REPUBLIQUE DU SENEGAL

Un Peuple - Un But - Une Foi

MINISTERE DE L'ENVIRONNEMENT ET DU DEVELOPPEMENT DURABLE

DIRECTION DE L'ENVIRONNEMENT ET DES ETABISSEMENTS CLASSES

50th session of Subsidiary Bodies -UNFCCC
Koronivia Joint Work on Agriculture workshop on topic 2.c
18 June 2019

Improving soil carbon, soil health and soil fertility under grassland and cropland as well as integrated systems, including water management : Country experiences Senegal

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OUTLINES

- Introduction
- Fertility management systems under cropland and grassland
- Framework and policy to resolve land degradation and fertility losses
- Issue related to soil carbon monitoring : approaches and methods
- Conclusion and recommandations for effective action on the fields

Introduction

Africa has a diverse range of soils and land use systems. But very large [land] areas, particularly in West Africa, are infertile or of low fertility (FAO and ITPS, 2015).

Soil organic matter (SOM) is :

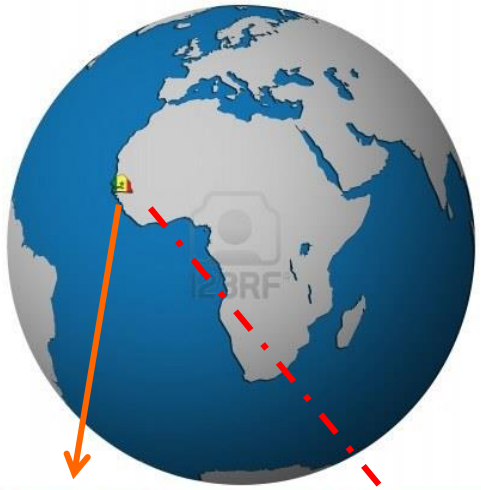
- a core indicator of the sustainability of cropping systems in semi arid-sub-humid tropics;
- key component of soil health: positively affect availability of soil micronutrients, structure, water retention;
- mainly bounds together sand, silt and clay particles to form clumps or aggregates : aeration, roots, infiltrat.

Role of OM will depend on two parameters : - critical threshold values for SOM and – the quolity of OM (N, polyphenol) that could interfere with microbial processes that release soils assimilable nutrients for crops.

The substrate properties (levels of clay and silts)**, pH and soil levels in exchangeable bases**, especially potassium and calcium, due to **erosion and leaching**, **[biomass] removal** and predictable soil a**cidification** (Serpantié et Ouattara, 2000), are also other indicators important to appreciate soil fertility and health.

OM content is generally less than 1% in the leached soils of the Central Plateau of Burkina Faso. Senegal, OM levels in kaolinite clay sandy soils are low *(Duponnois, 2012),* **0,20% in the peanut basin** (INP, 2012).

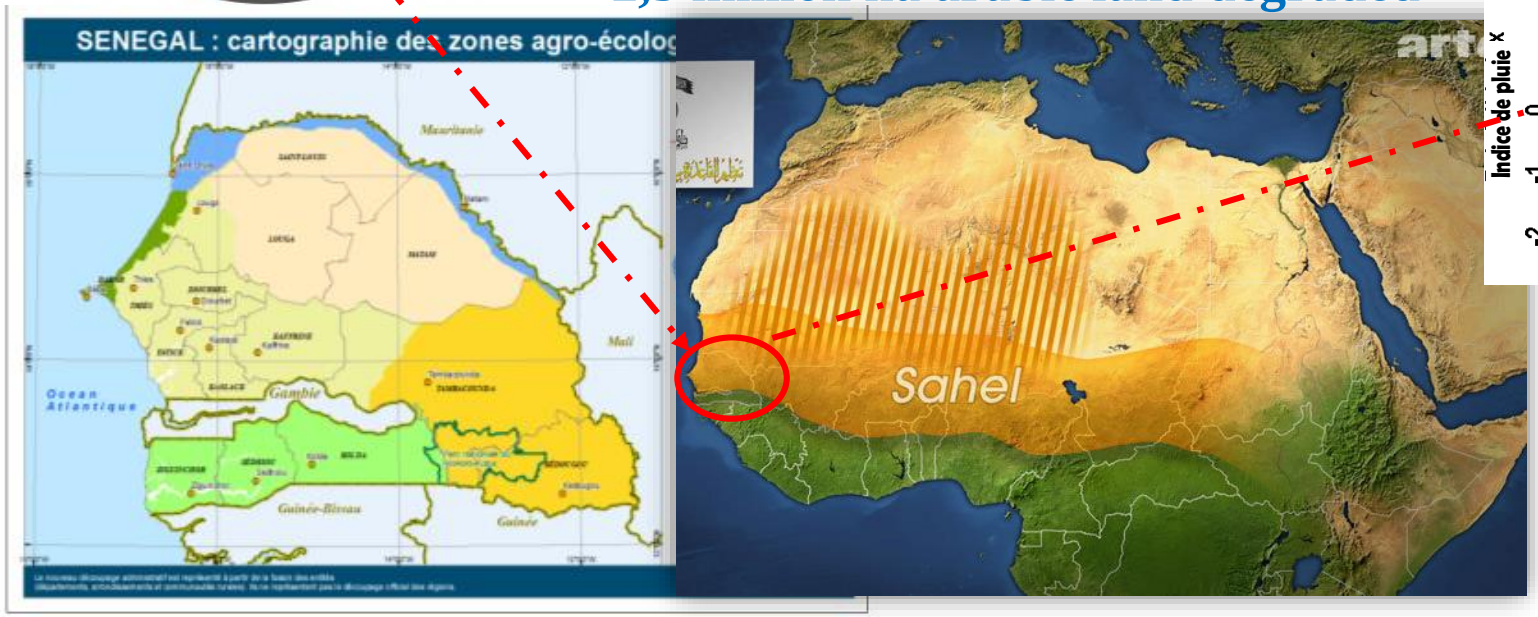
SENEGAL

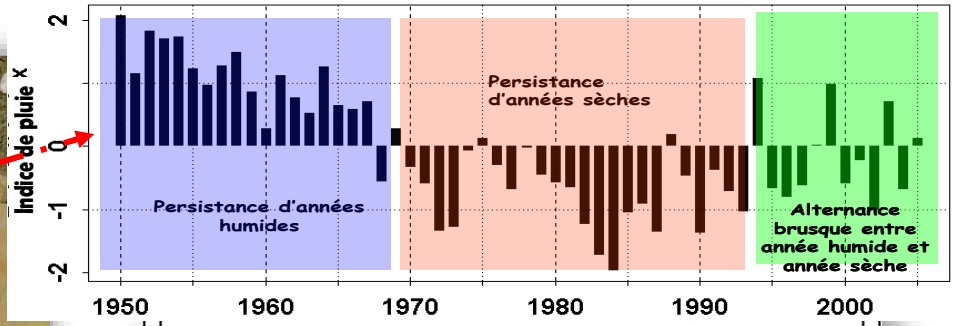


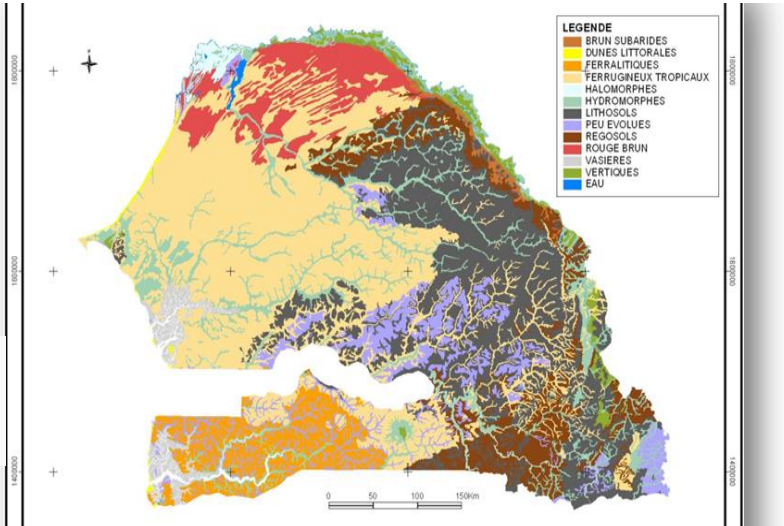
- Area : 196 712 Km2
- Population : 13 508 715 hbts (2013)
- Agriculture **60% of the population**
- **70% of small size farms (1 - 5 ha)**
- Arable land : 3,8 million ha
- **2,5 million ha arable land degraded**

A sahelian country (semi dry)

- Rainy season : June to October
- Dry season : Novemb. to May
- Climat : 16°C to > 40°C;
- Rainfalls : <300 mm to > 1000 mm







Arable land are degrad., low OM content, low fertility. Dry and sandy soils (north), tropical ferrigenous soils (middle), lateritic soils (south) CSE, 2018

Integrated soil fertility management is the backborn of smallholder farming systems

Int systems

Trees

c. residus

Manure

Grassland

Trees grass

Manure

Cropland

Crop residus

Manure

4 main cropland fertility management systems

Long natural fallows

Rotation with legums

Crops-livestock asso.

Org. amendments

Soil orga. matter

Soil bio. functions

Carbon

Fertility

N P Mg CEC K C/N

Health

RANGE OF DEGRADATION ON ARABLE LAND BY AGROECOLOGICAL ZONE (HA)

2,5 million hectare of arable land are degradated, of a potential of 3,8 million ha.

Causes : Monoculture, Straw removal, Tree cover decrease, Residus burning ➡ Erosion, Salinization

Type of degradation	Casamance	Eastern Senegal	Peanut basin	Sylv. Past. zone	Senegal riv. valley	Niayes	National
Salinization	300 000	100 000	200 000	-	40 000	5 000	645 000
Water Erosion	300 000	150 000	900 000	30 000	100 000	30 000	1 510 000
Wind Erosion	20 000	15 000	50 000	90 000	100 000	12 000	287 000
Total	**620 000**	**265 000**	**1 150 000**	**120 000**	**240 000**	**47000**	**2 442 000**

Source : INP, 2013

Challenge : 65,8 % of arable land to be restored for meeting SDGs, UNCCD, NDC

Government is commited to resolve sustainably the issue of fertility loss in cropland and grassland. Specialised institution + deep diagnostic + synergies

National Pedology Institute-INP (..2004) + Dir. water, forest… soil conservation.

❑ National framework for strategic investment on sustainable land management (CNIS-GDT)



❑ **SLM INTEGRATED FUNDING STRATEGY**

- SLM as PSE component

- **Agroforestry** : assisted natural regeneration + legumes parklands, hedges
- **Pastoral units** : protected grazing areas, improved pasture lands
- **Woody stone bunds - Night paddock (in farms – 0,1 to 5 t/ha/yr)**
- **Composting, organic matter, Ramial chipped wood (RCW)**
- **Other water and soil conservation sytems : zai**
- **Crop rotation with or wthout Fallow -GREAT GREEN WALL**

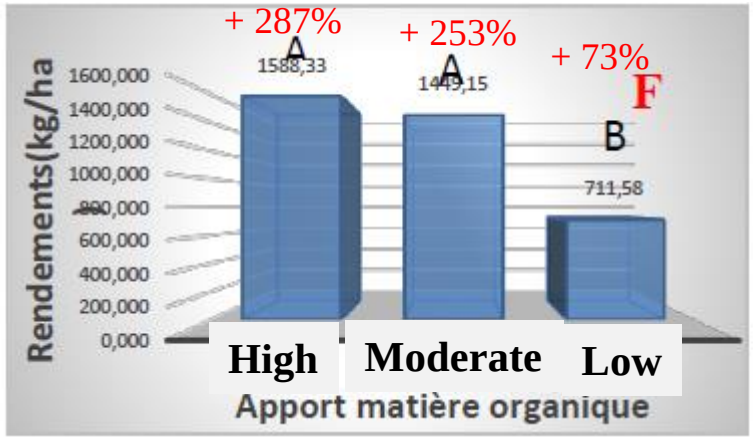
Many actions implementing on the ground, few of them measuring SOC and soil fertility dynamics. SERVEY (low cost) Vs SOIL ANALYSES (high cost)

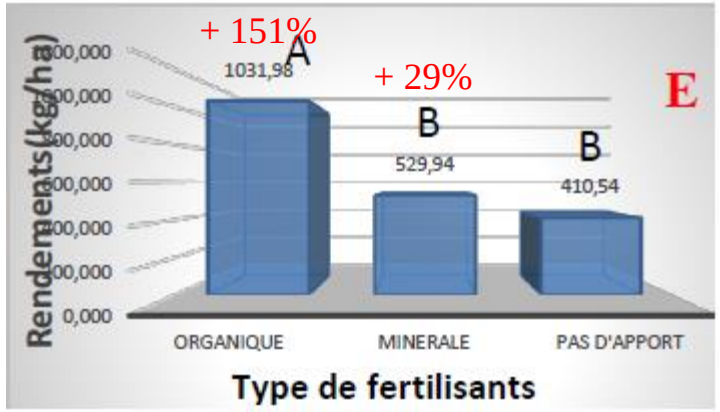
enda pronat

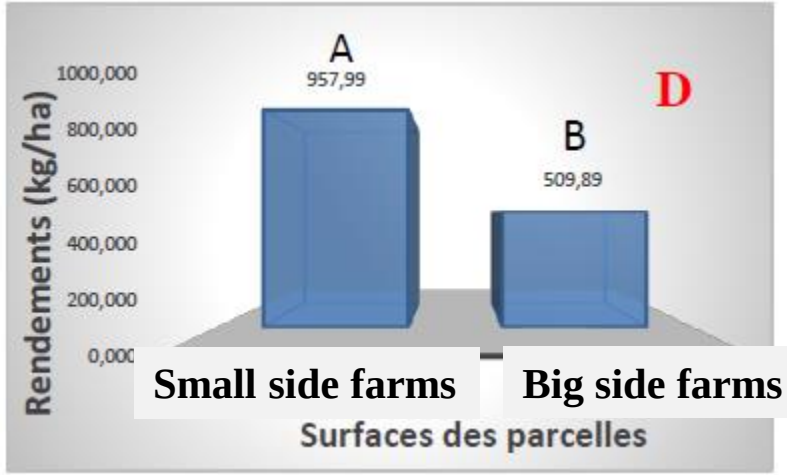
84 samples
2 800 USD
lab. analys.

Paramètres	2015	2017
PH eau 1/ 2,5	6,077 b	6,808 a
CE 1/ 10 µs/Cm	22,615 b	169,423 a
% C	021,7 b	046,6 a
MO %	037,4 b	080,3 a
C/N	10,965 b	11,6 a
Ca meq /100g	2,339 a	1,529 b
Mg meq/100g	0,932 a	0,632 b
Na meq/100g	0,656 a	0,103 b
K meq/100g	2,185 a	0,008 b
N %	0,02 b	0,04 a
CEC meq/100g	18,923	20,00

Source DIOGO N. M. (2018)

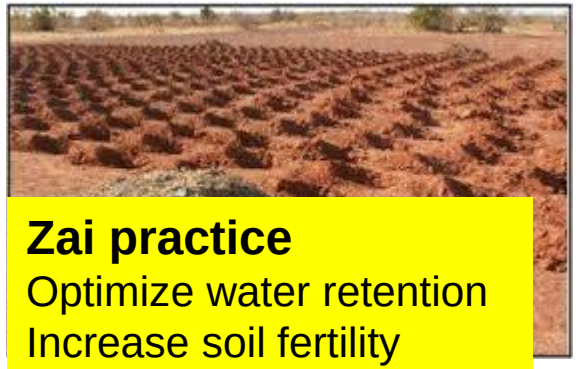






SLM project 20 066 ha : OM ranges from 1,82% to 2,29%, soil biological functions improv. (C/N=10-13)

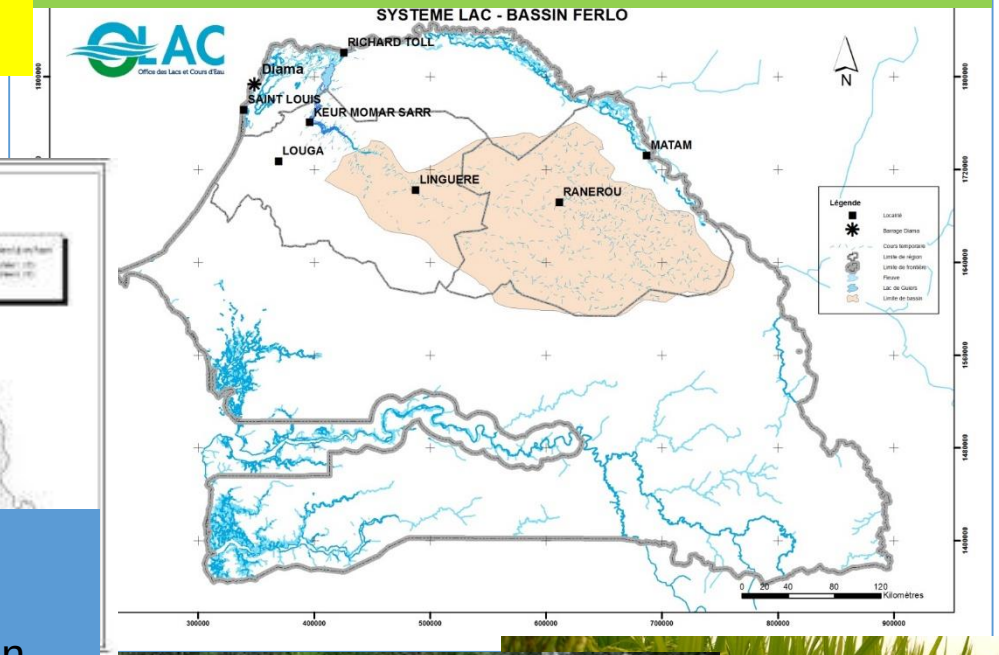
Surface water resources management (mapping – planning - monitoring)
Control and valorization of runoff water in both watersheds and cropland

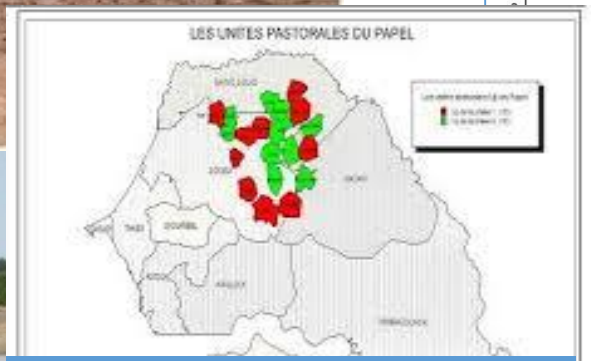


Zai practice
Optimize water retention
Increase soil fertility

Stone bunds
Water infiltration
Stops water erosion
Reduce fertility loss

Revitalization of the fossil valleys project





Pastoral units
Best control of biomass
Reduce land degradation

Water retention basins and ponds
Keep livestock around fields + reduce runoffs

Small scale irrigation programme

A country-wide Soil fertility and carbon monitoring is high budget implication

Global soil stock 680 PgC at first 30 cm (FAO and ITPS, 2018). Determining how these carbon stocks change and what are the main drivers of these changes is crucial for local, national and global mitigation stocktaking.

Conventional labor. analyses of soil properties are expensive, processing time requires intensive labour to generate neces. data. ***Detailled information on soils with LOW COST and time-effective tools, is a challenge***.

A promising method in the estimation of SOC changes is modelling. **RothC** model (Coleman and Jenkinson, 2005) and **CENTURY** (Parton et al., 2004) one of the soil organic carbon models employed most to predict soil carbon dynamics, in Senegal.

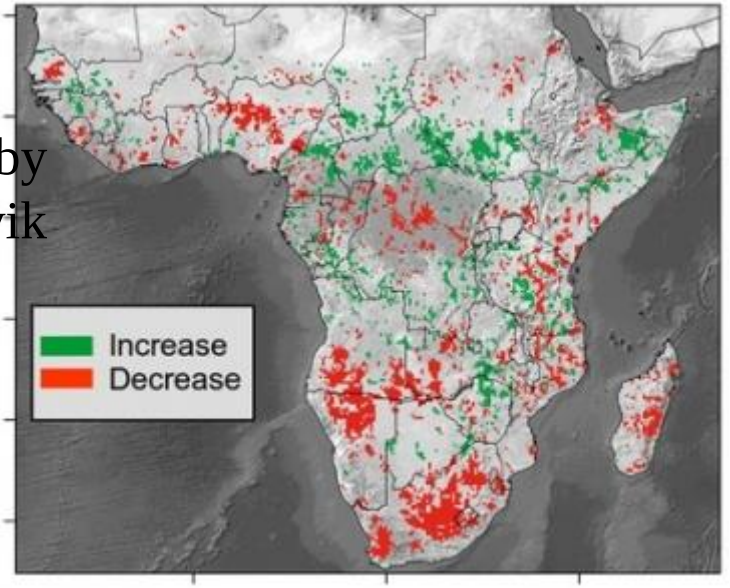
NEW AND INNOVATIVE TOOLS

Near Infrared Spectroscopy (NIRS) : promising tool to quantify C storage by improving systems and also to understand mechanisms of sequestration (Mevik and Wherens, 2007). It predicts various soil properties, including SOC.

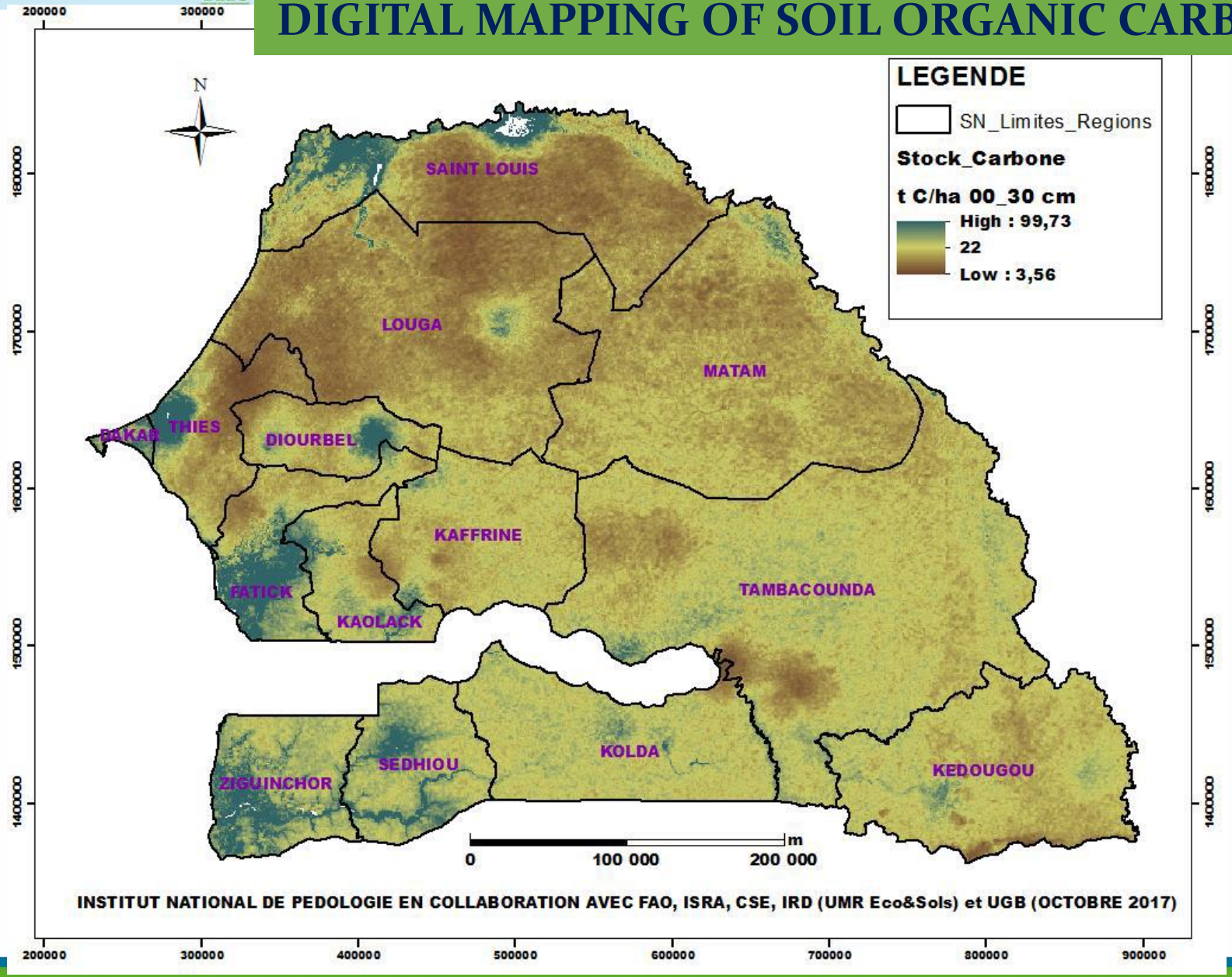
TropicCfarm tool (Rakotovoa et al, 2017) : C balance in farm, program.;

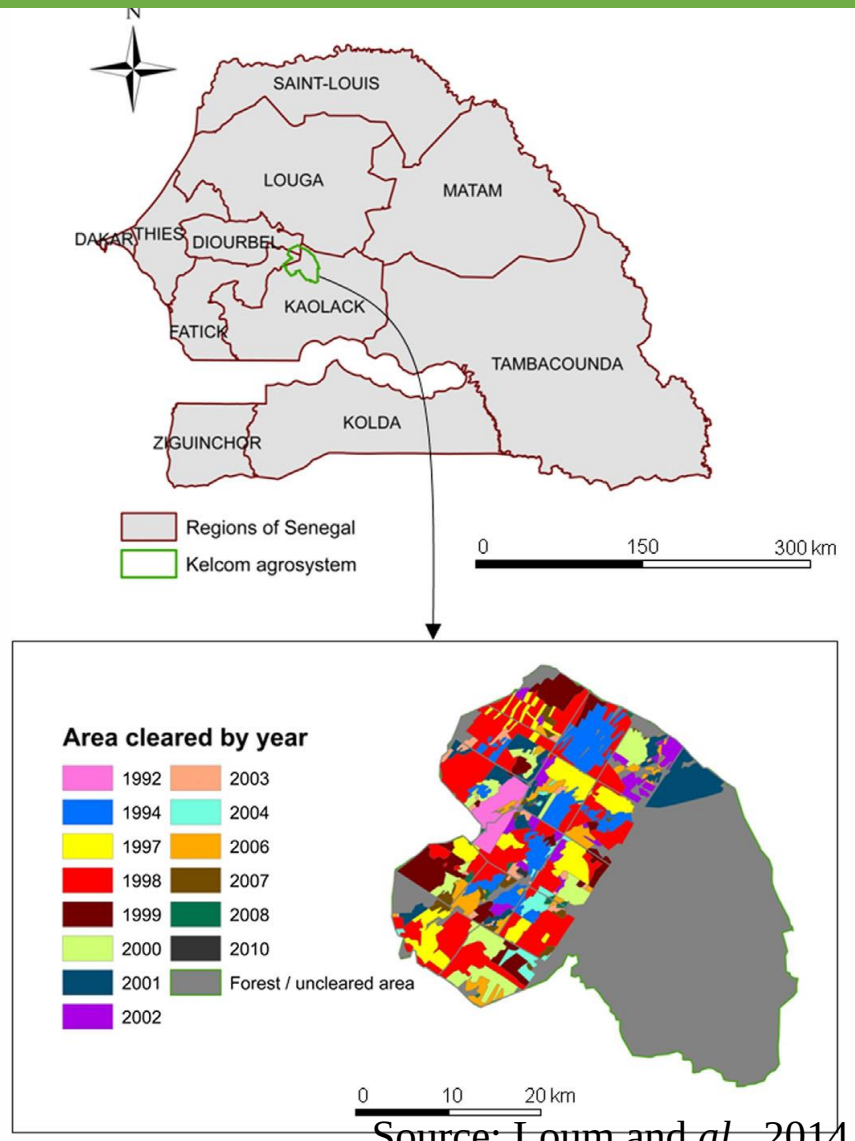
EX-ACT tool (FAO, 2013) : C balance for programmes,…SOC.

…



DIGITAL MAPPING OF SOIL ORGANIC CARBON STOCKS (0-30 CM DEEPTH)





Source: Loum and *al.*, 2014

➢ CENTURY model: to estimate the carbon sequestration potential in Senegal arable soil (Tschakert & al., 2004)

Loss of -8,8 t C ha-1 (2002-2050)

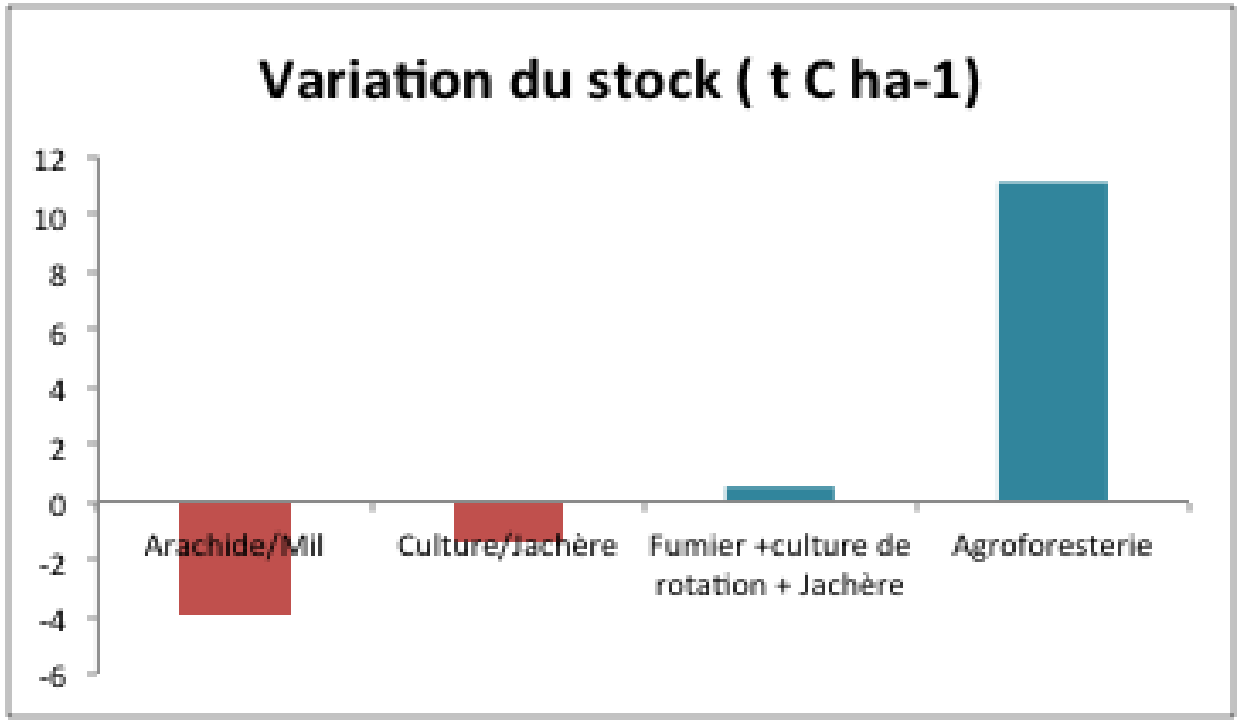
Rotation Millet-peanut

+14,9 t C ha-1 (2002 et 2050)

Faidherbia albida + millet

➢ **CENTURY model (Parton et al., (1993) applied in the Groundnut Basin by Tschakert et al., (2004)**

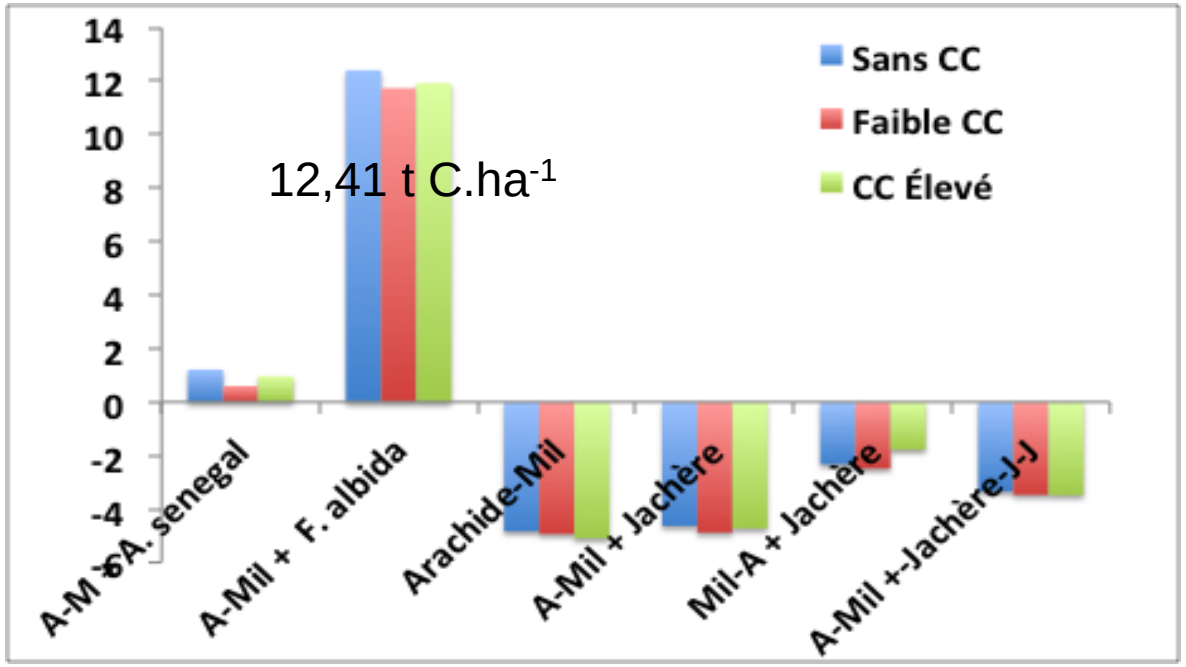
Large exportation of crop residues from cultivated fields and lack of fertilizer use are recognized as major management factors leading to soil fertility loss (Bationo et al., 2006; Lal, 2000).



RothC *model : to estimate the carbon sequestration potential in Senegal arable soil (*Loum *et al.*, 2014)

Faidherbia albida + Millet

Tropical ferruginous soil
0-35 cm deepth
20 years



Rotation Millet-peanut

Tropical ferruginous soil
0-35 cm deepth
20 years

Rotations with *Acacia* increased SOC stocks by 0.5 to 2.9 t C/ha by 2080.

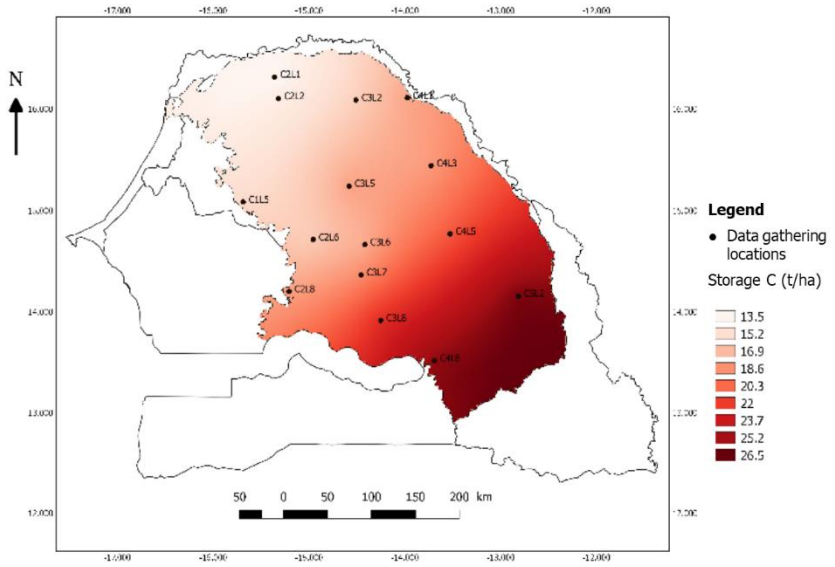
Rotations with *Faidherbia* lead to higher C stocks soil

Mitigation using groforestry = SOC + aboveground biomass carbon

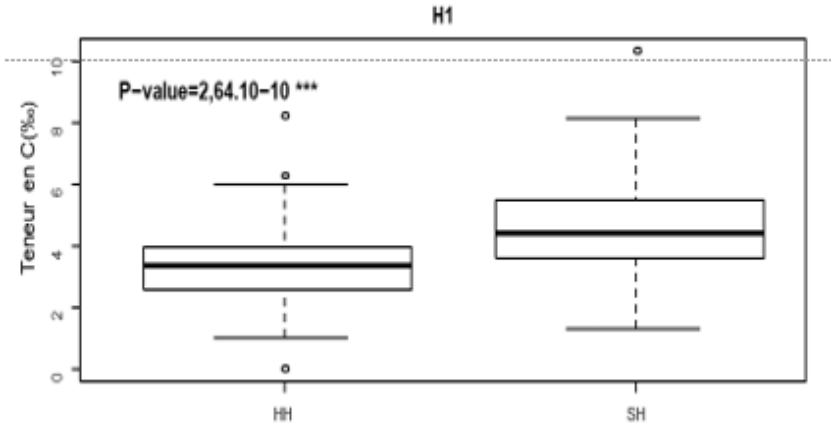
Done- Master thesis of Ange N'Goran

4th World Congress on Agroforestry

Carbon stocks (0-30cm deepth) in these sandy soils varied from
9.29 to 29.72 t.ha^{-1}



Mapping of the control sites and C stock interpolation in the sylvopastoral zone of Senegal



Difference between under (SH) and outside (HH) tree crown content of C at 0-10 cm deep

Tree effect on C stocks

Centre de Suivi Ecologique · Institut de Recherch pour le Développemen FRANCE · Laboratoire Mixte International iesol Intensification Ecologique des Sols Cultivés en Afrique de l'Ouest · SELMET · CERAAS Centre d'étude régional pour l'amélioration de l'adaptation à la sécheresse · DAAD Deutscher Akademischer Austauschdienst German Academic Exchange Service · ISRA · cirad AGRICULTURAL RESEARCH FOR DEVELOPMENT

➢ On Progress - PhD of Adama Tounkara, (ANR Cerao)

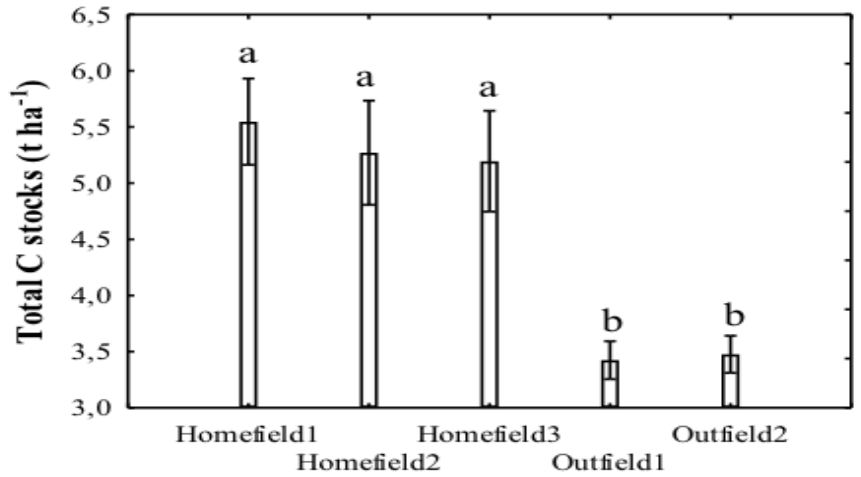
Carbon storage and millet yield on farmers plots in Niakhar

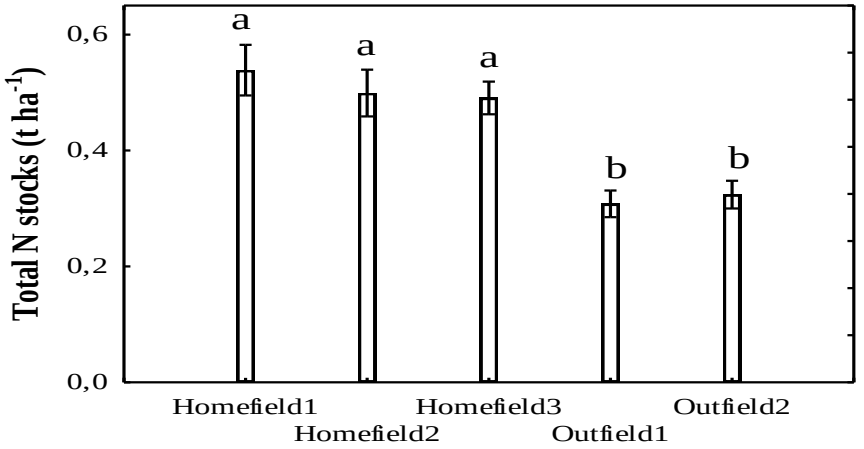
Studied Factor	Organic matter management (dose, method of application, and frequency)	Rotation crop	Number of fields
Cropping system type			
Homefield1	5-8 t ha^{-1}/2years	Millet/Millet	3
Homefield2	10-15 t ha^{-1}/2years	Millet/Millet	5
Homefield3	18-20 t ha^{-1}/2years	Millet/Millet	3
Outfield1	No manure	Millet/Peanut/fallow	4
Outfield2	No manure	Millet/Millet	4

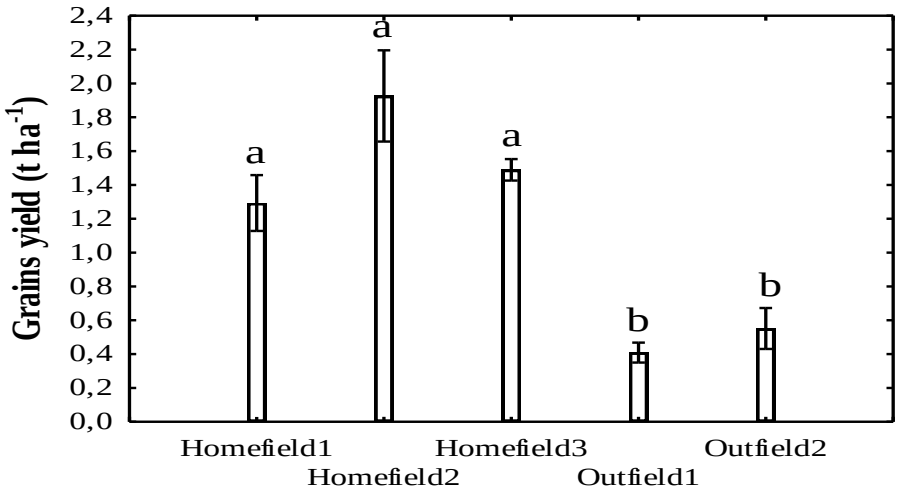
➢ On Progress - PhD of A. Tounkara, (ANR Cerao)

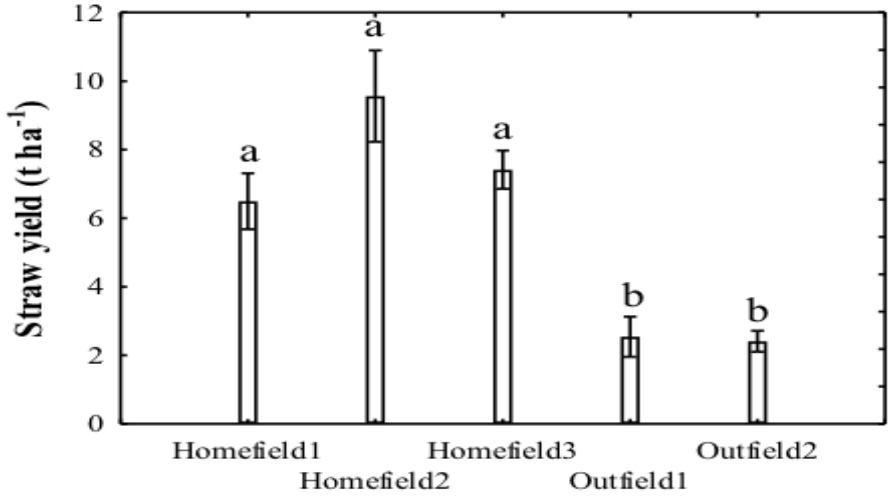
Laboratoire Mixte International iesol Intensification Ecologique des Sols Cultivés en Afrique de l'Ouest

Carbon storage and millet yield on farmers plots in Niakhar









Conclusion and Suggestions

Lessons learned

- Various OM management systems lead to various soil fertility and soil C stocks
- Tradeoff between soil carbon storage and soil fertility (soil productivity)
- Biomass is main source of C inputs into soil, land degradation is a factor of loss.
- Analyse soil properties in laboratories is high cost and challenging for DCS.
- Setting up low cost & accurate tools for a best monitoring and reporting C flux

Suggestions to UNFCCC bodies

1. **Support unlocking soil mitigation potential** :
   - **Enabling c. for funds access : GCF, NAMA**
2. **Sup. integrated watersheds management and soil fertility under agro-sylvo-pastoral areas**
3. **Improve soil carbon and fertility assessment**
   1. Diagnostic of existing SOC assessment tools
   2. Harmonizing SOC character. tools/approach
   3. Facilitating field scale applicable modeling
   4. Research, Capacity building, Networking
4. **Ecosystem based SOC and fertility management**

Thanks for your attention!

ACKNOWLEGMENTS

We would like to express our gratitude to all researchers who express an appreciable commitment by sharing informations and documents to support this presentation. IOSOL Lab, ISRA, IRD, CIRAD, INP, ENDA Pronat

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Made by Senegal agriculture negociators team.

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Institutions	Period	Work areas
IRD (Research)	1965 to 1990	**Soils mapping**
BPS (Research)	1990 - 1999	**Soils mapping**
SAED (Development)	1997 - 2005	**Soils characterization**
SENAGROSOL	1987 - 2005	Land development planning, Degradation and fertility
INP (Soils management)	2006 - 2013	**Soils characterization** Degradation and fertility

From 1965 to 2013 : more than 109 studies on Senegal soils (CSE, 2018)