Strategies and Options for Agriculture in the Context of 21st Century Sustainability

CSD Inter-governmental Preparatory Meeting
February 24, 2009
Things we know about the 21st century that affect agricultural sustainability:

- **Demand/need for food** will grow by ~50% by 2050 - given probable increases in population and income + need to reduce hunger in the world.
- **Arable land per capita** will be less - given population growth, conversion for other uses, and land degradation.
- **Water supply and reliability** will be less - given likely changes in climate.
Things we know about the 21st century that affect agricultural sustainability:

- Climate for agricultural production will generally become more adverse
  - Need more resistance to pests/diseases
  - Need more tolerance of abiotic stresses

- Costs of energy and petrochemical products are likely to become higher
  - Input-dependence will lower farm incomes

- Substantial capital requirements will be a constraint on poverty reduction
These are objective facts and trends -- not matters of ideology. They raise serious questions about the sustainability of our present strategy of ‘modern agriculture’.

This strategy favors production that is: large-scale, mechanized, monocropped (not biodiverse), energy-intensive, input-dependent, ‘thirsty’, and vulnerable to pests and diseases, and to drought, storm damage, etc.
This strategy -- widely referred to as the Green Revolution -- has been successful in the 20th century.

But reasonable questions can be raised about how appropriate this will be for the expected conditions in the 21st century.

Can the world feed and sustain its population by doing 'more of the same'? What do we do for an encore? Is there any alternative?
World Grain Production, Total and Per Capita, 1961-2003
Two Paradigms for Agriculture:

• 'Modern Agriculture' strategy is to:
  (a) Change the genetic potential of plants, and
  (b) Increase the use of external inputs -- more water, more fertilizer and insecticides

• Agroecology (e.g. SRI) makes changes in the management of plants, soil, water & nutrients:
  (a) Promote the growth of root systems, and
  (b) Increase the abundance and diversity of soil organisms to better enlist their benefits - with goal of producing better PHENOTYPES
MADAGASCAR: Rice field grown with SRI methods
CAMBODIA: Farmer in Takeo Province: yield of 6.72 tons/ha > 2-3 t/ha
CUBA: two rice plants of same variety (VN 2084) and same age (52
MALI: Farmer in the Timbuktu region showing difference between regular and SRI rice plants in 2007 trials

SRI yield 8.98 t/ha
Control yield 6.7 t/ha
MALI: Rice grain yield for SRI plots, control plots and farmer-practice plots, Goundam circle, Timbuktu region, 2008

<table>
<thead>
<tr>
<th></th>
<th>SRI</th>
<th>Control Plots</th>
<th>Farmer Practice</th>
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<tbody>
<tr>
<td><strong>Yield t/ha</strong></td>
<td>9.1</td>
<td>5.49</td>
<td>4.86</td>
</tr>
<tr>
<td><strong>Standard Error (SE)</strong></td>
<td>0.24</td>
<td>0.27</td>
<td>0.18</td>
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<tr>
<td>% Change compared to Control Plots</td>
<td>+ 66</td>
<td>100</td>
<td>- 11</td>
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<tr>
<td>% Change compared to Farmer Practice</td>
<td>+ 87</td>
<td>+ 13</td>
<td>100</td>
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<tr>
<td>Number of Farmers</td>
<td>53</td>
<td>53</td>
<td>60</td>
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* adjusted to 14% grain moisture content
SRI Was Developed in Madagascar

by Fr. Henri de Laulanié in early 1980s after 20 years of working with farmers to develop low-cost methods to reduce hunger & poverty

• Farmers who had gotten 2 tons/ha produced 8 tons w/o new seeds or fertilizer
  • Ranomafana National Park
  • Same results in an AFD irrig. project on the Haut Plateau
• SRI has been spreading around world since 2000

<table>
<thead>
<tr>
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<th>Peasant Practice</th>
<th>SRA*</th>
<th>SRI</th>
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<tr>
<td><strong>Area</strong></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>1994/95</td>
<td>1875.5</td>
<td>4361.9</td>
<td>34.5</td>
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<tr>
<td>1995/96</td>
<td>1501.5</td>
<td>5224.5</td>
<td>88.7</td>
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<td>1996/97</td>
<td>1419.0</td>
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<td>1997/98</td>
<td>3122.0</td>
<td>2893.8</td>
<td>229.7</td>
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<td>1998/99</td>
<td>2768.1</td>
<td>2628.0</td>
<td>542.8</td>
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<tr>
<td><strong>Yield</strong></td>
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<tr>
<td>1994/95</td>
<td>2.02</td>
<td>3.96</td>
<td>8.62</td>
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<td>1995/96</td>
<td>1.96</td>
<td>3.41</td>
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<td>1996/97</td>
<td>2.08</td>
<td>3.30</td>
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<td>1997/98</td>
<td>2.84</td>
<td>3.78</td>
<td>8.59</td>
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<tr>
<td>1998/99</td>
<td>2.97</td>
<td>4.61</td>
<td>8.07</td>
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<tr>
<td>Average</td>
<td>2.36</td>
<td>3.77</td>
<td>8.55</td>
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Agence Française de Développement, Antananarivo (Janvier 2000), Annexes 13-14
Status of SRI as of 1999:

Madagascar
SRI Status Today: Benefits demonstrated in 35 countries of Asia, Africa, and Latin America

China, Indonesia, Cambodia, Vietnam, Philippines, Laos, Myanmar, Thailand, Timor Leste; India, Nepal, Bangladesh, Sri Lanka, Pakistan, Bhutan; Iraq, Iran, Afghanistan, Egypt; Gambia, Guinea, Senegal, Sierra Leone, Mali, Benin, Moz., Rwanda, Zambia; Cuba, Peru, Ecuador, Costa Rica, Brazil
SRI LANKA: same rice variety, same irrigation system, and same drought -- conventional rice (left); SRI (right)
VIETNAM: Farmer in Dông Trù village - after typhoon
# Reduction in Diseases and Pests

Vietnam National IPM Program evaluation based on data from 8 provinces, 2005-06

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<thead>
<tr>
<th></th>
<th>Spring season</th>
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<th>Summer season</th>
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<tbody>
<tr>
<td></td>
<td>SRI Plots</td>
<td>Farmer Plots</td>
<td>Difference</td>
<td>SRI Plots</td>
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<tr>
<td>Sheath blight</td>
<td>6.7%</td>
<td>18.1%</td>
<td>63.0%</td>
<td>5.2%</td>
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<tr>
<td>Leaf blight</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>8.6%</td>
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<tr>
<td>Small leaf folder *</td>
<td>63.4</td>
<td>107.7</td>
<td>41.1%</td>
<td>61.8</td>
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<tr>
<td>Brown plant hopper *</td>
<td>542</td>
<td>1,440</td>
<td>62.4%</td>
<td>545</td>
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<tr>
<td>AVERAGE</td>
<td></td>
<td></td>
<td>55.5%</td>
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* Insects/m²
Non-Flooding Rice Farming Technology in Irrigated Paddy Fields
Dr. Tao Longxing, China National Rice Research Institute, 2004
Agroecological strategy differs from input-dependent ‘Green Revolution’

Management-oriented approach capitalizes upon (a) existing genetic potentials - also in other crops like wheat, finger millet, sugar cane - and (b) endogenous processes and potentials in soil systems - seeking to mobilize, support and benefit from the life in the soil - N fixation, P solubilization, mycorrhizal fungi, etc.
SRI concepts and methods are being extended to wheat production in India.

Pictures sent by Madhya Pradesh Rural Livelihoods Program operating in tribal communities in Mandla and Shahdol districts of Madhya Pradesh state, Central India.
Finger Millet Intensification (left); regular management of improved variety (center) and of traditional variety (right), India
Sugar cane grown with SRI methods (left) in Andhra Pradesh

Reported yields of 125-235 t/ha compared with usual 65 t/ha
IMPACT OF COMPOST USE ON CROP YIELDS IN TIGRAY, ETHIOPIA

Sue Edwards, Arefayne Asmelash, Hailu Araya and Tewolde Berhan Gebre Egziabher

Food and Agriculture Organization of the United Nations

Rome, Italy, December 2007
Average grain and straw yields (kg/ha) for 7 cereal crops, based on the averages for each crop, Tigray, 2000-2006
(s=observations for straw yield; g=observations for grain yield)
Estimated marginal value product of nitrogen fertilizer (Kshs/kg N) conditional on plot soil carbon content (Marenya and Barrett, AJAE, 2009)
Changes in management practices can contribute to:

- Higher yields – no need to expand area
- Higher factor productivity, esp. from water – *more crop per drop*
- Lower costs of production and higher household incomes
- Better environmental quality
- More agricultural sustainability
Agroecological strategies

- Not a solution to all of the challenges in agricultural sector but AE benefits are available now
- Still ‘a work in progress’ -- like CA, based on science and on experience
- Can offer many opportunities to meet needs for food security and income in a sustainable manner
SRI website:
http://ciifad.cornell.edu/sri/