Too Little N and P in Agriculture

How to provide enough?

How to avoid adding too much?
Global trends in cereal yields by region (1961-2005)

From: Hazell and Wood, 2008
Farm Nitrogen Balances (kg/ha/y)
Too much AND too little

<table>
<thead>
<tr>
<th></th>
<th>Netherlands</th>
<th>Rwanda</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>IN</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mineral fertilizer</td>
<td>440</td>
<td>0.4</td>
</tr>
<tr>
<td>Organics</td>
<td>200</td>
<td>1.6</td>
</tr>
<tr>
<td>Atom. deposition</td>
<td>50</td>
<td>5.0</td>
</tr>
<tr>
<td>N fixation</td>
<td>0</td>
<td>8.8</td>
</tr>
<tr>
<td>Others</td>
<td>8</td>
<td>1.8</td>
</tr>
<tr>
<td><strong>TOTAL IN</strong></td>
<td><strong>698</strong></td>
<td><strong>17.6</strong></td>
</tr>
<tr>
<td><strong>OUT</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Harvested product</td>
<td>82</td>
<td>27.3</td>
</tr>
<tr>
<td><strong>IMBALANCE</strong></td>
<td><strong>+616</strong></td>
<td><strong>-10</strong></td>
</tr>
</tbody>
</table>

(From: Smaling, 1993)
Sauri, Kenya – Maize Yields
1000 Households Receiving Subsidized Fertilizer and Improved Seeds

![Bar chart showing maize yields in Sauri, Kenya between 2004 and 2007. The chart compares control and intervention groups. The intervention group shows a significant increase in maize yields, particularly in 2006.]
Conceptual Model
Agronomic Efficiency of fertilizers, organic resources, and ISFM

Vanlauwe

Move towards ISFM

'Full ISFM'

Responsive soils
Poor, less-responsive soils

Increase in knowledge

A, B, C

Current practice
Germplasm & fertilizer
Germplasm & fertilizer’ + Organic resource mgt
Germplasm & fertilizer + Organic resource mgt + Local adaptation
### ORGANIC AND INORGANIC INPUTS TO SOIL
Production and Nutrient Use Efficiency

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Pearlmillet (t/ha)</th>
<th>N Uptake (kg/ha)</th>
<th>NUE (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>N0P0</td>
<td>1.51</td>
<td>31</td>
<td>--</td>
</tr>
<tr>
<td>N120P40</td>
<td>2.76</td>
<td>66</td>
<td>29</td>
</tr>
<tr>
<td>N60P20 + N60 (FYM)</td>
<td>2.33</td>
<td>51</td>
<td>17</td>
</tr>
<tr>
<td>N60P20 + N60 (wheat straw)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N60P20 + N60 (Sesbania)</td>
<td>3.15</td>
<td>76</td>
<td>38</td>
</tr>
</tbody>
</table>

(Goyal et al., 1992)
Integrated Soil Fertility Management:
Low Adoption Rates of Organic Components

Mineral fertilizer + Organics

Cover crops

Legume trees

Biomass transfer

Manure
Can we subsidize organic inputs?

Is that sufficient?

How will price of fertilizers impact decisions?

What about PES, such as carbon credits?
Soil Functional Capacity Classification System, Version 4: High Phosphorus Fixation

Clayey topsoils with more than 20% iron or aluminum oxides in their clay particles 'fix' large quantities of phosphate ions into slowly soluble iron and aluminum phosphates, which, while not immediately available to plants, are made available over a period of several years. This map shows the percentage of FAO map units containing the following soil units, which if they are fine-textured, have been assigned the 'i' modifier to indicate high phosphorus fixation: A, Ao, Af, Ah, Ap, Ag, F, Fo, Fx, Fr, Fh, Fa, Fp, N, Ne, Nd, Nh, Bf, Lf.
Implications of P limiting soils

P fertilizers must be added – at least to get the system moving

Animal manures do have sufficient P, but usually not available

Organics add efficiency;

Targeting needs for appropriate fertilizer rates

How can we rapidly identify these soils?

On N fluxes: larger if P requirements not met
The Fate of Added Nutrients: Plot level and Beyond

Need to establish list of site characteristics

Soils, Climate, Topography

Vegetation-type, %cover, distribution

Management practices: intensity

to determine most predominant loss pathways
to development management recommendations
Big unknowns:

Commercial plantations

Biofuels in the tropics
System configurations – How does this change N dynamics
....and tradeoffs or synergies

Food, Fodder, Fuel
Production and Forest

Soil Condition
- Erosion
- Nutrient cycling (N retention)

Greenhouse Gas Regulation
- C sequestration
- N2O, CH4, NOx emissions
- Full accounting for fertilizer

H2O Availability
- Infiltration
- Water storage
- Leaching
- Evapotranspiration

H2O Quality
- NO3-
- Sediment
- Pathogens

Disease Regulation
(Plants, animals, people)
- Major crop diseases associated with N management (Striga, streak viruses)
- Vector-borne diseases; Zoonotic (malaria, schisto) and chronic (malnutrition) diseases