PRECISION AGRICULTURE IN SENEGAL

WEST AFRICAN FORUM ON PRECISION AGRICULTURE

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Ghana, February 11th to 12th 2020

PRECISION AGRICULTURE IN SENEGAL

outline

I. Introduction

II. Technologies

III. Cases Studies

IV. Perspectives

Introduction

INTRODUCTION

- In Senegal, agriculture is the key sector of the economy
  - ✓ Up to 8% to the country's GDP (DAPSA, 2014)
  - ✓ Job creation
  - ✓ food security

For several decades, Senegalese agriculture has faced biotic and abiotic stresses which have given rise to several research topics

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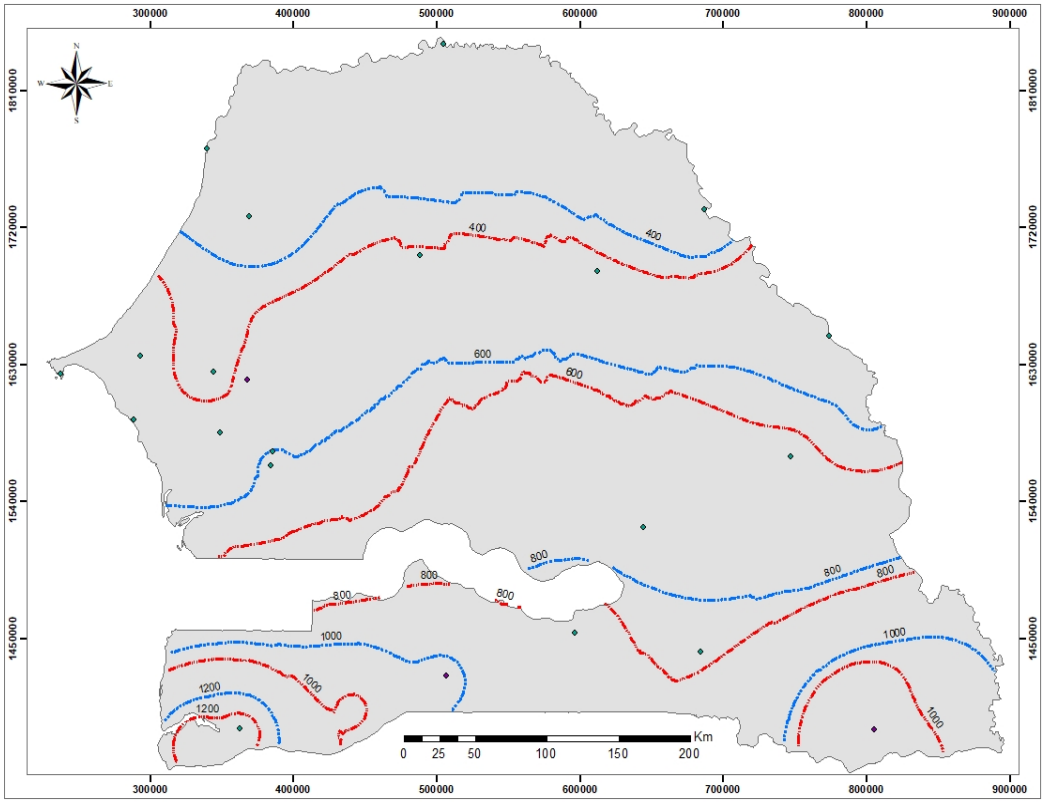
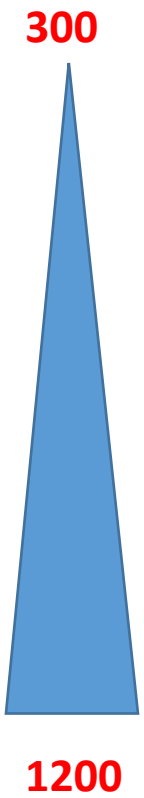
- The country is part of the Sahelian zone which is identified as the most vulnerable to the impacts of climate change (IPCC, 2007).



Map of isohyets to showing spatial variability



North-South rainfall gradient

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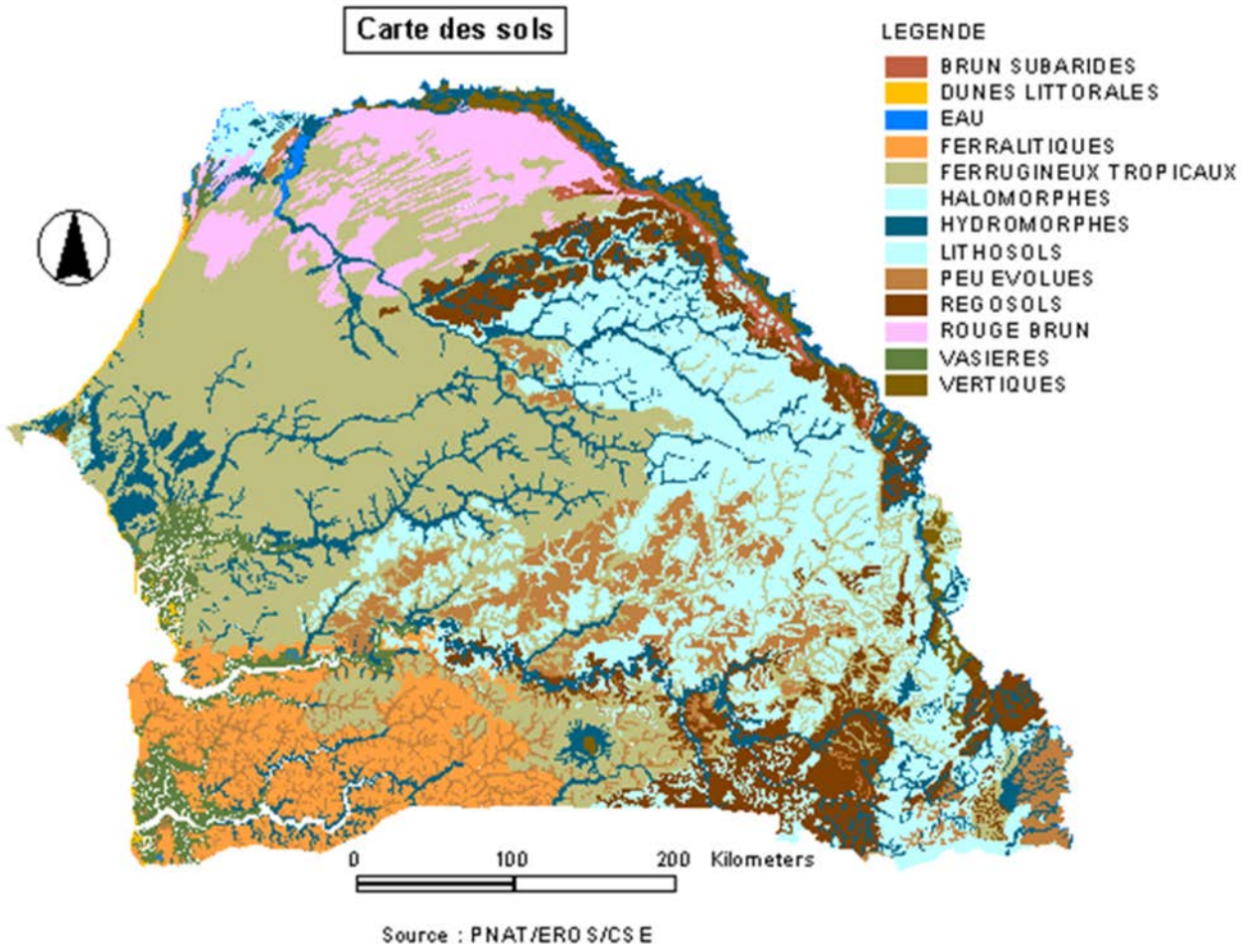

Map of the main types of soil in Senegal

Various types of soil affected by different forms of degradation

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❖ Despite agricultural potentials in agro-ecological zones in Senegal, crop potential yield is constrained by

- ✓ Wind erosion
- ✓ Salinization
- ✓ Water erosion
- ✓ Poor agricultural practices

Zone agro-écologique	% terres cultivables	Superficie x 1000 ha
Vallée du Fleuve Sénégal	8	300
Zone sylvopastorale	4	150
Zone du Littoral et des Niayes	1	36,2
Bassin Arachidier	57	2168,2
Casamance	20	750
Centre-Est et le Sud-Est (Sénégal Oriental)	10	

Utilisation agricole des terres (Plan Céréalier, DEL/L Berger et al. in PAF, 1996)

❖ 1,000,000 out of 3,500,000 ha of cultivable land are affected

❖ No reliable estimate of available plots based on scales

- ✓ 1 / 1,000,000 (Maignien, 1965);
- ✓ 1 / 500,000 (ISRIC, INP, CSE, 2008) and
- ✓ 1 / 250,000 to 1 / 20,000 in specific studies

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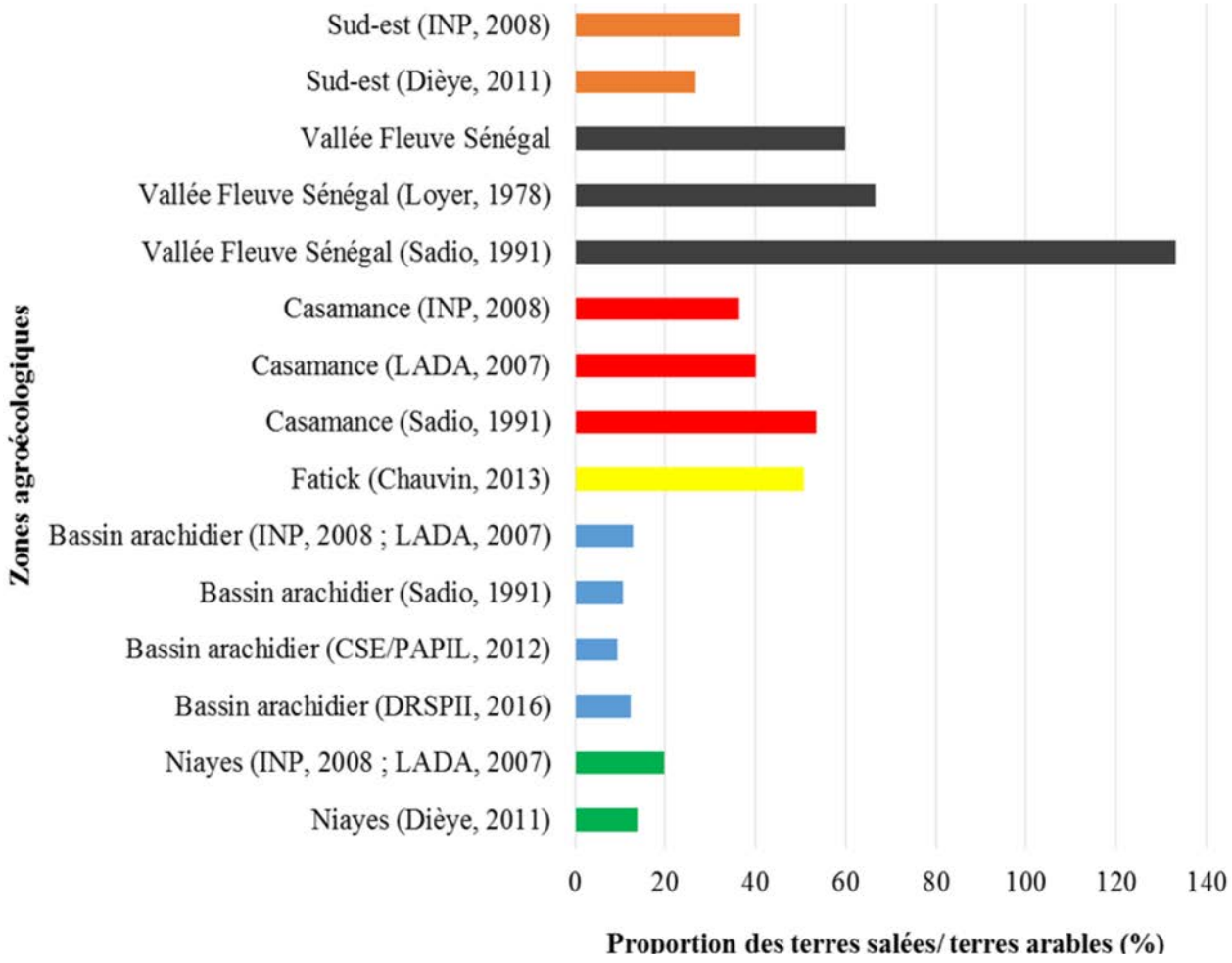

Disparity in estimates of area affected by salinization (ANSTS, 2019)

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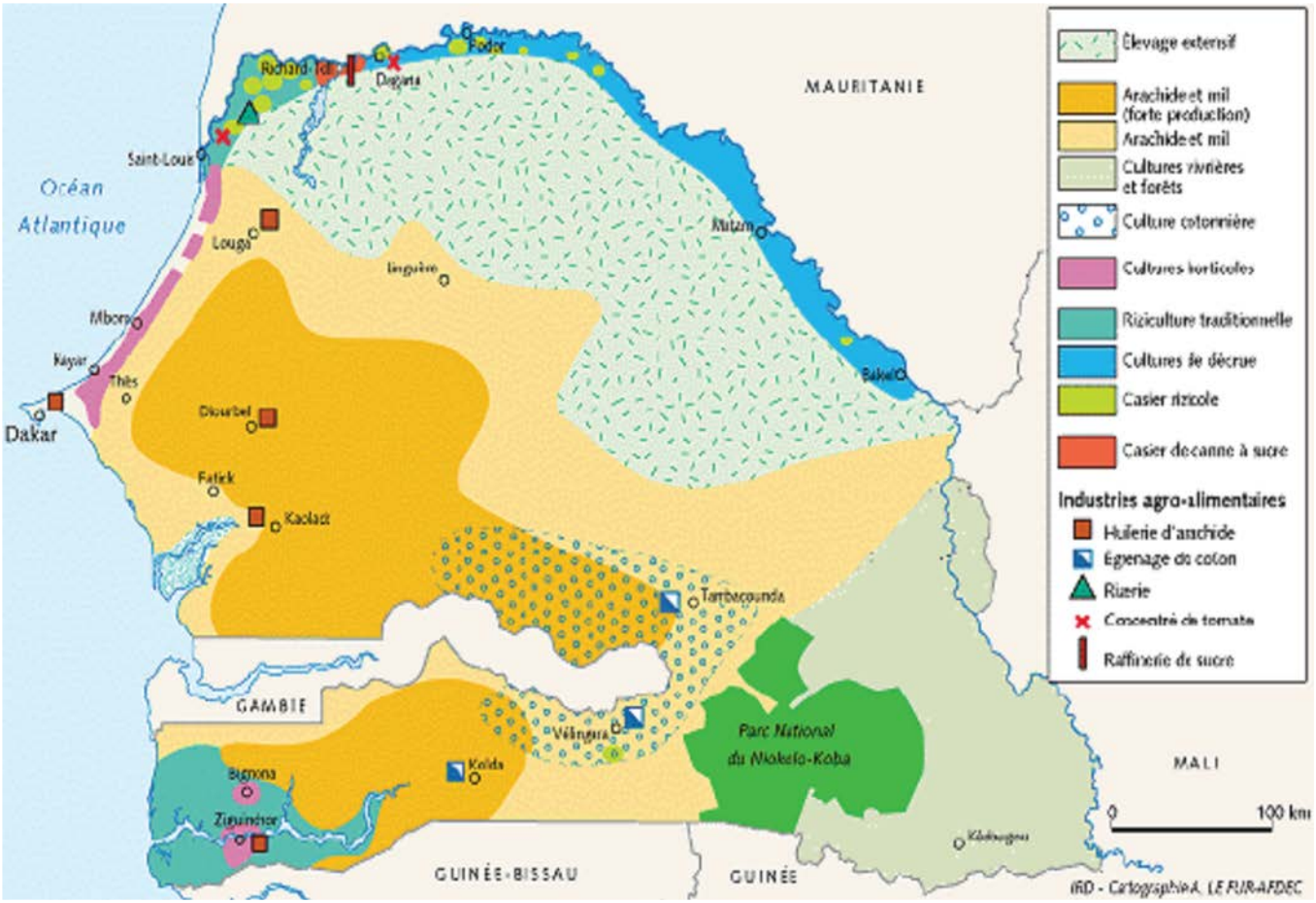

Variability in cropping systems and Ecologies

Map of the agricultural area of Senegal (IRD, 2018)

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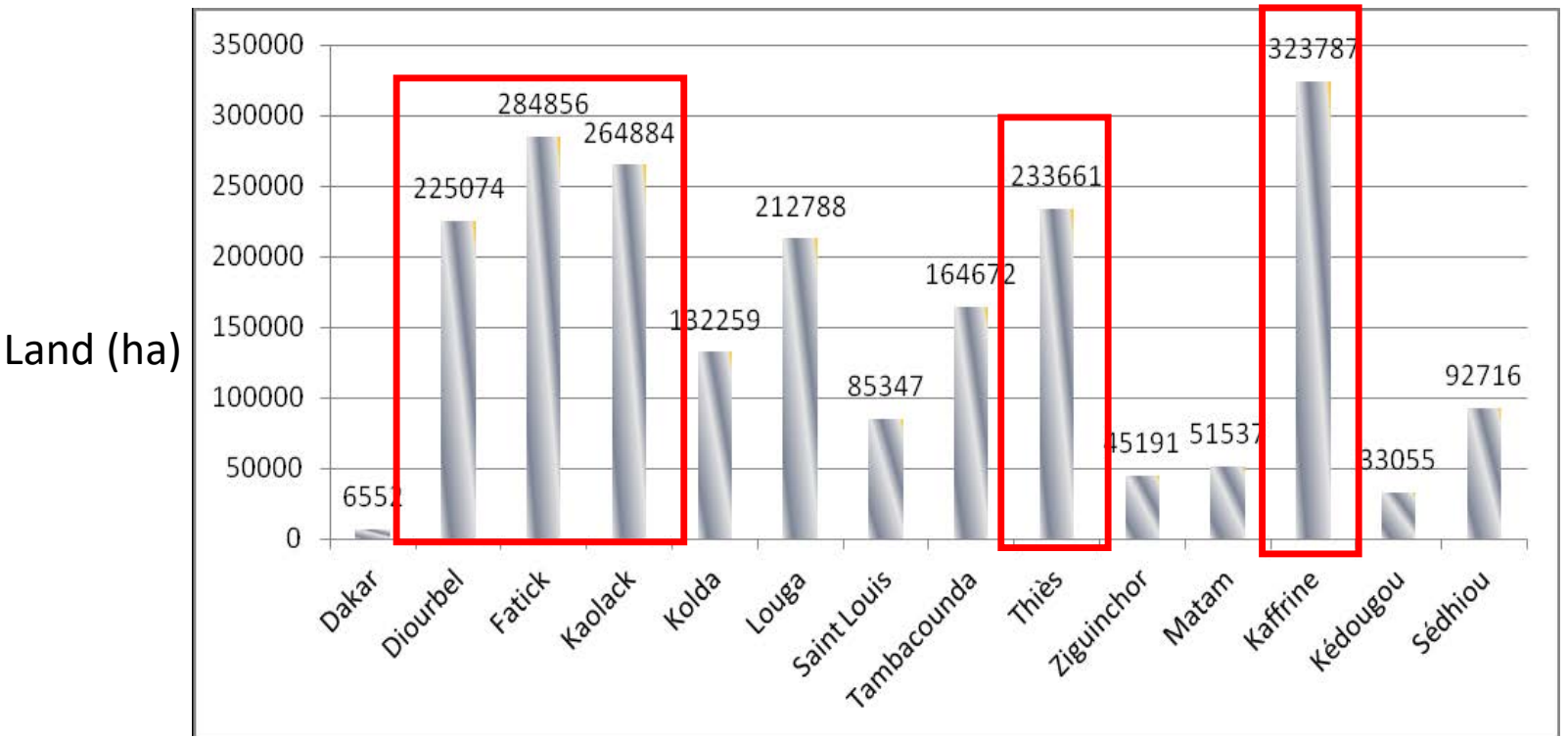

Estimate of cultivated areas (2013/2014)

Agriculture development also constitutes a form of degradation caused by the high rate of use in cropping of available plots particularly in the peanut basin

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Fitting the 4th German-African Forum, January, 2018

- **Digitization of Agricultural**
- **Use of ICT** for precision farming, dissemination and popularization of agricultural advice and management of soil fertility.
- **Experiencing a growing of agribusiness** (with a political option of coexistence with small farms).
- **Short rainy season** : Need of innovations that provide reliable information so that producers make best decisions (sowing date, suitable seeds, soil preparation and application of fertilizers.

Technologies

To overcome land degradation, sustainable management

solutions and technologies have been proposed, among others:

Proposed Technologies for a smart agriculture

To overcome land degradation, sustainable management solutions and technologies have been proposed, among others:

- Fertility map and fertilizer formulation
- Use of NIRS
- Seedball technology
- Climate Information management
- PPU technology (IFDC project)
- Drones
- ICT-based irrigation

Fertiliy map and fertilizer formulation

➢ Knowledge and mastery of soil resources

The initiatives underway in Senegal include mapping the physical and chemical properties of soils and the formulation of fertilizers.

Faced with the constraints linked to the acquisition of data in terms of cost and time, the use of methods such as NIRS constitutes an innovative approach for precision farming.

Within the framework of soil fertility management, Senegal has known three successive phases whose evolution tends towards the promotion of precision farming.

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➢ framework of soil fertility management

PHASE 1 Country Scale	PHASE 2 Agroecological zone Scale	PHASE 3 Plot scale
Use of the same fertilizer formulas for all agro-ecological zones	Realization of the soil fertility map	Ongoing initiatives with the use of Nutrient Expert
	Development of specific fertilizer formulas for each agro-ecological zone	
Example		IPNI and ISRA partnership
Millet formula	Ongoing projects with partnerships	Ongoing trials in agro-ecological zones
Peanut formula	OCP, IFDC, ISRA , INP, ANCAR, OP…	

Fertiliy map and fertilizer formulation

- Soil samples are taken according to a reprentative grid of 250x250 m with a random choice of cluster
- The physico-chemical parameters of soil are mesured in laboratory (Wet and dry and chemistry
- Soil fertility map are established
- Fertilizer formulas are made

A first experience on rice fertilisation initiated by OCP is underway in the valley in partnership with ISRA, SAED, INP and ISRIC

In the same intervention logic IFDC as part of the Dundel Suuf project planned to carry out the fertility map of 4 agroecological zones with fertilizer formulas for several crops

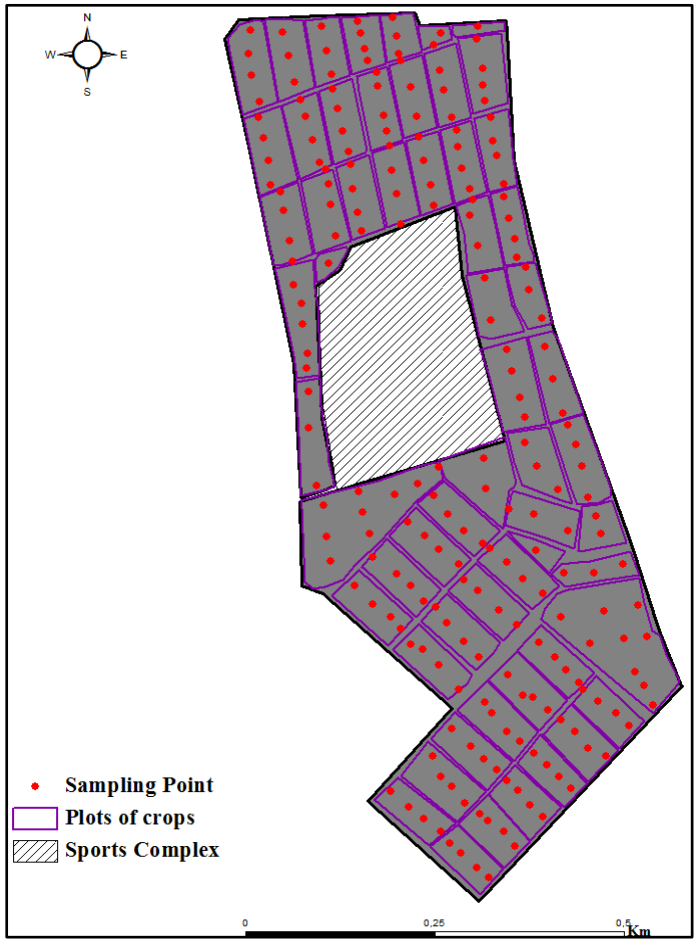
Test will be carried out to validate the formulas -------- **Rule of Research sector**

Manufacturers will also be involved in the production of fertilizers

Notes on NIRS

- NIRS (Near Infrared Spectroscopy)
  - ✓ Using hyperspectral remote sensing
  - ✓ Analyzing physical and chemical properties of the soil
- Principle
  - ✓ Spectroradiometer on different wavelengths
  - ✓ Measuring the reflectance of the soil samples
  - ✓ Building spectral libraries

Agricultural benefits of NIRS



A technique that complements conventional laboratory methods

Reduce the analytical cost of soil properties

Save substantial time

Accurately map soil fertility indicators through rapid analysis of large soil datasets.

Notes on Drones

- Mapping of crop plots
- Detection of stresses
  - ✓ crop diseases
  - ✓ Deficiencies in mineral elements
  - ✓ Water stress
- Phytosanitary treatments
- High-throughput phenotyping

Agricultural benefits of Drones

Caméra RGB

Multispectral sensor

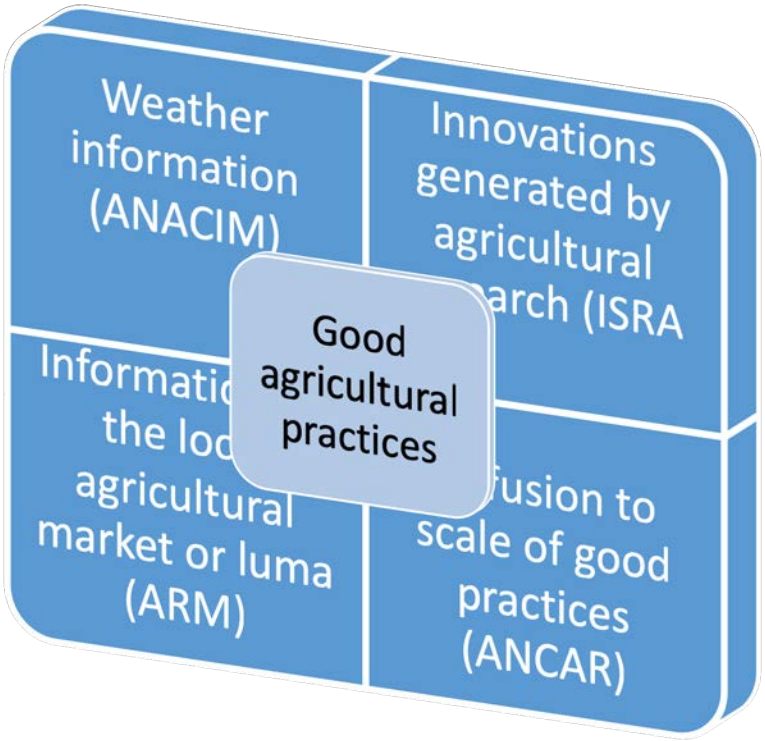
Possibility to have 2 sensors 1 RGB camera and 1 multispectral camera

Notes on Climate Information Management

- Characterizing the rainy season profile
  - ✓ Analyze senarii and climate projections
- Tools for public authorities, populations and all actors
- Choice of varieties which can be early or late maturing
- Sowing calendar
- Periods of fertilization

Agricultural benefits of Climate Information Management

- Involvement of several actors and use of various communication pathways
  - ✓ ANACIM (National Weather)
  - ✓ Multidisciplinary Working Group (GTP)
    - Technical Services (ISRA, DRDR)
    - Consulting Support Services (ANCAR)
    - Farmer organizations and beneficiarie
  - ✓ Communication channels
    - Magazines
    - Television, Radio
    - Telephone (Call, SMS



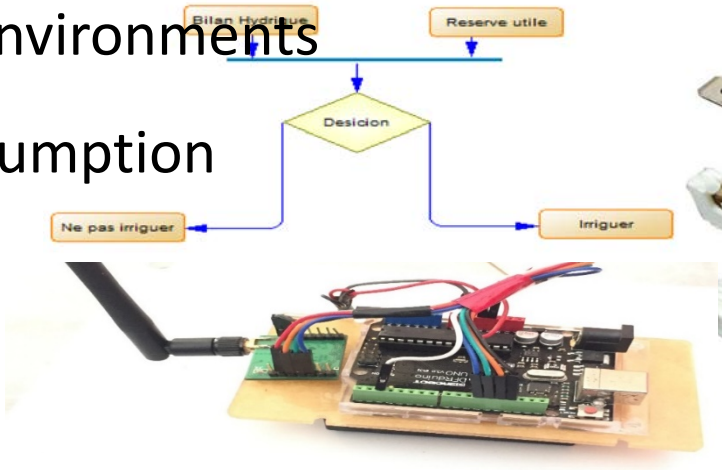
Notes on ICT-based Irrigation

- Climate change
  - ✓ The Earth's climate has changed throughout history (NASA)
  - ✓ Small variations in Earth's orbit change the amount of solar energy received
  - ✓ Heat-trapping nature of carbon dioxide and other gases
- Rainfed Agriculture in the Sahel
  - ✓ Low crop productivity
  - ✓ Food insecurity

Agricultural benefits of ICT-based Irrigation

- ❖ Accessing water in harsh environments
- ❖ Optimization of water consumption
- ❖ Intelligent irrigation system
- ❖ Automatic climate stations
- ❖ Wireless sensors
- ❖ Use of crop water balance, maximum evapotranspiration and knowledge of the amount of water available for the plant.

• **Électrovanne**



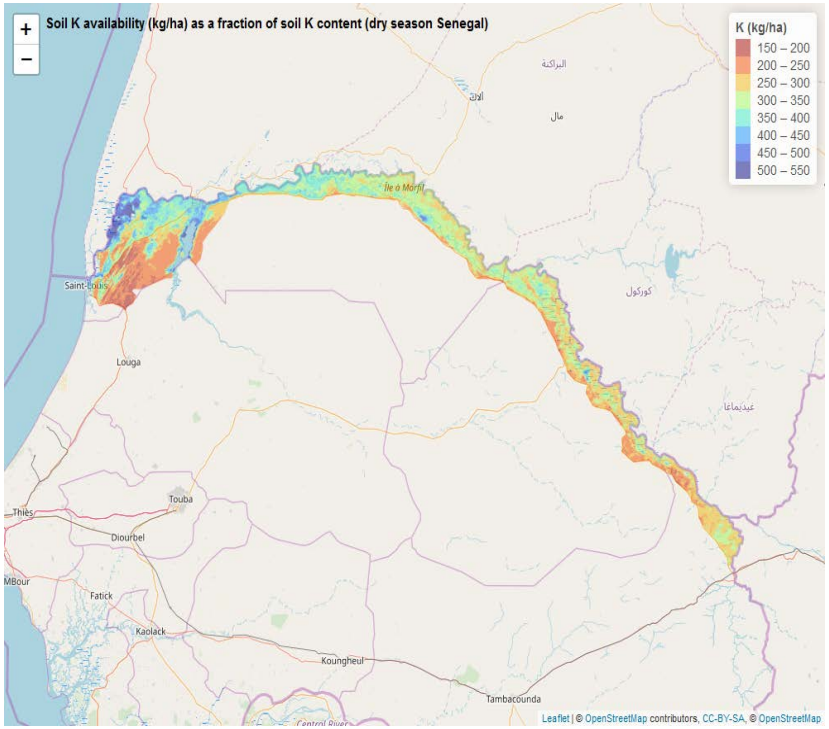
Notes on Seedball

❖ Seeedball adapted in area threatened by :

- Wind erosion, granivorous bird,
- Risk of light rain which an limit germination and only effective rain can cause germination
- They improve also soil fertility
- Protects young plants from pathogenic microorganisms during germination
- May help the young plant's pre-growth

CASE STUDY

Fertiliy map and fertilizer formulation



Example of soill fertility map of the valley (OCP, 2019)

OCP project with ISRA, SAED, INP, ASPRODEB and ISRIC Soil fertility Map of different elements (N, P, K, S, Cu, Zn, Mn, Fe and B) and fertilizer formulas are made for Valley and the Region of Kaffrine

❖Trials on
- Rice in the Valley
- Peanut in Kaffrine region

Fertiliy map and fertilizer formulation

- **Survey**
  - ✓ 52 conglomérats de points
- **3 fertilizer formulas**
  - ✓ 18-16-10S-0.5Zn-0.1B-0.4Cu
  - ✓ 14-38-10S-0.2Zn-0.3Cu
  - ✓ 18-17-10S-0.1Zn-0.1B-0.3Cu

Zones	Cluster	%
Delta	28	54%
Middle valley	15	29%
Hupper valley	9	17%
TOTAL	52	100%

Domaine	Type	N (%)	P2O5 (%)	K2O (%)	S (%)	Zn (%)	B (%)	Cu (%)	Taux (kg/ha)
SN1	Fx	18	16	0	10	0.5	0.1	0.4	100
SN1	Fx-ex	18	16	0	0	0	0	0	100
SN2	Fy	14	38	0	10	0.2	0	0.3	100
SN2	Fy-ex	14	38	0	0	0	0	0	100
SN3	Fz	18	17	0	10	0.1	0.1	0.3	100
SN3	Fz-ex	18	17	0	0	0	0	0	100

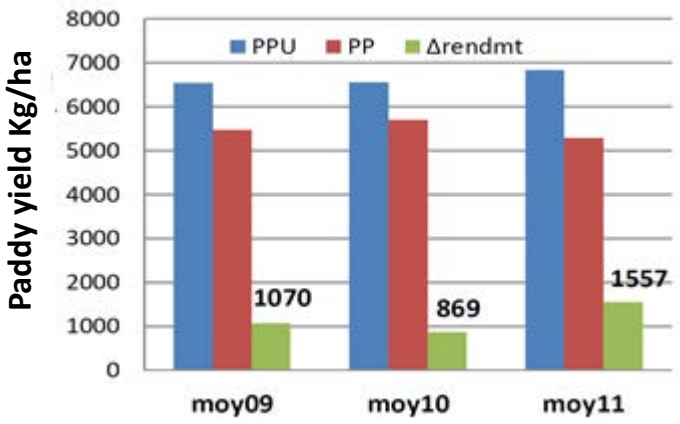
Deep placement of Urea or PPU method

- Objectives
  - ✓ Demonstrational trial on the use of PPU in Podor, Dagana Matam, Nioro Kolda and Anambe
  - ✓ Dissemination of the use of PPU in irrigated corn and tomatoe and oignon

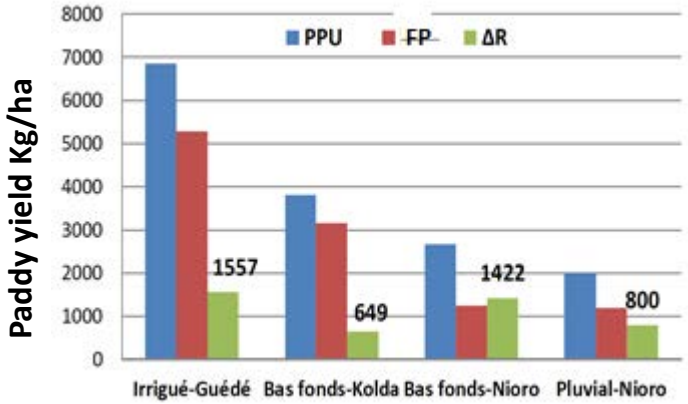
- Collaborators
  - ✓ ISRA, IFDC, SAED, AGRITECH
  - ✓ Symbiose, 7A Ma Rewee
  - ✓ OPGC
  - ✓ FEPRODES, FEPROBA
  - ✓ USAID Yajeende

Deep placement of Urea or PPU method

- Yield of rice
  - ✓ 21% increase with the use of PPU
  - ✓ Gain of 1165 kg/ha of riz paddy
- Pricing
  - ✓ 18% reduction of production fees



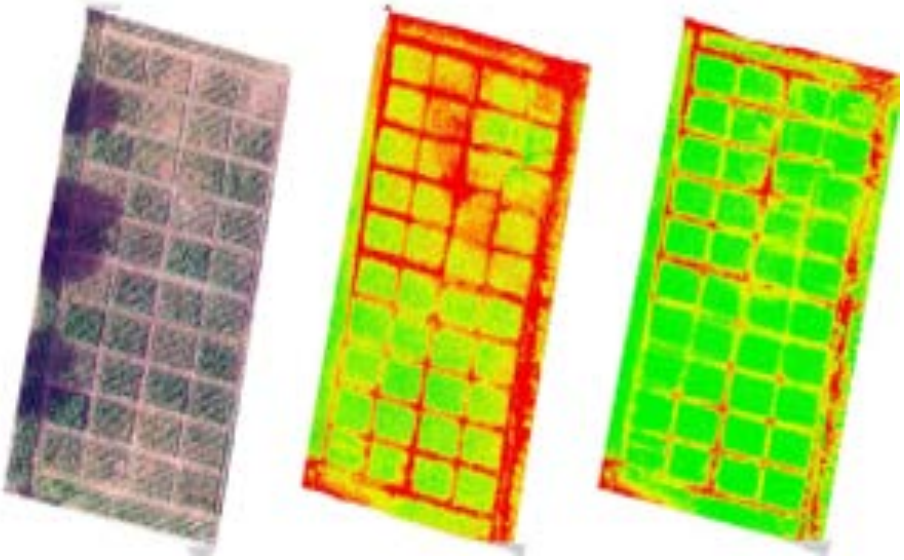
Yield per year (PPU vs FP



PPU vs FP of rice according to cultivation systems, 2011

Using Drones at Bambey research station

- **Sorghum and Peanut trials**
  - ✓ Nutrient deficiency
  - ✓ Diseases
  - ✓ Yield



RGB | Chlorophyll Index | NDVI

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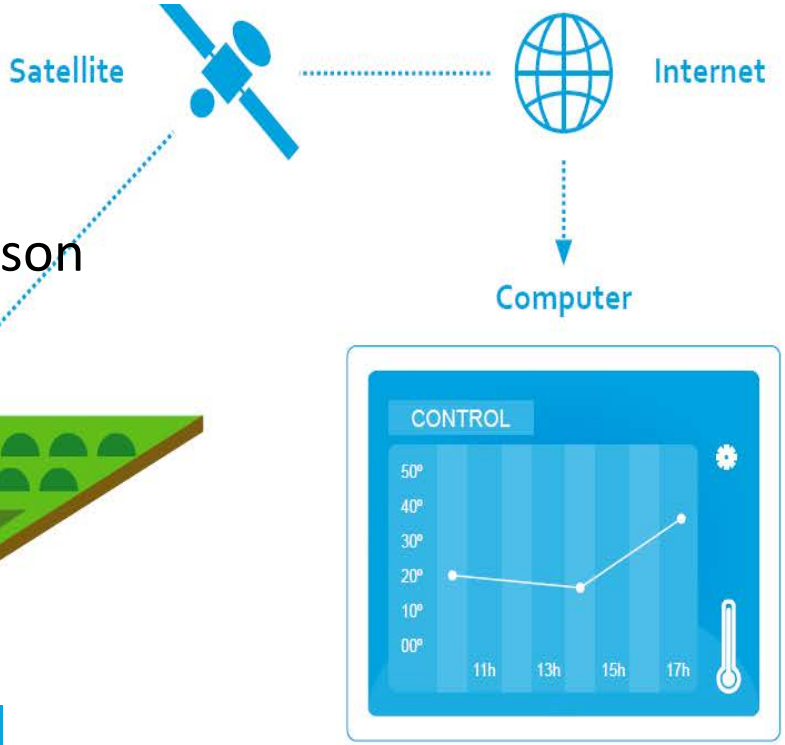
Using Climate data to manage agriculture

- **Farmer / Scientist Network**
  - ✓ Data collection
  - ✓ Training
  - ✓ Sms – whatsaap on the rainy season



IRRIWEST

NDVI

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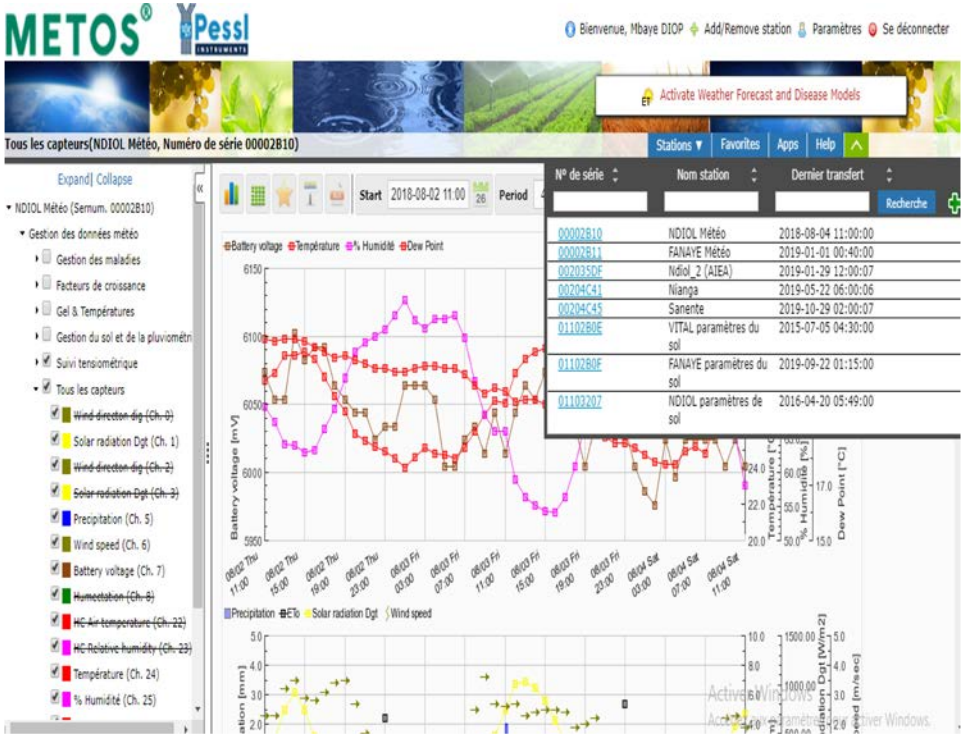
Using ICT-based irrigation to mitigate water uses

Overall objective : Enhance irrigation efficiency in WA to optimize water resources management and increase agricultural productivity

- **Pilot fields**
  - ✓ Participatory process
    - Researchers
    - Extension agents
    - Meteorological services
    - Beneficiaries
- **Monitoring key parameters**
  - ✓ Determine crops water need
    - Pilot fields in Ghana
    - Pilot fields in Senegal



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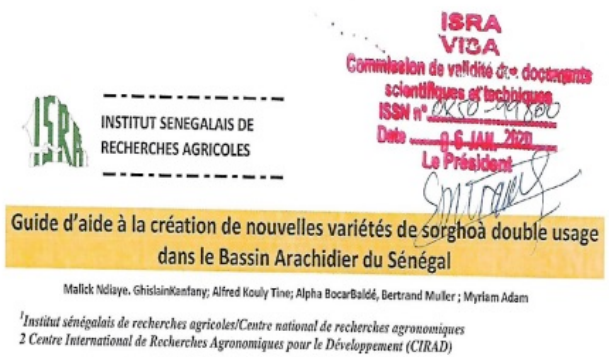
Researchers inputs

Proven strategies



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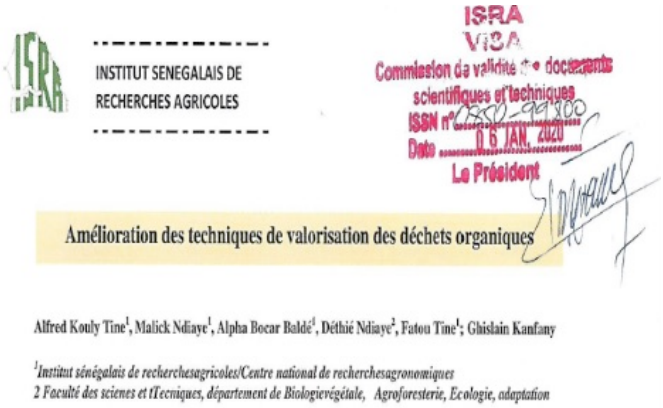
ISRA VISA Commission de validité des documents scientifiques et techniques ISSN n° 0850-9948 Date 06 JAN. 2020 Le Président

Guide d'aide à la création de nouvelles variétés de sorgho à double usage dans le Bassin Arachidier du Sénégal

Malick Ndiaye. GhislainKanfany; Alfred Kouly Tine; Alpha BocarBaldé, Bertrand Muller ; Myriam Adam

[1]Institut sénégalais de recherches agricoles/Centre national de recherches agronomiques
2 Centre International de Recherches Agronomiques pour le Développement (CIRAD)



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Amélioration des techniques de valorisation des déchets organiques

Alfred Kouly Tine[1], Malick Ndiaye[1], Alpha Bocar Baldé[1], Déthié Ndiaye[2], Fatou Tine[1]; Ghislain Kanfany

[1]Institut sénégalais de recherchesagricoles/Centre national de recherchesagronomiques
2 Faculté des sciences et tTecniques, département de Biologievégétale, Agroforesterie, Ecologie, adaptation

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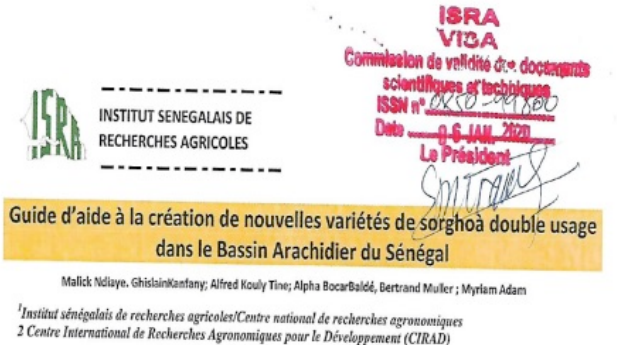
Dose d'engrais minéraleet densité de semis recommandées pour la culture de variétés hybrides de maïsau Sénégal

Alpha Bocar Baldé ; Alfred Kouly Tine ; Malick Ndiaye ; Ciré Elimane Sall C. ; Gualbert Séraphin Dorego;



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Importance of precision agriculture

- to secure investment
- to plan capacity building and sustainable soil management actions
- to strengthen the synergy of actors at national and international level
- to use whole set of technological packages
- Major challenges remain the scalling up of proven technologies

THANKS

FOR YOUR ATTENTION