Simulating rice yield in Bangladesh

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Rice simulation models

- Over 30 simulation models (as literature shows). In addition, there are few disease & pest models
- Four approaches:
  - Wageningen: Current IRRI models
  - USA: Ceres models under DSSAT platform
  - Japan: Simple models (SIMREW, VSM)
  - Australia: APSIM platform (previous model “maNage Rice”)
“RYSIM” & Why another model?

- RYSIM is a revised version of “RIBHAB” model based on Wageningen approach (*Agricultural Systems*, 1994, Volume 46, Issue 3)

- RYSIM
  - is much simpler than IRRI models
  - has few processes newly developed
  - is built in MS-Excel (no programming skill required)
  - is transparent & easy to modify and/or calibrate
The model “RYSIM”

- RYSIM simulates potential yield of transplant rice, not constrained by water, nutrition & yield suppressors except for weather
- Model iteration: 1 day
- Inputs:
  - Weather: Daily maximum & minimum temperature, solar radiation (or sunshine hours) and seasonal CO$_2$ concentration
  - Crop planting: Date of seeding & age of seedlings to be transplanted
  - Model iteration: 1 day
- Outputs: All growth & development attributes including yield
The blue-print of the model “RYSIM”
Model testing and application using ‘BRRI dhan29’ for Boro rice (winter irrigated rice)
Model testing: Mymensingh, seedling age 36 days

Data source: PhD Thesis 2016, Department of Agronomy, Bangladesh Agricultural University (BAU)
Model simulation: seasonal & regional yield variation

Mymensingh: 7821±554 kg ha⁻¹
Gazipur: 6617±650 kg ha⁻¹
± is 95% confidence interval

Seedling age: 45 days
Time of transplanting: 10 January
Model simulation: seasonal & regional yield variation

<table>
<thead>
<tr>
<th>Location</th>
<th>Intercept</th>
<th>Coefficient: Low T induced sterility</th>
<th>Coefficient: High T induced sterility</th>
<th>P</th>
<th>R²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mymensingh</td>
<td>8628.42</td>
<td>-70.47</td>
<td>-80.01</td>
<td>0.02</td>
<td>0.68</td>
</tr>
<tr>
<td>Gazipur</td>
<td>8225.32</td>
<td>-55.61</td>
<td>-85.85</td>
<td>0.001</td>
<td>0.95</td>
</tr>
</tbody>
</table>
Model simulation: yield $\times$ transplanting time in 2009-10

**Grain yield**

- **Mymensingh**: $78524 \pm 1657$ kg ha$^{-1}$
- **Gazipur**: $3496 \pm 1944$ kg ha$^{-1}$

**Sterility (%)**

- **Mymensingh**
- **Gazipur**

**Time of transplanting**

Seedling age: 45 days
Growing season: 2010-11

Low temperature induced sterility
High temperature induced sterility

$\pm$ is 95% confidence interval
## Model simulation: climate change, Mymensingh region

<table>
<thead>
<tr>
<th>Year</th>
<th>CO₂ (ppm)</th>
<th>Grain yield (kg ha⁻¹) by transplanting date</th>
<th>High temperature induced grain sterility (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1-Jan</td>
<td>15-Jan</td>
</tr>
<tr>
<td>2000-11</td>
<td>379</td>
<td>7719</td>
<td>7359</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0%)</td>
<td>(0%)</td>
</tr>
<tr>
<td>2029-30</td>
<td>427</td>
<td>6486</td>
<td>5833</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(16%)</td>
<td>(21%)</td>
</tr>
<tr>
<td>2069-70</td>
<td>503</td>
<td>5767</td>
<td>2367</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(25%)</td>
<td>(68%)</td>
</tr>
</tbody>
</table>

Seedling age: 36 days
Future of the model “RYSIM”

- RYSIM, at its current state, has potential for estimating yield and production of Boro rice (irrigated winter rice) in Bangladesh – needed weather data.
- RYSIM can be modified and/or further simplified to estimate yield and production in other seasons (Aus and Transplant Aman) in Bangladesh
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