**Problem**
Heavy metal is polluting soil in the Pearl River Delta, South China
- Food is still grown
- Significant health risks

**Causes**
Rapid development of agriculture, industrial, and traffic practices

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**Solution: Sustainable Phytoremediation**
Using sunflowers to remove heavy metal from soil

- Sunflower seeds donated to farmers in PRD
- Farmer donates a portion of seeds to neighboring farm
- Plant waste is sold to recycling companies as biofuels
- Sunflowers harvested after about 100 days
- Sunflowers pull nutrients from soil through their roots...
- ...While naturally extracting heavy metals in the process
- Farmers plant sunflower seeds alongside their existing crops

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**Costs**
- Takes 5-10 years
- Labor cost ↑
- Seed transportation
- Sunflower seeds: ≤ $30 per acre

**Benefits**
- Yield ↑
- Sunflowers can be recycled as biofuel
- ALL polluting metals are remediated
- Aesthetically pleasing
- Economically feasible
- Productivity ↑

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**Heavy Metals: Concentrations in PRD**

<table>
<thead>
<tr>
<th>Heavy Metal</th>
<th>Current Concentration (mg/kg)*</th>
<th>Non-Polluted Concentration (mg/kg)*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cadmium</td>
<td>1.4 to 1.8</td>
<td>&lt; 0.3</td>
</tr>
<tr>
<td>Copper</td>
<td>11.0 to 41.0</td>
<td>&lt; 25</td>
</tr>
<tr>
<td>Lead</td>
<td>23.0 to 83.0</td>
<td>&lt; 40</td>
</tr>
<tr>
<td>Zinc</td>
<td>36.0 to 149.0</td>
<td>&lt; 40</td>
</tr>
<tr>
<td>Mercury</td>
<td>0.29 ± 0.26</td>
<td>&lt; 0.42</td>
</tr>
<tr>
<td>Chromium</td>
<td>46.7 ± 27.7</td>
<td>&lt; 25</td>
</tr>
<tr>
<td>Arsenic</td>
<td>20.0 ± 20.8</td>
<td>&lt; 20</td>
</tr>
</tbody>
</table>

*Taken from (Hu, 2013), (Chang, 2013), (Bai, 2011)

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**Conclusions/Recommendations**
- Goal: concentrations of the heavy metals decrease by 50% after 10 years
- Expand use of phytoextraction crops, such as the sunflower, to other affected locations
  - 12% of worldwide soil is polluted

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**References**

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**Soil Testing**
- Inexpensive: $12-$100
- Cost of test covered by selling sunflowers for biofuel

**Test**
- Soil tested for heavy metals biannually at professional labs

**Results**
- Compile data to evaluate solution

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**Soil Testing Solution: Sustainable Phytoremediation**
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**Sunflower Power: Phytoextraction in Action**
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