2012 Forecasted Corn Yield Potential based on simulations using Hybrid-Maize model

Patricio Grassini, Haishun Yang, and Kenneth G. Cassman

Department of Agronomy and Horticulture
University of Nebraska-Lincoln
July 1st, 2012
Hybrid-Maize model

- Simulates growth and development of corn for yield potential and water-limited situations.
- Temperature-driven growth and development functions from CERES-Maize
- Mechanistic descriptions of light interception, photosynthesis and organ-specific respiration from generic models (SUCROS/INTERCOM/WOFOST)
- A linear relationship between growing degree-days (GDD) from emergence to silking and GDD from emergence to physiological maturity is used for prediction of day of silking

Hybrid-Maize

A simulation model for corn growth and yield

H.S. Yang
A. Dobermann
K.G. Cassman
D.T. Walters

User-friendly, robust, minimal input parameters, publicly available at:
http://www.hybridmaize.unl.edu/
Crop models: tools to predict yield potential

- Daily intercepted solar radiation: \[ f_x = \text{solar radiation, LAI} \]
- Length crop cycle
- Cumulative intercepted solar radiation
- Gross assimilation
- Maintenance Respiration
- Growth respiration
- Dry matter production
- Temperature
- Water supply

[around silking] Kernel #

- Kernel weight
- Kernel growth rate
- Grain-filling duration

YIELD POTENTIAL
Validation of Hybrid Maize

Validation of Hybrid-Maize model for irrigated and rainfed crops grown under no nutrient limitations and kept free of diseases, insect pests, and weeds.

Hybrid-Maize does not account for nutrient deficiencies, insect pests, diseases or weeds.

Grassini et al., (2009), Agric. For. Meteoro. 149, 1254-1265
In-season yield forecasting

Using real-time climate data for a growing season:
- Estimate actual yield potential or water-limited yield based on actual + historical daily records of solar radiation, temperature, and rainfall.
- Decision aid for:
  - comparing growth with normal years/other years.
  - adjusting yield goal and making adjustments in fertilizer amounts (sidedress, fertigation)
  - evaluating soil moisture and making decisions on irrigation
  - marketing decisions (farmers)
  - grain purchasing decisions (feedlots, ethanol plants)
  - overall corn production forecasts (policy makers, crop insurance, markets, etc.)

Example 1: 2003 forecasted dryland corn yield at Mead NE

Sowing date: 30 April, Pioneer 114d RM, 26k plants ac⁻¹, loam soil, fully-recharged profile at planting. Long-term simulated yield: 206 bu ac⁻¹; 2003 simulated yield: 159 bu ac⁻¹
Example 2: 2004 forecasted irrigated corn yield at Mead NE

Sowing date: 30 April, Pioneer 114d RM, 30k plants ac⁻¹
Long-term simulated yield: 236 bu ac⁻¹; 2003 simulated yield: 258 bu ac⁻¹

Simulations were performed every 7 days based on actual weather until the date of the yield forecast and historical weather data to simulate the rest of the season; this gives a range of possible yields by the end of the season.

Note that the range of possible yields narrows as the crop approaches maturity.
Simulated locations across the U.S. Corn Belt

Stars indicate the sites for which in-season yield forecasting were performed using the Hybrid-Maize model with actual weather and dominant management practices and soil series at each site.

Weather data were retrieved from High Plain Regional Climate Center (HPRCC) and the Water and Atmospheric Resources Monitoring Program (WARM) through the Illinois Climate Network (Illinois State Water Survey [ICWS], Prairie Research Institute, University of Illinois at Urbana-Champaign).
## 2012 In-season Yield Potential Forecasts using UNL Hybrid-Maize Model

<table>
<thead>
<tr>
<th>Location, state</th>
<th>Water regime</th>
<th>Soil type &amp; initial water</th>
<th>PP (ac⁻¹)</th>
<th>RM (days)</th>
<th>Planting date†</th>
<th>Long-term Yp (bu/ac)‡</th>
<th>2012 forecasted Yp (bu/ac)</th>
<th>75th</th>
<th>Median</th>
<th>25th</th>
</tr>
</thead>
<tbody>
<tr>
<td>Holdrege, NE</td>
<td>Irrigated</td>
<td>Silt loam 100% ASW</td>
<td>32.4k</td>
<td>113</td>
<td>April 27</td>
<td>248</td>
<td>257</td>
<td>241</td>
<td>228</td>
<td></td>
</tr>
<tr>
<td>Clay Center, NE</td>
<td>Irrigated</td>
<td>Silt clay loam</td>
<td>32.4k</td>
<td>113</td>
<td>April 23</td>
<td>250</td>
<td>263</td>
<td>244</td>
<td>232</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Rainfed</td>
<td></td>
<td>24.0k</td>
<td>113</td>
<td>April 23</td>
<td>146</td>
<td>153</td>
<td>123</td>
<td>103</td>
<td></td>
</tr>
<tr>
<td>Mead, NE</td>
<td>Irrigated</td>
<td>Silt clay loam 100% ASW</td>
<td>32.4k</td>
<td>113</td>
<td>April 30</td>
<td>240</td>
<td>251</td>
<td>234</td>
<td>218</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Rainfed</td>
<td></td>
<td>28.0k</td>
<td></td>
<td></td>
<td>160</td>
<td>173</td>
<td>145</td>
<td>129</td>
<td></td>
</tr>
<tr>
<td>Concord, NE</td>
<td>Irrigated</td>
<td>Silt loam 100% ASW</td>
<td>32.4k</td>
<td>104</td>
<td>May 3</td>
<td>235</td>
<td>244</td>
<td>232</td>
<td>223</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Rainfed</td>
<td></td>
<td>29.0k</td>
<td></td>
<td></td>
<td>154</td>
<td>180</td>
<td>148</td>
<td>110</td>
<td></td>
</tr>
<tr>
<td>O’Neill, NE</td>
<td>Irrigated</td>
<td>Sandy loam 100% ASW</td>
<td>32.4k</td>
<td>106</td>
<td>May 3</td>
<td>225</td>
<td>255</td>
<td>231</td>
<td>221</td>
<td></td>
</tr>
<tr>
<td>Brookings, SD</td>
<td>Rainfed</td>
<td>Silt clay loam 100% ASW</td>
<td>30.0k</td>
<td>98</td>
<td>May 4</td>
<td>120</td>
<td>150</td>
<td>132</td>
<td>99</td>
<td></td>
</tr>
<tr>
<td>Sutherland, IA</td>
<td>Rainfed</td>
<td>Silt clay loam 100% ASW</td>
<td>31.4k</td>
<td>99</td>
<td>May 1</td>
<td>168</td>
<td>190</td>
<td>157</td>
<td>127</td>
<td></td>
</tr>
<tr>
<td>Gilbert, IA</td>
<td>Rainfed</td>
<td>Loam 100% ASW</td>
<td>32.4k</td>
<td>110</td>
<td>April 26</td>
<td>200</td>
<td>227</td>
<td>187</td>
<td>171</td>
<td></td>
</tr>
<tr>
<td>Nashua, IA</td>
<td>Rainfed</td>
<td>Loam 100% ASW</td>
<td>32.4k</td>
<td>99</td>
<td>May 1</td>
<td>198</td>
<td>225</td>
<td>191</td>
<td>156</td>
<td></td>
</tr>
<tr>
<td>Monmouth, IL</td>
<td>Rainfed</td>
<td>Silt loam 100% ASW</td>
<td>32.4k</td>
<td>112</td>
<td>April 27</td>
<td>212</td>
<td>229</td>
<td>186</td>
<td>161</td>
<td></td>
</tr>
<tr>
<td>DeKalb, IL</td>
<td>Rainfed</td>
<td>Silt clay loam 100% ASW</td>
<td>32.4k</td>
<td>111</td>
<td>May 1</td>
<td>201</td>
<td>252</td>
<td>197</td>
<td>165</td>
<td></td>
</tr>
<tr>
<td>Bondville, IL</td>
<td>Rainfed</td>
<td>Silt clay loam 100% ASW</td>
<td>32.4k</td>
<td>114</td>
<td>April 20</td>
<td>197</td>
<td>206</td>
<td>156</td>
<td>140</td>
<td></td>
</tr>
</tbody>
</table>

† Simulations based on dominant soil series, average planting date, and plant population (PP) and relative maturity (RM) of most widespread hybrid at each location (Grassini et al., 2009). ‡ Average (20+ years) simulated yield potential (Yp)