. CO = organic carbon; ECEC = Effective cation exchange capacity(Pyame et al, 2016)

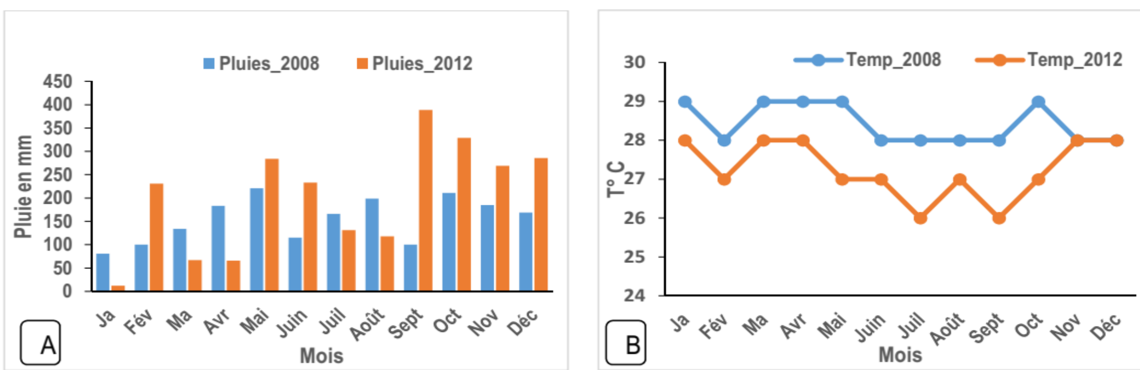

***Fig. 1 (A, B). Evolution of monthly average temperatures and rains at the experimental site, between 2008 and 2012 (data from the first and last year of the study). Source: IFA, Department of Plant Science*.**

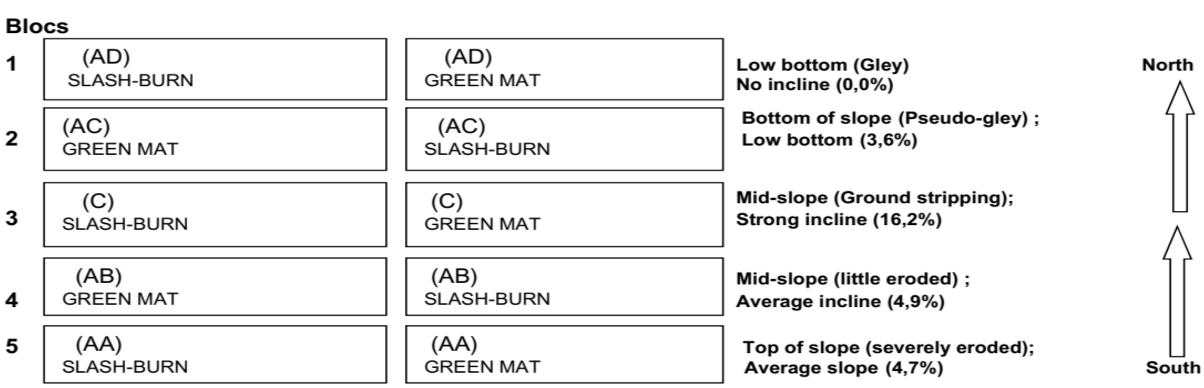

Fig. 1. Experimental device on the test on the strategic establishment and the refined evaluation of carbon stocks and sinks under agroforests of the agroforestry fallow-grassland type, faced to slash-and-burn cultivation.

Legend: AA, AB, AC, AD and C designate the different experimental blocks. The plots form blocks perpendicular to the slope, the latter facing from South to North. The factor "morpho-edaphic properties" varying from one block to another (position, slope) was not taken into account at this scale of analysis. ⇨ Direction of slope.

SHORT APPROACH

The operations necessary to carry out this study took place in the field, on the one hand, and in the soil analysis laboratory, on the other. It all started with the establishment of improved fallow to restore soil fertility.

Establishment of Agroforetry fallows-green manure Mucuna-Pennisetum

Fallow fields green manure with*Mucuna-Pennisetum* were intercroped between hedgerows of *Albizzia chinensis* previously established in 4mx2m, on each of the plots the Green Mat system. The first operation was slashing, carried out by clearing-stumping technic at ground levelwith a machete.Each plot was crossed by 8 lines of *Pennisetum purpureum*, the latter being established at spacing of 50 x 50cm, thus observing a holy space of 25 cm on either side. One line of *Mucuna pruriens* was then inserted, established in pockets (2 grains) arranged with a hoe every 100 cm.

Assessment of carbon stocks and sinks in agroecosystems

The established agroforestry fallow-grassland was managed alternately, every 6 months, with food crops. *P. purpureum* and *A. chinensis* formed a permanent "green mat", structured in crisscrossing hedges and observing alveolar spaces of 10m^2 intended to receive crops.These hedges were regularly trimmed during cultivation, providing an abundant and rich biomass intended to cover and permanently amend the soil, thus enriching it with organic matter (carbon). Anecosystemmulticriteria approach of C quantification was used.There was evaluation: (1) of the C of the organic soil layer formed under litter, (2) of the quadratic diameter characterizing the average tree of the stand, (3) of the volume and density of the wood for the different fractions of the average tree, (4) of various weight indices, (5) of the biomass of the herbaceous layer, (6) of that of litter and composts produced in situ, finally (7) the deduction of stocks and sinks of C for each ecological compartment and for the whole agro-forest.In general, organic C is obtained by volumetric determination, for soil compartments, and deduced from the phytomass (50% DM) for above-ground compartments (Lal, 2010; CIRAD, 2013).

Determination of the mycorrhizal potential of the soil in different sectors

A global operating mode, according to Vierheilig *et al.* (1998), served as our guide. Soybean served as a test crop because of its very pronounced mycotrophic character.

At the end of the microscopic observations related to the detection of mycorrhizae, a brief samary of the results related to decimal dilutions of the soil carrying or not mycorrhizal propagules was obtained. They were therefore noted positive (blue coloration of the tissues of the root invaded by structures of the fungus) or negative (all the tissues remaining transparent). Consulting the microbial abundance probability tables allowed us to estimate the most probable number of propagules per series of 4 decimal dilutions, then per gram of soil sampled.

Efficiency of mineral fertilization and rainwater recovery

The efficiency of mineral fertilization expresses the increase in yield induced by the use of one kilogram of the applied fertilizer. The rainwater recovery efficiency expressed in total biomass (DM) is thus the fraction of this production that can be obtained by the volume unit of the rainfall recorded on a seasonal or annual basis. This is most often referred to the average annual rainfall obtained over a period of 10 years.

Chemical characterization of the soil

The current analyzes used are: pH in water and in Kcl, total nitrogen, carbon and organic matter, cation exchange capacity, exchangeable bases (calcium, magnesium, potassium, sodium), total exchangeable acidity, exchangeable aluminum, organic phosphorus and assimilable phosphorus. These analyzes were carried out at the soil laboratory of the University of Ghent following the compilation of Pauwels *et al.* (1992).

Assessment of the nodulating potential of the soil under the agroecosystems

Nodulating potential is the ability of a soil colonized over time and space by legumes to fix, multiply and perpetuate bacteria of the rhizobium genus, naturally establishing a symbiotic relationship with them. It is assessed through the establishment in a nursery, on a substrate consisting of the soil under examination, of an appropriate legume, the production of nodules of which in the root system is then assessed. The evaluation was carried out according to the methods proposed by Martin and Lemanceau (2007).

Enumeration of aerobic microbial organisms.

Samples were taken from the topsoil (0–15cm) of the plots in the experimental area. In the laboratory, an aliquot of 5g was taken per sample and diluted in a flask containing 50g of peptone water. From the stock solution thus constituted, therefore representing the 1/10 dilution, decimal dilutions were made until 1 / 10,000 was obtained.

The actual count followed the operational path followed by Kazadi (2012). Thus, 1 ml of the last two dilutions was taken and introduced aseptically into a separate petri dish, in two repetitions. Supercooled nutrient agar cooled to 50°C was then poured aseptically into the petri dishes.

After homogenization and solidification, a final layer of agar was poured. Incubation took place at 30°C for 72 hours.

Statistical analyzes

The data collected on cards, in the various tests described below, were organized and processed first on Excel software sheets. The statistical processing which followed made use of Statgraphics software. The majority of parameters that have been studied in this device have recourse, in turn, to two-factor ANOVA, for the significance of the differences between treatments, coupled with the Duncan's test for their discrimination.

RESULTS AND DISCUSSION

Mycorrhizal potential, nodulating potential and density of microbial germs

The related data are illustrated in **Figures 3**, below.

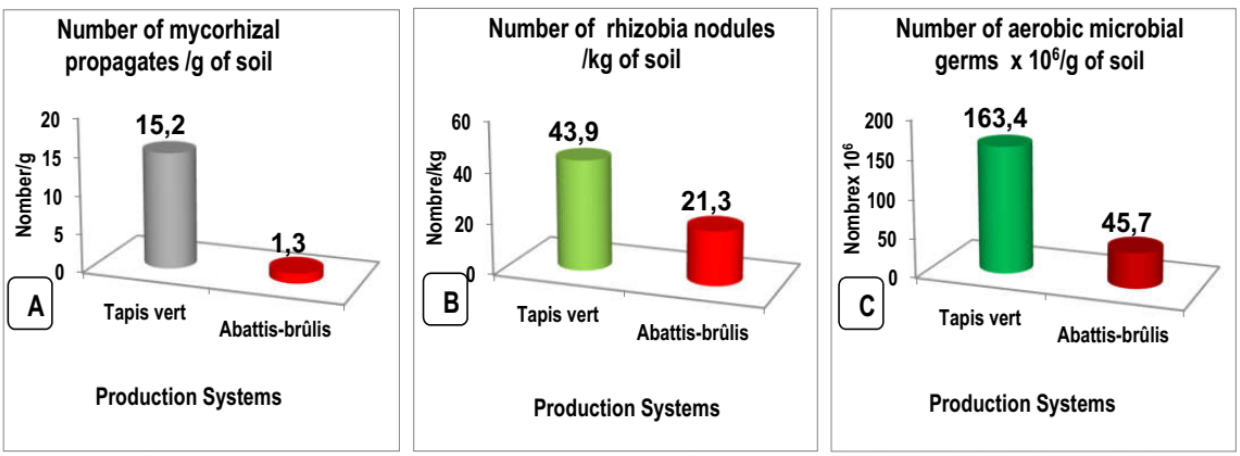

Fig. 3 (A, B, C). The mycorrhizogenic potential (A), the nodulating potential (B) and the density of aerobic microbial germs in the arable soil, opposing the systems of culture under green carpet and culture on slash and burn. PA = 0.0000; PB = 0.0000; PC = 0.0000.

It emerges from Figures. 3, comparing the Green Mat and Slash-and-burn systems that the density of Mycorrhizal propagules, rhizobial nodules and aerobic microbial germs is, respectively, 15.2 vs 1.3 /g, 43.9 vs 21.3 /kg and 163.4×10^6 vs 45.7×10^6 /g. Let the Green Mat system be superior ($p < 0.0001$) of the order of 11.7, 2.0 and 3.6 respectively.

Several performance factors have been mentioned by many authors. It was emphasized in particular:

1) the effect of zero tillage, high organic matter content and perennial hairy roots on mycorrhizal proliferation and biological activity (Carpenter-Boggs *et al,* 2003; Panuara and Tarafdar, 2006, Gu*et al,* 2020 ; Vázquez et al, 2020);

2) the effect of restoring micromorphology on degraded soils, correlated with very prospective grass rooting (Roldán *et al,* 2007; Wang *et al,* 2010) and straw incorporation which alters soil organic C and N (Liu*et al,* 2021) ;

3) the exceptional agroecological productivity of tropical regions which gives microorganisms (VAM) the role of nutrient reservoir and indicator of soil quality (Traoré *et al,* 2007; Johson and Guerring, 2007; CIRAD, 2013) and the response of rhizosphere soil, enzyme activities and microbial diversity to intercropping patterns (Gong *et al,* 2020);

4) the effect of the strategic pre-establishment of highly mycotrophic crops, such as soybean or Mucuna, which substantially increase the mycorrhizogenic potential of the soil (Panja and Chaudhuri, 2004 ; Mayer et al, 2019);

5) the effect of cropping practices such as mulching of crop residues, cereal-legume rotations as well as a considerable rate of metal sesquioxides in the soil, which increase the abundance and diversity of soil fungi through their effect on micro aggregation (Plenchette *et al,* 2005; Wang *et al,* 2010 ; Essel *et al,* 2019 ; Zheng *et al,* 2020);

6) the genetic diversity and the legendary multifunctionality of VAMs which give them the greatest ability to face the most diverse stressful situations, including acidity, soil sealing by compaction and water deficit (Miransari *et al,* 2009).
7) Effects associated with the biogeochemical cycle of agriculture under permanent plant cover on bio-edaphic agents (Álvaro-Fuentes *et al,* 2012; Douglas *et al,* 2013; Munkholm *et al,* 2013; Nascente *et al,* 2013 ; Dekemati *et al,* 2019).
8) subsoil and deep Tillage having stronger effect on AM fungal community than residue retention (Gu*et al,* 2020)and manure or poultry litter applications which stimulate glomalin, extraradicular mycelium production, and aggregation in the soil (Bertagnoli *et al,* 2020).

Net carbon sequestration in agroecosystems

The related data are illustrated in **Figures 4**, below.

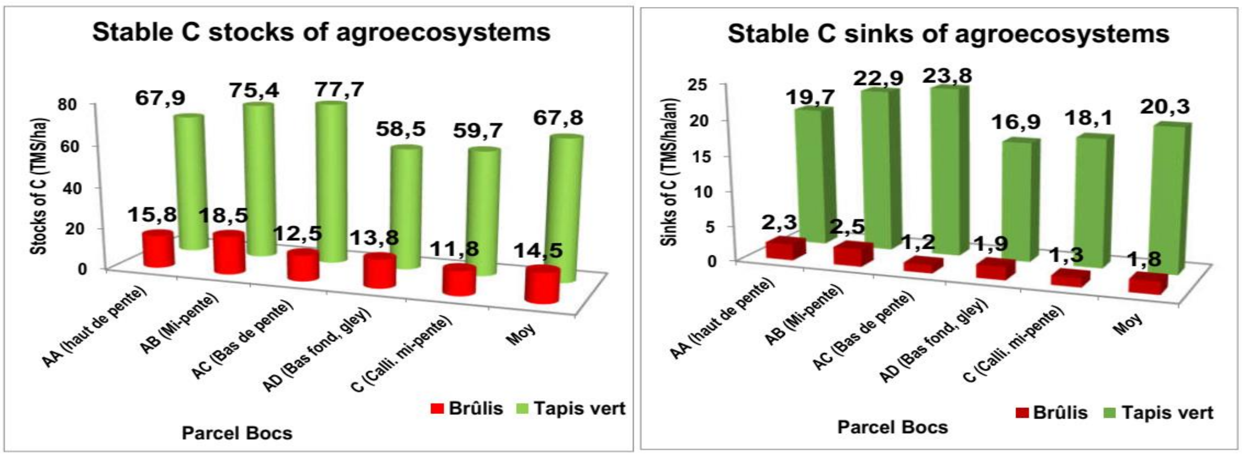

Fig. 4 (A, B): Stable carbon stocks (t / ha) and sinks (t / ha / year) for the Green Carpet and Slash-and-burn systems over the entire landscape. The stable C is obtained by multiplying the organic C freshly incorporated into the soil by 1/3 which is the humified fraction, according to CIRAD (2013), and the C of trees by 2/3 (live wood remaining after treatment forestry and pruning operations under cultivation). PA = 0.0000; PB = 0.000

From the analysis of the data in Figures 4A and 4B, it emerges that the stable carbon stocks of agroecosystems in the biotic and abiotic parts embracing the aerial sphere and the underground sphere up to 30 cm deep range from 11.8 to 18.5 t/ha for the Slash-and-burn system and from 58.5 to 77.7 t/ha for the ATV system. The improvement is 5.4 times (p <0.0001) in terms of stocks (67.8 vs 14.5 t/ha) and 11.3 times (p <0.0001) in terms of sinks (20.3 vs 1.8 t /ha/year), thereby strengthening ecological and social resilience.

Albrecht and Kandji (2004), who worked in peasant agro-forestry systems in western Kenya, estimated, for the entire soil-vegetation system, a sequestration of C ranging from 12 to 228 t DM /ha, margin including the results observed by Swamy *et al.* (2003) and Oelberman *et al.* (2004).

This is in line with our results, namely 58 - 77 t / ha, for a soil-plant system embracing 30cm of surface soil, more specifically an 18-month-old agroforest.It is by creating agricultural carbon sinks that it will tomorrow be possible to produce more, better, with less inputs, while developing biodiversity (IAD, 2011 ; Zhou et al, 2020).

A biomass evaluation carried out in Tanzania by Kamara and Maghembe (2003) on agro-forestry legumes, 28 months after planting, reports a stock of C for the aerial parts ranging from 8.5 to 29 t. This also matches our results, namely 11 to 20 t C /ha.
Several performance factors can be mentioned for these results.

Firstly, crop-livestock integration systems have the advantage of permanently including "leguminous-perennial grasses" combinations suitable for the synthesis of root organic matter, forming very effective erosion barriers as silt and nitrate traps (Ding*et al,* 2012). Futhermore, the nitrogen balance established and the intense activity of the root systems confers a higher potential for mineral recycling and C sequestration. Mycorrhizal fungi find there an ideal proliferation medium allowing them to establish highly efficient symbiotic associations (González-Chávez *et al,* 2010; Curaqueo *et al,* 2012; Owens *et al,* 2012; Davinic *et al,*2013).

Secondly, the maintenance of high carbon levels in the soil of the Brazilian Cerrado, up to 30 years after cultivation, is attributed to the high clay content of the soil and the high proportion of Fe and Al sesquioxides, conditions observed in this context, which form with humus organomineral-type conglomerates, therefore constituting more stable C sinks (Churchman *et al.,* 2010 ; Peltre, 2010; Wright and Conceição *et al.,* 2013; Lenka and Lal, 2013);

Thirdly, many factors including the type of soil, the climate, the history of the cultivation of the land, the topography, the positioning on the watershed and the management methods largely influence the C sequestration process (Olson *et al,* 2005). We will underline, in this case, the highest influence of agroecosystem management factors, which also explains the high productivity of the Green Mat cropping system.

Finally, according to Séguy *et al.* (2002), "the highest resultenregistrefor the annual sequestration (sink) of C in the soil are the opposite of what predicted knowledge on the process of carbon mineralization-accumulation: from 0.1 to 0.3 t C /ha/year in France, but from 0.8 to 3.4 t C /ha/year and from 1.8 to 3.0 t C /ha/year in ferralitic soils in a humid tropical climate, respectively in Brazil and Madagascar.

”It is up to them to conclude:“ it is the humid tropics which express the highest sequestration capacity, whereas, paradoxically, it is the place where the mineralization of organic matter is the most active! ".

Efficiency of organomineral fertilization and rain recovery

The data relating thereto are illustrated in **figures. 5 and 6**, below.

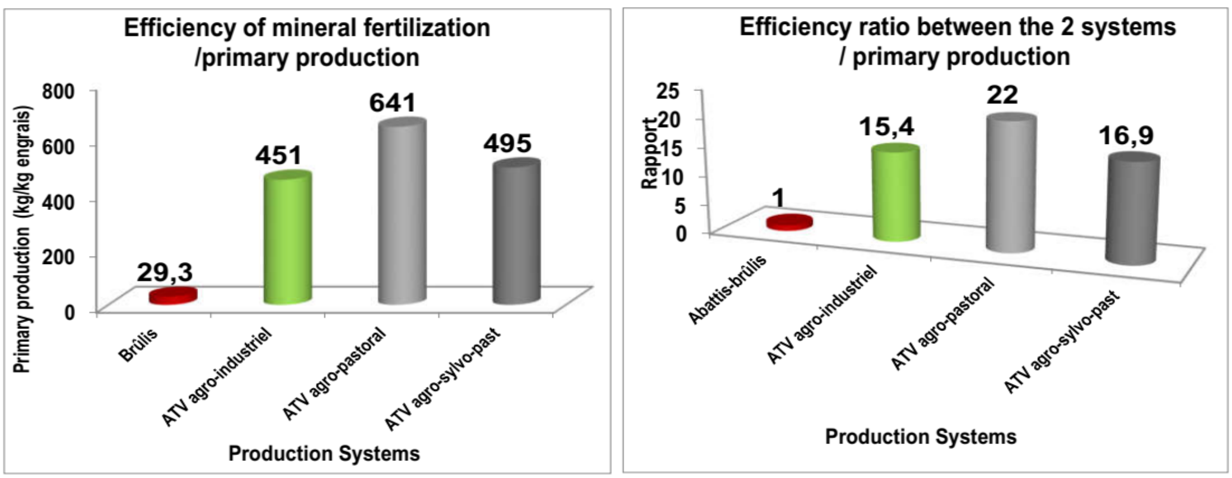

Fig 5. Efficiency of mineral fertilization (production generated by 1kg of fertilizer) focused on overall production including crop residues (A) and efficiency ratio between the 2 systems (B). The statistical probability: PA = 0.0000; PB = 0.0000.

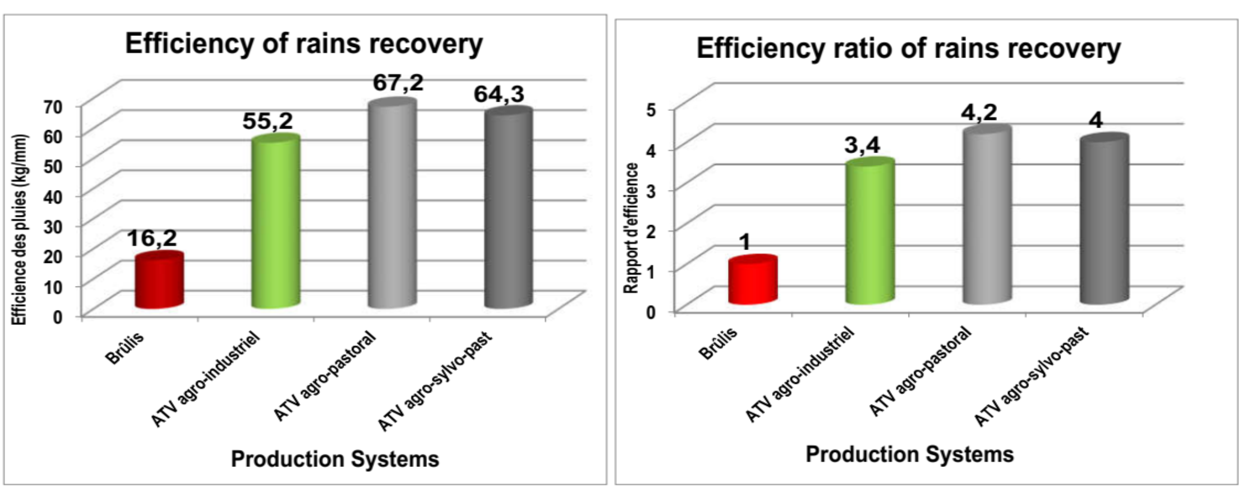

Fig. 6: Efficiency (A) and efficiency ratio (B) to the recovery of rainwater, for the system of cultivation on plates under green carpet versus the system of slash-and-burn cultivation, based on the overall production including crop residues (phytomass).

From the analysis of the data in Figures 5A and 5B, it appears that the efficiency of mineral fertilization, in kg of overall dry production /kg of mineral fertilizer, is 29.3, 451, 641 and 495; or an efficiency ratio of 1, 15, 17 and 22, respectively for slash-and-burn cultivation and green mat cultivation in its three variants.

We note, with the use of the Green Mat system, an improvement in the efficiency of rainwater recovery by 4 times (62.2 vs 16.2 kgMS / mm rain) and in the efficiency of fertilizer recovery by 18 times (529 vs 29.3 kgMS / kg of fertilizer). The crops and meadows managed in zero tillage report very high efficiency in the use of fertilizers, which is conferred by their high rooting density. Grifith in Whyte (1959) reports a root extraction of nitrates 40 times more efficient under *Pennisetum purpureum* than under spontaneous fallow.

Mulching with straw from previously established local grasses has succeeded, according to the proliferation of soil flora / fauna, doubling the efficiency of rain recovery in Burkina Faso (Strosnijder, 2009). A trial on the previous wheat crop in a semi-arid zone, conducted by Cayci *et al.* (2009) was able to establish a stormwater efficiency of around 10 kg/mm. A maximum of 15 kg/mm has been recorded under the same conditions in China (Wang *et al,* 2007). With 62 kg of DM /mm, the efficiency of rain recovery is 4 times greater than in the best agrosystems of the semi-arid environment, however reputed to be economical.

Competitive agriculture can only emerge as a result of the synergistic integration between a whole panoply of ecosystem factors (Reicosky and Wiltz, 2005). This would make it possible to develop a range of economic opportunities that are sorely lacking with the usual export monocultures (Charlton, 2002).

Also, integrated and balanced management strategies from agroecological and socio-economic points of view, capable of sustaining permanent mineral recycling, must be found as an alternative to the use of fertilizers, chemical pesticides and calcium amendments in tropical agroecosystems (Melero *et al,* 2012; Calegari *et al,* 2013).

Thus, in a trial carried out in Mexico on a corn farm using fallow land with Mucuna pruriens, Ortiz-Ceballos *et al.* (2007) found a clear synergy in the increase in yields between *Mucuna pruriens* and Balanteodrilus pearsei, a common earthworm in the environment. In particular, it was noted that the system has improved fertility parameters and allows, under manual farming conditions, to dispense somewhat with irrigation, plowing, nitrogen fertilizers and chemical herbicides; which makes it more competitive (Dube *et al,* 2012)!

In addition, the use of live mulch increases the intensity of microbiological and biochemical processes allowing to "sustain" production at a lower cost (Erenstein *et al,* 2008). Thus, soil invertebrates are essential and can serve as bioindicators agrosystem productivity (Douglas *et al,* 2011; Lou *et al*, 2011; Niemeyer *et al,* 2012).

CONCLUSION

From comparison of the "Green Mat" (ATV) and Slash-and-burn systems, it emerges overall that:

- ✓ the density of mycorrhizal propagules, rhizobial nodules and aerobic microbial germs is, respectively, 15.2 vs 1.3 /g, 43.9 vs 21.3 /kg and 163.4×10^6 vs 45.7×10^6 /g. That is, an "Green Mat" system superiority of 11.7, 2.0 and 3.6 times respectively;
- ✓ the stable carbon stocks of agroecosystems in the biotic and abiotic parts compren ing the aerial sphere and the underground sphere up to 30 cm deep range from 11.8 to 18.5 t /ha for the Slash-and-burn system and from 58.5 to 77.7 t /ha for the "Green Mat" system. That is, an improvement of 5.4 times in terms of stocks (67.8 vs 14.5 t /ha) and 11.3 times in terms of sinks (20.3 vs 1.8 t /ha/year);
- ✓ the use of "Green Mat" system implies an improvement by 4 times for the efficiency of rain recovery(62.2 vs16.2 kgMS /mm rain) and by 18 times for the efficiency of fertilizer recovery (529 vs 29.3 kgMS /kg NPK).

There is therefore a considerable improvement both in the mycorrhizal potential and in the agroecosystem's carbon stock and sink. This places "Green Mat" system among the most efficient technologies of Conservation Agriculture (Agroecology) and thus strengthens ecological and social resilience.

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