ENHANCING SOIL HEALTH FOR RICE GROWTH

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CHILDREN ARE INTRODUCED TO AGRICULTURE

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SRI in Indonesia 2012

- 29 PROVINCES (2012)
- 196 DISTRICTS
- >80,000 HA, PROJECT (?) MOA
- 4.9 TONS/HA ---- 7.25 TONS/HA

----------------------------------------------

- LARGER AREA: NGO FARMERS
- CSR COMPANIES: GARUDA, SAMPURNA, OIL COMPANY
Soil health?

- Continued capacity of soil to function as a vital living system, within ecosystem and land-use boundaries, to sustain biological productivity, to promote the quality of soil, water and air environment, and to maintain plant, animal and human health
Why rice is soo important in ASIA?
It is the staple food for more than half of the world's population
➢ A billion people depend for their livelihoods on rice cultivation
➢ Most rice is cultivated according to these standard methods:
   - flooded conditions,
   - transplanting of older rice seedling
   - narrow distance between plants
   - using mostly inorganic NPK fertilizers.

FLOODED CONDITIONS: HEALTHY SOIL CONDITIONS?

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SRI practices enhance soil health for rice to grow better! Why?

• Moist soil conditions, not continuously flooded, so mostly aerobic soil conditions support they grow of beneficial soil microbes
• Weeding by using rotary weeder, aerates the soil as it controls weeds
• Application of good quality of organic fertilizers is recommended, to ‘feed the soil’ so that the soil can then feed the plant
• All these practicers enhance soil health for rice to grow
• Why?

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FLOODED CONDITIONS: ARE THEY REALLY HEALTHY FOR RICE TO GROW?

• LESS $O_2$ IN THE SOIL, WHICH MAKES IT DIFFICULT FOR ROOTS TO GET THE NEEDED $O_2$
• - REDOX POTENTIAL IS LOW - 200 mVolt
• - TOXIC ELEMENTS BUILD UP such as $Fe^{2+}$
• - UNFAVOURABLE CONDITIONS FOR MOST BENEFICIAL (MICRO) BIOTA
• IS THIS FAVOURABLE FOR RICE PLANT TO GROW?

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RICE CULTIVATION

CONVENTIONAL

- FLOODED SOIL CONDITION
- MORE SEED: 40 KG/HA, SYNTHETIC FERT @ 500-600 KG/HA, PESTICIDE
- 6-8 SEEDLINGS/HILL
- SEEDLINGS 30 DAYS OLD
- NARROW PLANTING DISTANCE: 20 X 20 CM

S.R.I.

- MOIST SOIL, NOT ALWAYS FLOODED
- LESS SEEDS, EFFICIENT FERTILIZER
- YOUNG SEEDLINGS 8-10 DAYS OLD, WITH ATTENTION TO ROOTS
- WIDER PLANTING DISTANCE: 25 X 25 CM OR 30 X 30 CM

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Minggu Setelah Tanam

SOIL Eh

SOIL Eh

Methanogens active

FORMATION OF CH₄ -150 mVolt

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Eh: flooded vs SRI

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‘WEEDING Soil Aeration is inducing a better growth condition

GET RID OF WEEDS

SOIL AERATION

STIMULATE ROOT GROWTH

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Stimulate microbial activity and populations

A review of studies on SRI effects on beneficial organisms in rice soil rhizospheres

Iswandi Anas · O. P. Rupela · T. M. Thiyagarajan · Norman Uphoff

Presented at J-SRI Meeting at University of Tokyo, Japan, 27 September 2012
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Total bacteria</td>
<td>312%</td>
<td>ND</td>
<td>65%</td>
</tr>
<tr>
<td>Total diazotrophs b</td>
<td>61%</td>
<td>6.4%**</td>
<td>NM</td>
</tr>
<tr>
<td>Azospirillum b</td>
<td>32%</td>
<td>NM</td>
<td>211%</td>
</tr>
<tr>
<td>Azotobacter b</td>
<td>36%</td>
<td>NM</td>
<td>94%</td>
</tr>
<tr>
<td>P-solubilizing microbes</td>
<td>53%</td>
<td>3.6%**</td>
<td>78%</td>
</tr>
<tr>
<td>Dehydrogenase (µg TPF g⁻¹ 24 h⁻¹)</td>
<td>140%</td>
<td>22.5%**</td>
<td>125%</td>
</tr>
<tr>
<td>Microbial biomass N (mg kg⁻¹ soil)</td>
<td>NM</td>
<td>20%**</td>
<td>NM</td>
</tr>
</tbody>
</table>

ND no difference, NM not measured

a These trials included wet-season results when water control was incomplete and therefore aerobic soil conditions were difficult to maintain

b N₂-fixing bacteria

** Significant at 0.05 level of confidence
Total microbes, numbers of beneficial soil microbes under Conventional and S.R.I Rice Cultivation Methods at Nagrak, Sukabumi (Iswandi et al 2008)

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<table>
<thead>
<tr>
<th>Treatments</th>
<th>Total Microbes* (x10^5)</th>
<th>Azotobacter* (x10^3)</th>
<th>Azospirillum* (x10^3)</th>
<th>PSM* (x10^4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conventional (T0)</td>
<td>2.3a</td>
<td>1.9a</td>
<td>0.9a</td>
<td>3.3a</td>
</tr>
<tr>
<td>In-Organic S.R.I (T1)</td>
<td>2.7a</td>
<td>2.2a</td>
<td>1.7ab</td>
<td>4.0a</td>
</tr>
<tr>
<td>Organic-S.R.I (T2)</td>
<td>3.8b</td>
<td>3.7b</td>
<td>2.8bc</td>
<td>5.9b</td>
</tr>
<tr>
<td>In-organic S.R.I + BF (T3)</td>
<td>4.8c</td>
<td>4.4b</td>
<td>3.3c</td>
<td>6.4b</td>
</tr>
</tbody>
</table>

*CFU/g soil  
PSM = Phosphate Solubilizing Microbes

Total microbes and number of beneficial soil microbes under conventional and SRI rice cultivation methods at Tanjung Sari, Bogor (Iswandi et al 2009)

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Population of soil fauna (numbers/m²) under conventional (T0) and SRI rice cultivation (T1, T2 and T3) (Iswandi et al. 2009)

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AERENCHYMA? ARE THESE NEEDED?

Conventional Management
(note hole in the middle)

Inorganic S.R.I.
(more solid tissue)

Organic S.R.I.
(most solid tissue)

Photos by Iswandi Anas and Fakhrur Razie, 2009

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### Root length (cm)  
*(Iswandi et al. 2009)*

<table>
<thead>
<tr>
<th>Location</th>
<th>Method</th>
<th>Weeks after transplanting (WAT)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>4</td>
</tr>
<tr>
<td>Sukabumi</td>
<td>Conventional</td>
<td>21.20</td>
</tr>
<tr>
<td></td>
<td>Inorganic S.R.I</td>
<td>42.50</td>
</tr>
<tr>
<td></td>
<td>Organic S.R.I</td>
<td>24.40</td>
</tr>
<tr>
<td>Depok</td>
<td>Conventional</td>
<td>16.57</td>
</tr>
<tr>
<td></td>
<td>Inorganic S.R.I</td>
<td>33.63</td>
</tr>
<tr>
<td></td>
<td>Organic S.R.I</td>
<td>20.20</td>
</tr>
<tr>
<td>Bogor</td>
<td>Conventional</td>
<td>25.67</td>
</tr>
<tr>
<td></td>
<td>Inorganic S.R.I</td>
<td>36.00</td>
</tr>
<tr>
<td></td>
<td>Organic S.R.I</td>
<td>25.50</td>
</tr>
<tr>
<td>Tanjung Sari</td>
<td>Conventional</td>
<td>22.30 a</td>
</tr>
<tr>
<td></td>
<td>Inorganic S.R.I</td>
<td>75.00 b</td>
</tr>
<tr>
<td></td>
<td>Organic S.R.I</td>
<td>70.43 b</td>
</tr>
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</table>

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<th>Location</th>
<th>Methods</th>
<th>Weeks after transplanting (WAT)</th>
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</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>4</td>
</tr>
<tr>
<td>Sukabumi</td>
<td>Conventional</td>
<td>8.89</td>
</tr>
<tr>
<td></td>
<td>Inorganic S.R.I</td>
<td>15.77</td>
</tr>
<tr>
<td></td>
<td>Organic S.R.I</td>
<td>6.70</td>
</tr>
<tr>
<td>Depok</td>
<td>Conventional</td>
<td>1.11 a</td>
</tr>
<tr>
<td></td>
<td>Inorganic S.R.I</td>
<td>2.41 c</td>
</tr>
<tr>
<td></td>
<td>Organic S.R.I</td>
<td>1.70 b</td>
</tr>
<tr>
<td>Bogor</td>
<td>Conventional</td>
<td>16.49</td>
</tr>
<tr>
<td></td>
<td>Inorganic S.R.I</td>
<td>5.69</td>
</tr>
<tr>
<td></td>
<td>Organic S.R.I</td>
<td>2.94</td>
</tr>
<tr>
<td>Tanjung Sari</td>
<td>Conventional</td>
<td>2.34</td>
</tr>
<tr>
<td></td>
<td>Inorganic S.R.I</td>
<td>11.92</td>
</tr>
<tr>
<td></td>
<td>Organic S.R.I</td>
<td>5.99</td>
</tr>
</tbody>
</table>

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Other advantages of unflooded conditions

- Reduce methane emissions from rice field
- Reduce toxicity such as Fe toxicity

- It remains to be evaluated conclusively whether there is offsetting increase of \( \text{N}_2\text{O} \) in response to SRI management; so far, studies have shown little or no increase

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Methane Fluxes (Hutabarat, 2010)

Fluxes CH₄ (mg CH₄-C m⁻² jam⁻¹)

Minggu Setelah Tanam

CONVENTIONAL

SRI

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Table 14. Effects of Slag (AgriPower and Minekal) on C-CH₄ emission

<table>
<thead>
<tr>
<th>Treatment</th>
<th>T1</th>
<th>T2</th>
<th>T3</th>
<th>T4</th>
<th>T5</th>
<th>T6</th>
<th>T7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average</td>
<td>4.363</td>
<td>7.848</td>
<td>4.945</td>
<td>7.299</td>
<td>3.383</td>
<td>0.462</td>
<td>1.253</td>
</tr>
</tbody>
</table>

*T1 = 100% NPK, T2 = 100% NPK + 500 kg ha⁻¹ AgriPower, T3 = 100% NPK + 1000 kg ha⁻¹ Minekal, T4 = 100% NPK + Mid-Season Drainage, T5 = 50% NPK + 500 kg ha⁻¹ AgriPower, T6 = 100% NPK as farmer level + 1,000 kg Minekal (Particle Size =3.3 mm) + SRI, T7 = 100% NPK as farmer level + SRI.

![Graph showing emission C-CH₄ for CONVENTIONAL and SRI treatments](image-url)
Fe-toxicity In ACID SULFATE SOILS

Keracunan Fe

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Presented at J-SRI Meeting at University of Tokyo, Japan, 27 September 2012
CONVENTIONAL  SRI

Presented at J-SRI Meeting at University of Tokyo, Japan, 27 September 2012
CONVENTIONAL

SRI

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YIELD INCREASE
63% average in the studies reported below

<table>
<thead>
<tr>
<th></th>
<th>CONVENTIONAL (TON/HA)</th>
<th>SRI (TON/HA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SUGIYANTA (2008)</td>
<td>5.0</td>
<td>7.5</td>
</tr>
<tr>
<td>HERODIAN ET AL. (2008)</td>
<td>5.5</td>
<td>8.9</td>
</tr>
<tr>
<td>ISWANDI ET AL. (2008)</td>
<td>4.5</td>
<td>6.5</td>
</tr>
</tbody>
</table>

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**SRI – MOA PROGRAM**

- 29 PROVINCES (2012)
- 196 DISTRICTS
- >80,000 HA
- LARGER AREA: NGO FARMERS

<table>
<thead>
<tr>
<th>Year</th>
<th>Area (Ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2007</td>
<td>1,100</td>
</tr>
<tr>
<td>2008</td>
<td>1,320</td>
</tr>
<tr>
<td>2009</td>
<td>1,840</td>
</tr>
<tr>
<td>2010</td>
<td>1,240</td>
</tr>
<tr>
<td>2011</td>
<td>1,140</td>
</tr>
<tr>
<td>2012</td>
<td>60,000</td>
</tr>
</tbody>
</table>

SRI AVERAGE YIELD 7.25 TONS/HA
NATIONAL AVERAGE YIELD 4.90 TONS/HA
AVERAGE INCREASE OF 48%

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S.R.I NEEDS MORE STUDY:

AGRONOMY
SOIL AND SOIL BIOLOGY
MANAGEMENT
ENVIRONMENTAL IMPACTS
PEST AND DISEASES
WEED SCIENCE: WEEDERS, ETC.
POST-HARVEST
NUTRITIONAL VALUES
SOCIAL-ECONOMY ASPECTS
FARMER INCOMES
CULTURE
GENDER

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PROF DR ISWANDI ANAS KULIAH UMUM DIES NATALIES UNB 30 JULI 2011

Presented at J-SRI Meeting at University of Tokyo, Japan, 27 September 2012
IPM-SRI WORKSHOP IN UKM MALAYSIA 12-13 SEPTEMBER 2012  ORGINIZED BY SRI-MAS ATTENDED BY 202 PARTICIPANTS

Presented at J-SRI Meeting at University of Tokyo, Japan, 27 September 2012
Presidential Candidate for 2014-2019  Prabowo Subianto

Presented at J-SRI Meeting at University of Tokyo, Japan, 27 September 2012