HIGH-LEVEL MEETING ON THE INITIATIVE FOR THE ADAPTATION OF AFRICAN AGRICULTURE TO CLIMATE CHANGE "AAA"

RENCONTRE DE HAUT NIVEAU SUR L'INITIATIVE POUR L'ADAPTATION DE L'AGRICULTURE AFRICAINE AUX CHANGEMENTS CLIMATIQUES "AAA"
RATTAN LAL

Nobel Prize Recipient
Sustainable and Resilient Soil Management in Climate Context

Carbon Management and Sequestration Center

Dr. Rattan Lal

Morocco
The African Dilemma

It is ironic that Africa; despite vast endowments of natural resources comprising of a wide range of climates/biomes/soils and human capital; and with capacity to be a bread basket of the world by creating the so-called "Cerrado Miracle" within its own savannas and steppes; cannot even feed itself. This is the dilemma that the AAA initiative to proposed at COP22 must address.
Population of Africa

I = P x A x T

P = Population
A = Affluence
T = Technology
## Maize Yield Gap in Africa

<table>
<thead>
<tr>
<th>Region</th>
<th>Potential (Mg/ha)</th>
<th>Average (Mg/ha)</th>
<th>Gap (Mg/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mid-Altitude Sub-Tropical</td>
<td>7</td>
<td>2.5</td>
<td>4.5</td>
</tr>
<tr>
<td>Tropical Lowland</td>
<td>4.5</td>
<td>0.7</td>
<td>3.8</td>
</tr>
<tr>
<td>Western Kenya</td>
<td>3.7</td>
<td>1.7</td>
<td>2.0</td>
</tr>
</tbody>
</table>

Lobell et al. (2009)
Suspended Sediment Transport and Soil Erosion in the Maghreb (Probst and Suchet, 2016)

<table>
<thead>
<tr>
<th>Watershed/Region</th>
<th>Suspended Sediment Yield (Mg/km² yr)</th>
<th>Suspended Sediment Discharge (10⁶ Mg/yr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Atlantic Ocean</td>
<td>613</td>
<td>152</td>
</tr>
<tr>
<td>Mediterranean Sea</td>
<td>397</td>
<td>100</td>
</tr>
<tr>
<td>Total Maghreb</td>
<td>504</td>
<td>252</td>
</tr>
</tbody>
</table>
Land Area Equipped for Irrigation

- World: Cropland = 1450
- India: Cropland = 163
- Africa: Cropland = 300

FAO (2015)
# Irrigation Potential and Use In Africa

(FAOSTAT, 2012)

<table>
<thead>
<tr>
<th>Status</th>
<th>Area (10^6 ha)</th>
<th>2007</th>
<th>2011</th>
</tr>
</thead>
<tbody>
<tr>
<td>Area Equipped for Irrigation</td>
<td>2.1</td>
<td></td>
<td>3.5</td>
</tr>
<tr>
<td>Irrigation Potential</td>
<td>45.1</td>
<td>45.1</td>
<td></td>
</tr>
<tr>
<td>Area Under Actual Irrigation</td>
<td>1.9</td>
<td></td>
<td>1.7</td>
</tr>
</tbody>
</table>
COMPARATIVE FERTILIZER CONSUMPTION IN INDIA, SUB-SAHARAN AFRICA AND THE WORLD

World Bank (2015)
"By 2030, ensure sustainable food production systems and implement resilient agricultural practices that increase productivity and production, that help maintain ecosystems, that strengthen capacity for adaptation to climate change, extreme weather, drought, flooding and other disasters and that progressively improve land and soil quality."
SDG-TARGET 15.3

"By 2020, combat desertification, restore degraded land and soil, including land by desertification, drought and floods, and strive to achieve a land degradation neutral world."
ECONOMICS OF RESIDUE REMOVAL FOR BIOFUEL

“Soil biota is the bioengine of the Earth”

There is no such thing as a free biofuel from crop residues.
• Extractive Farming/Subsistence
• Depletion of SOC and Nutrients
• Decline in Soil Structure
• Loss of Soil Resilience
• Decline in Ecosystem Functions and Services
• Loss of Soil biodiversity
• Disruption of Key Processes

THE REGIME SHIFT BY EXTRACTIVE FARMING

• Hunger
• Malnutrition
• Political Unrest
• Civil Strife
• War and insecurity
• 65 Million Refugees in 2016

Severe Degradation
Resilience of Soil-Ecological Systems

It has multiple regimes (stable states) which are separated by thresholds.

- Resilience
- Thresholds
- Critical Threshold
- Irreversible Degradation

The current state of the system.
Possible states in which the system can still have the same function.
The strategy is to produce more crops:

- from less land,
- per drop of water,
- per unit of input of fertilizers and pesticides,
- per unit of energy, and
- per unit of C emission.

Pulses in rotation can produce more from less.
SUSTAINABLE SOIL MANAGEMENT

• Replace what is removed,

• Respond wisely to what is changed, and

• Predict what will happen from anthropogenic and natural perturbations

• Enhance soil resilience
The strategy is to produce more crops:
• from less land,
• per drop of water,
• per unit of fertilizers and pesticides,
• per unit of energy, and
• per unit of C emission.

SUSTAINABLE INTENSIFICATION

Pulses in rotation can produce more

Produce more from less
SOIL C SEQUESTRATION

- Subsistence farming, none or low off-farm input soil degradation
- New equilibrium
- Adoption of RMPs
- Maximum Potential
- Attainable Potential
- C Sink Capacity
- Rate
- Accelerated erosion
- MRT = \( \frac{\text{Pool}}{\text{Flux}} \)

- Conservation Agriculture
- Biochar
- Agroforestry
- Desert Control
- Afforestation
- Pasture Mgmt
- H₂O harv., DSI
- Farming Systems

Time (Yrs)

Data from Lal, 2004
A HEALTHY AND AN ECO-EFFICIENT SOIL

Soil is Life

Transforming Death into Life

Water
Carbon
Nitrogen
Phosphorous
Sulfur