Lessons learnt from a transAtlantic comparison

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Goals

= More *nutritious and tasty* food
= From less land
= Fewer exotic pesticide and fertilizer inputs
= Less water input
= Less carbon output

How do we do it?
Nina Fedoroff: “The science is quite clear” on the benefits of GM crops.

“The reason farmers turn to genetically modified crops is simple: yields increase and costs decrease.”
Comparative analysis of North America vs. Western Europe

- Same hemisphere
- Same latitudes
- Equal access to advance biotechnologies
- Elite germplams
- Mechanised and educated sector

Source: Heinemann et al. International Journal of Agricultural Sustainability
### Country comparisons vs Meta analysis

<table>
<thead>
<tr>
<th>Country comparisons</th>
<th>Meta analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Potentially benefits from long term big scale measures providing statistical strength</td>
<td>Potentially assembles strong statistical power from robust side by side comparisons</td>
</tr>
<tr>
<td>Lacks replication because only one Earth</td>
<td>Tend to be short term, small scale studies of variable input data (eg, farmer surveys mixed with measures of yield)</td>
</tr>
<tr>
<td></td>
<td>In practice, have excluded most robust individual studies that contradict conclusions</td>
</tr>
</tbody>
</table>

http://rightbiotech.tumblr.com/post/103665842150/correlation-is-not-causation

http://www.inbi.canterbury.ac.nz
The story of maize

Low germplasm biodiversity
Depleted soils requiring high external inputs
Reduced farmer contribution/power
Reducing farmer choice
High pesticide use
Concentration of breeder power

How did we get here?
Maize yield comparisons


Western Europe  United States

no statistically significant difference
Projected maize yield increases


Europe outpacing US on projections
Resilience (maize)


United States

Linear (United States)

89 trillion kcals

coefficient of variation

US: 14    W. Europe: 11
Rapeseed yield

Rapeseed Yield 1961-2011

- Canada
- Western Europe + (Total)

$y = 391.67x + 16606$
$y = 179.46x + 8013$

97% GM
First GM
Projected yield increases


European yields increasing faster
**US Pesticide Use**

- **Insecticide**
- **Herbicide**

<table>
<thead>
<tr>
<th>Year</th>
<th>Insecticide</th>
<th>Herbicide</th>
</tr>
</thead>
<tbody>
<tr>
<td>1995</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>2007</td>
<td>85</td>
<td>108</td>
</tr>
</tbody>
</table>

- Insecticide down
- Herbicide up

Source: Heinemann et al International Journal of Agricultural Sustainability
No GM crops
insecticide DOWN
herbicide DOWN

Source: Heinemann et al International Journal of Agricultural Sustainability
Lessons from the history of innovation in US Agriculture

- Relatively low yields
- High pesticide use
- Concentration of breeder power
  - Low germplasm biodiversity
  - Reduced farmer contribution/power
- Reducing farmer choice
Europe meets or exceeds US yields with no GM

Agriculture is not just genes, it is breeding, management and social good

GM is not the cause:
• of germplasm concentration;
• farm size increases and diversity decreases;
• loss of farmer knowledge and contribution as breeders;
• yield stagnation;
• subsidies.

GM contributes to and accelerates these trends.
Criticism: why measure such a large period?

**US Maize Yield Trend Lines Sequentially Varying by 1 Year of Data**

- X United States to 2010
- • United States to 2011
- • United States to 2012
- Linear (United States to 2010)
- Linear (United States to 2011)
- Linear (United States to 2012)

<table>
<thead>
<tr>
<th>Period</th>
<th>change in slope</th>
</tr>
</thead>
<tbody>
<tr>
<td>2001-2010</td>
<td>baseline</td>
</tr>
<tr>
<td>2001-2011</td>
<td>decreased 28%</td>
</tr>
<tr>
<td>2001-2012</td>
<td>decreased another 78%</td>
</tr>
</tbody>
</table>
Yields flat during 90% of GM period

**US vs. W Europe Maize Yields 2001-2012**
- United States 2001-2012
- Western Europe 2001-2012
- Linear (United States 2001-2012)
- Linear (Western Europe 2001-2012)

<table>
<thead>
<tr>
<th>Period</th>
<th>slope (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2001-2012 US</td>
<td>~flat m=250</td>
</tr>
<tr>
<td>2001-2012 Western Europe</td>
<td>positive m=1200</td>
</tr>
</tbody>
</table>
Yields decline during 75% of GM period

<table>
<thead>
<tr>
<th>Period</th>
<th>slope (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2005-2012 US</td>
<td>negative m=-1230</td>
</tr>
<tr>
<td>2005-2012 Western Europe</td>
<td>positive m=2520</td>
</tr>
</tbody>
</table>
In contrast, Europe consistent
Industrial European Ag not the answer either

<table>
<thead>
<tr>
<th>Region</th>
<th>Number of countries represented</th>
<th>Number of projects analysed</th>
<th>Number of farmers in projects (million)</th>
<th>Number of hectares under organic and near-organic agriculture (million ha)</th>
<th>Average change in crop yields compared with beginning of projects (per cent)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Africa (all countries with data)</td>
<td>24</td>
<td>114</td>
<td>1,900,000</td>
<td>2.0</td>
<td>+116</td>
</tr>
<tr>
<td>East Africa</td>
<td>7 (Kenya, Malawi, Tanzania, Ethiopia, Uganda, Zambia)</td>
<td>71</td>
<td>1,600,000</td>
<td>1.4</td>
<td>+128</td>
</tr>
<tr>
<td>East Africa (countries focused upon within this study)</td>
<td>3 (Kenya, Tanzania and Uganda)</td>
<td>44</td>
<td>1,300,000</td>
<td>1.2</td>
<td>+120</td>
</tr>
<tr>
<td>Kenya</td>
<td>1</td>
<td>18</td>
<td>1,000,000</td>
<td>0.5</td>
<td>+179</td>
</tr>
<tr>
<td>Tanzania</td>
<td>1</td>
<td>9</td>
<td>27,000</td>
<td>0.06</td>
<td>+67</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>17</td>
<td>241,000</td>
<td>0.68</td>
<td>+54</td>
</tr>
</tbody>
</table>

Yields do not necessarily mean that organic agriculture is more or less inherently inherently increases vary depending on the type of project and the crops/livestock.
Future directions

1. technological innovation and improvements in technologies that support agroecological and compatible methods should be the priority

2. these technologies must be customised as necessary to the adopting agroecosystem and societies (e.g., sub-Saharan Africa vs. Argentina’s pampas)

3. the main incentive should be sustainable societies rather than pursuit of intellectual property, or the invention of intellectual property instruments that deliver sustainable outcomes rather than counter-productive biotechnologies such as GM
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